Extinction

Future of Agriculture Curriculum for Teaching Sustainability

Name: _____ Hour_____Date: _____

Date Packet is due:_____ Why late? _____Score: _____
Day of Week Date If your project was late, describe why

Overview: in this unit, you will be learning about the causes of extinction of living organisms.

Main Questions

- How are levels of biodiversity affected by the location on the planet of an ecosystem and by the process of natural selection?
- What is an extinction? How is it different from a mass extinction?
- How do today's rates of extinctions compare to previous mass extinctions?
- What are the primary causes of extinction today?
- How many species are lost per hour on average? Why is this not more noticeable?
- Why are some species more at risk for extinction than others? How does this relate to the extinction vortex?
- What is a niche? What is a keystone species? How do these concepts relate to the risk of extinction for a species?
- What legal tools exist to prevent extinctions?

Weekly Schedule

Monday:
- Introduction to Extinction – Data Dive

Tuesday:
- Nutshell Video & Notes
- Class discussion & revisions of explanations

Wednesday:
- Habitat Extinction Risk Assessment (*outside – dress appropriately*)

Thursday:
- Review & Assessment

Friday:
- Weekly Reflection
- Career & Community Connections

Semester Schedule

Week 0: Introduction & Lab Safety

Atoms to Ecosystems

Week 1: Matter & Energy
Week 2: Cell Biology
Week 3: Biodiversity & Ecosystems
Week 4: Biodiversity & Habitats Lab
Week 5: Midterm Assessments

Causes of Extinction

Week 6: Extinction
Week 7: Habitat Loss
Week 8: Invasive Species
Week 9: Land & Water Pollution
Week 10: Atmospheric Pollution
Week 11: Overharvesting
Week 12: Midterm Assessments

Sustainable Societies

Week 13: Natural Resources Management
Week 14: Societies & Sustainability
Week 15: Individual Sustainability
Week 16: Personal Campaigns
Week 17: Personal Campaigns

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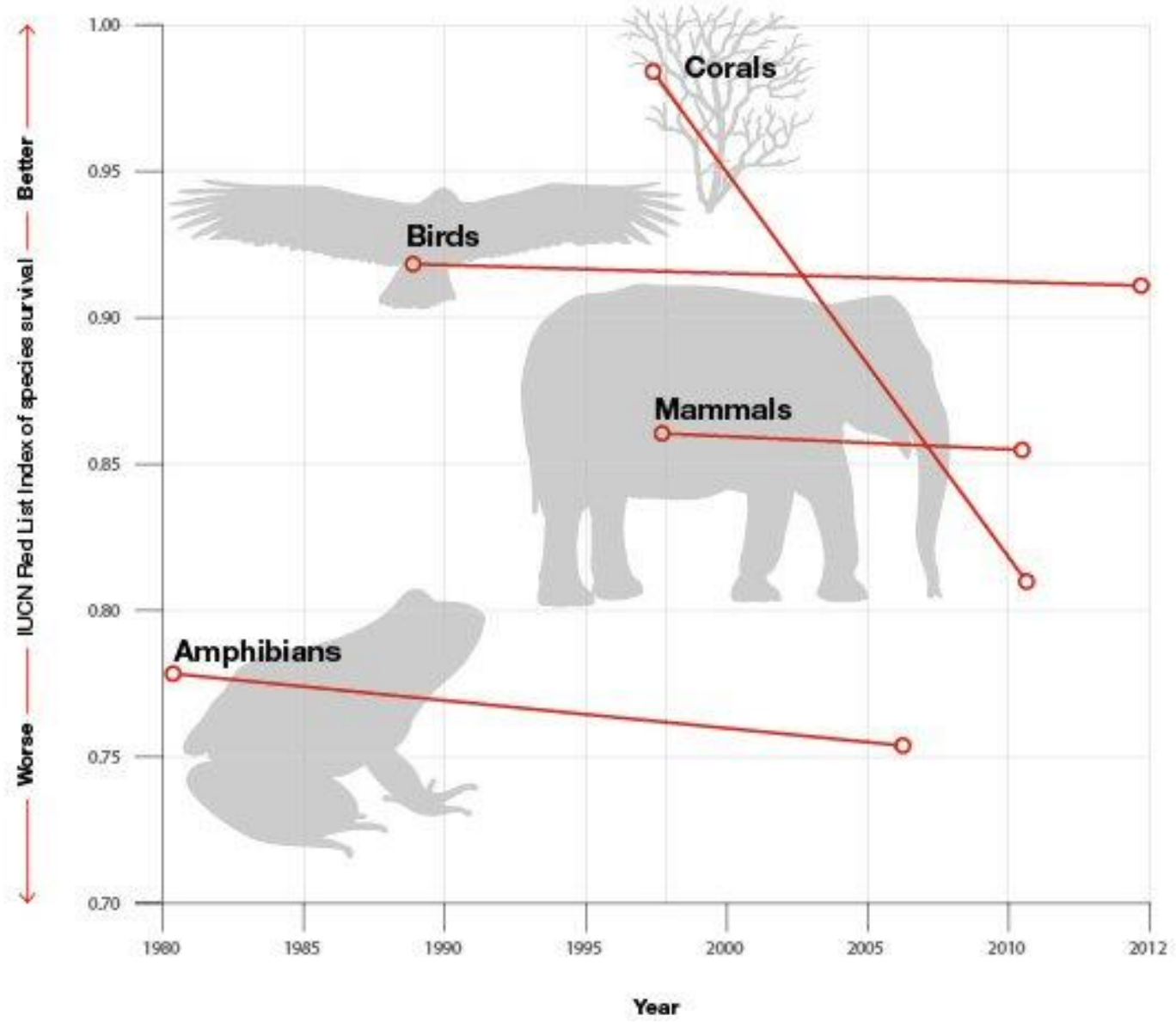
National Science Foundation WHERE DISCOVERIES BEGIN
KBS LTER Kellogg Biological Station Long-term Ecological Research
MICHIGAN STATE UNIVERSITY

Day 1: Data Dive

Intro Video: https://www.youtube.com/watch?v=3vzKIGUb3Xg

Overview: In this activity, your group will review data in order to identify patterns and trends that you will use to develop an explanatory model. You will then compare your observations and explanations to those of other groups in order to check your accuracy and refine your explanatory model.

Directions: look at the data provided below. Then use the data provided to you to answer the questions on the following page. If you are unsure about how to interpret the data, work with your group and seek help from your instructor if necessary. (*Data source: http://www.iucnredlist.org*)



How to read this graph: begin by looking at the x-axis (horizontal axis). Note that this shows the years, starting with 1980 on the left and 2012 on the right. Then look at the y-axis (vertical). Note that this shows the percent of species that survive, or that didn't go extinct. The higher the line, the lower the rate of extinction. The lower the line, the lower the survival and the higher the rate of extinction. Lines that slope down from left to right show an increasing rate of extinction. The steeper the slope down, the faster that species are going extinct.

1. Based on the graphs on the prior page, what is one conclusion that would be supported by this data?
    a. How is this conclusion supported by this data?
    b. What specifically suggests that your claim is accurate?

2. What is a second conclusion that would be supported by this data?
    a. How is this conclusion supported by this data?
    b. What specifically suggests that your claim is accurate?

3. Based on these graphs, how would you describe the rate at which species are going extinct? Are species going extinct at a faster or slower rate than they were 30 years ago? Explain.

    I think species are going extinct at a **faster/slower/similar** rate (*circle one*) because _____

    _____

    _____

4. Based on the data on the previous graph, create a **hypothesis** about future rates of extinction based on t the trends in extinction that are shown in this data.

    I hypothesize that _____

    _____

    I think that this hypothesis is accurate because _____

    _____

5. What do you think are the primary causes for these changes in the rate of extinction? Create a list of five possible causes of this rate of extinction using the space below. Try to be as specific as you can.

    1. _____

    2. _____

    3. _____

    4. _____

    5. _____

    Be prepared to discuss your ideas with other groups and/or as a class.

Day 2: Notes & Discussion

Introduction & Directions: In this activity, you will begin by watching a short video. This will help to clarify some of the questions you may have had yesterday. After the video, you will look at a short slideshow presentation that will provide you with specific information about this topic. Your instructor may decide to deliver the presentation as a classroom lecture or they may allow you to read the notes individually or in small groups (depending on your previous experience and capabilities with this content). After you have watched the video and finished with the slideshow, you will work in small teams to answer the questions listed below. You should take notes in a notebook, on a dry erase board, or on scratch paper so that you are prepared to deliver your responses during the class discussion that will follow. *Note: your instructor may assign your group to answer specific questions if time is limited.*

URL Links
YouTube Video: https://www.youtube.com/watch?v=fnp3ZfUpbyI
Also consider: https://www.youtube.com/watch?v=jphrpR9ffKA

Slideshow Presentation: https://www.factsnsf.org/uploads/1/4/0/9/14095127/2018-5-16_facts_extinction.pptx (or visit factsnsf.org and use the menu bar).

Discussion Questions:

1. What is the latitudinal diversity gradient? How does it relate to the production of biomass, biodiversity, and ecosystem services?
2. How are levels of biodiversity affected by the location on the planet of an ecosystem and by the process of natural selection?
3. What is an extinction? How is it different from a mass extinction?
4. When was the last mass extinction and how did it occur? How do the rate at which species went extinct then compare to the rate of extinction today?
5. What are the four primary causes of extinction today?
6. How many species are lost per hour on average? Why is this not more noticeable?
7. Why are some species more at risk for extinction than others? How does this relate to the extinction vortex?
8. What is a niche? What is a keystone species? How do these concepts relate to the risk of extinction for a species?
9. What is the Endangered Species Act and the Endangered Species List? How do these legal tools work to prevent extinctions?
10. In what was has ESA been successful? How could it be made more successful?

Be sure to revisit your explanations from the previous day's activity and add details or corrections as needed.

Day 3: Habitat Extinctions Risk Assessment

Overview: In this activity, you will be visiting a habitat near your classroom and performing a risk assessment to determine if your habitat is at risk for extinctions due to habitat loss, invasive species, pollution, and/or overharvesting.

Directions: Prior to leaving for this lab, your instructor will provide you with details about the specific area you are visiting. They should show or allow you to use a device to find satellite image of the area to help you to understand how human development in the surrounding area may affect your habitat. They may be able to provide you with some idea of the history and trends in regard to development in that area (e.g. if urban sprawl and human construction have increased, decreased, or remained steadily over the past decade or more). Your instructor may also be able to provide you with photographic guides of invasive species; if not, check to see if it would be ok to use a phone or other device in order to find a state department of natural resources website with information about possible invasive species in your area and how to identify them. An internet search can also provide you with information about potential pollutants in your area as well as hunting and fishing regulations that may pertain to your habitat. Your instructor may also have printed information available about these details.

While you are visiting your nearby habitat, you should use this information to hypothesize about the potential risk for local extinction that living species (plants, animals, fungi, and other species) in your habitat may face. Remember that this is just a hypothesis – due to the limited time and resources available, you will not have much time to make a fully-informed decision. Do the best that you can within the constraints that you have.

If time is too limited, your instructor may likely decide to assign a focus area or two to your group (e.g. three groups might look at habitat loss and invasive species while three other groups may focus on pollution and overharvesting). If you are assigned a topic or two, you only need to complete the sections of the following page that pertain to this focus.

If it is not possible to go outside, your instructor may choose to use remote options, such as internet search engines and satellite images from a source such as Google Maps. They may also have you perform this lab in a habitat outside of class time near your home as an out-of-class assignment.

Habitat Loss: is this habitat at risk for local extinctions due to habitat loss? Yes / Possibly / No

What evidence supports this conclusion? _____

_____

_____

_____

Invasive Species: is this habitat at risk for local extinctions due to invasive species? Yes / Possibly / No

What evidence supports this conclusion? _____

_____

_____

_____

Pollution: is this habitat at risk for local extinctions due to pollution? Yes / Possibly / No

What evidence supports this conclusion? _____

_____

_____

_____

Overharvesting: is this habitat at risk for local extinctions due to overharvesting? Yes / Possibly / No

What evidence supports this conclusion? _____

_____

_____

_____

Day 4: Review & Assessment

Directions: you will begin by reviewing the unit objectives in your small groups. For each objective, rank it as a 1 (*completely unsure*), 2 (*somewhat unsure*), or 3 (*completely sure*) based on your comfort with that objective. After a few minutes of review, your instructor will lead a whole-class review. This is your chance to ask any questions you still might have about the concepts in this unit. Begin with anything you ranked as a "1".

After you have completed the unit review, you will be taking an individual multiple choice quiz and/or a group short answer quiz. These quizzes may be graded in class to help you better understand the question and the correct answer.

Unit Objectives:

1. What is the latitudinal diversity gradient? How does it relate to the production of biomass, biodiversity, and ecosystem services?
2. How are levels of biodiversity affected by the location on the planet of an ecosystem and by the process of natural selection?
3. What is an extinction? How is it different from a mass extinction?
4. When was the last mass extinction and how did it occur? How do the rate at which species went extinct then compare to the rate of extinction today?
5. What are the four primary causes of extinction today?
6. How many species are lost per hour on average? Why is this not more noticeable?
7. Why are some species more at risk for extinction than others? How does this relate to the extinction vortex?
8. What is a niche? What is a keystone species? How do these concepts relate to the risk of extinction for a species?
9. What is the Endangered Species Act and the Endangered Species List? How do these legal tools work to prevent extinctions?
10. In what was has ESA been successful? How could it be made more successful?

Day 5: Career Connections

Directions: Begin with a group and class discussion about the topics of this week. What is still unclear? What is still confusing? What seemed most important to remember? How does this relate to Natural Resources? How does this relate to your potential future career?

Then complete your Resumes. To complete this activity, see the Resumes section of the Supervised Career Experience Packet.

Extinction Individual Quiz

Name: _____Hour_____Date:_____Score:_____/___

Directions: This quiz should be completed on an individual basis. A 3x5 notecard with handwritten notes can be used on this quiz.

1. **The latitudinal diversity gradient is a phenomenon in which…**
    a. Levels of biodiversity remain generally the same regardless of where an ecosystem is found.
    b. The closer you get to the equator, the greater of the biomass production and biodiversity.
    c. The higher the elevation or the further from the equator, the greater the levels of biodiversity.
    d. All of the above.
    e. None of the above

2. **What factors affect the amount of biodiversity in a given area.**
    a. The rate of biomass production in an ecosystem as a result of temperature, light, and moisture.
    b. The amount of time available for random beneficial mutations to occur.
    c. The rate at which extinctions occur in a given area.
    d. All of the above
    e. None of the above.

3. **How does a mass extinction differ from an extinction?**
    a. An extinction occurs when most of the individuals of a species are lost; a mass extinction occurs when no more individuals of that species exist in the world.
    b. A mass extinction occurs when no individuals of a species exist on the planet. An extinction occurs when no living species exist on a continent.
    c. An extinction occurs when a particular species is no longer in existence; a mass extinction occurs when more than 3/4s of species go extinct within a relatively short period of time.

4. **Which of the following best summarizes how the dinosaurs went extinct?**
    a. Almost all species on earth were lost when an asteroid struck the planet, engulfing the entire planet in flames.
    b. Most species continued to exist for tens of thousands of years after the asteroid strike. The reduction in photosynthesis due to the dust from the strike caused most extinctions.
    c. While a lot of species went extinct after the asteroid strike, a lot of species came back from extinction and evolved into new species.
    d. Most dinosaurs went extinct due to human activity.

5. **How do the rates of extinction of species today compare to the last mass extinction, the loss of the dinosaurs due to an asteroid strike 65 million years ago?**
    a. Rates of extinction today are now below normal, while the loss of the dinosaurs was a rapid and immediate event.
    b. Rates of extinction today are near normal, while the loss of the dinosaurs was a rapid and immediate event.
    c. Rates of extinction today are about the same as the rate at which the dinosaurs went extinct after the asteroid strike.
    d. Rates of extinction today are over a hundred times faster than the rates at which the dinosaurs went extinct.

6. **Which of the following is the rate at which species are currently going extinct?**
    a. 150-200 species per day, or about 6-8 species per hour go extinct on average.
    b. 150-200 species per year, or about 3-4 species per week go extinct on average.
    c. 150-200 species per decade, or about 15-20 species per year go extinct on average.
    d. 150-200 species per century, or about 1-2 species per year go extinct on average.

7. **In the space below, list the four primary causes of the current rate of extinction.**

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8. **Which of the following species would be at greatest risk of extinction?**
    a. A medium-sized grazing mammal found across large portions of Asia.
    b. A small rodent that can adapt to multiple environments.
    c. A medium-sized bird that is well suited to human-managed landscapes.
    d. A migrating bird that depends on the presence of specific species of plants.

9. **Which of the following best summarizes the extinction vortex?**
    a. As a species becomes more at risk for extinction, their threatened status becomes more and more apparent.
    b. As a species' population becomes smaller, genetic diversity is reduced, and the species becomes more susceptible to predation and disease, increasing the rate of loss of that species.
    c. As the rate of extinction increases, the willingness of people to take action to stop extinction also increases, which is why the rate of extinction has slowed down.
    d. As a species becomes more at risk for extinction, their rate of evolution also increases so that they can acquire new adaptations to prevent extinction.

10. **What is a species' niche?**

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11. **How does the niche of a species affect the rate at which other species in that ecosystem can go extinct?**
    a. If a species is no longer present to provide ecosystem services, the species that depend on those services are also more likely to go extinct.
    b. If a species is no longer present to provide ecosystem services, other species will evolve to fill that niche in order to prevent extinctions.
    c. If a species is no longer present to provide ecosystem services, the reduced rate of competition in an ecosystem also reduces the risk of extinction for other species.

12. **The loss of a keystone species would _____ the rate of extinction in an ecosystem.**
    a. Increase b. Decrease c. Not affect

13. **Explain your answer for the previous question:**

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14. **True or false: a species that is at risk of extinction in the United States does not receive federal protection unless it is added to the Endangered Species List (ESL).**
    a. True – even if a species is at risk of extinction, it only receives legal protection if it is on the ESL.
    b. False – the primary determinant for federal protection of endangered species is their risk of extinction. Even unlisted species receive protection if they are at risk of extinction.
    c. True – only endangered species have federal protection; threatened species do not receive federal protection until they become endangered.
    d. False – even species on the Endangered Species List lack legal protection in the US.

15. **True or false – the Endangered Species Act has been successful.**
    a. True – 99% of species protected by the ESA have not gone extinct.
    b. False – a large number of threatened and endangered species in the US lack protection under the ESA.
    c. True – the ESA has been a model for many other countries around the world.
    d. False – only 1% of species protected by the ESA have recovered enough to be de-listed.
    e. All of the above are accurate statements.

16. **If the current rate of extinction is as bad as claimed in this lesson, why aren't more people aware of this? List and describe at least two reasons for this.**

17. **Imagine that you post an article about the current rate of extinction on social media. Someone comments on your post, stating that this is not a big deal because extinctions have always occurred throughout the earth's history. How would you respond? Be sure to address the following in your response: 1) background rate of extinction; 2) human activity; 3) biodiversity & ecosystem services.**

Extinction Group Quiz

Names (F&L): _____

_____Hour_____Date:_____Score:_____/___

Directions: This quiz should be completed in your assigned groups. A 3x5 notecard with handwritten notes can be used on this quiz. Each person should take turns writing an answer. Those not writing should be actively working together to create their group's answer. Those who are not actively involved in answering every question may be asked to complete this quiz alone. Record the writer's name after each question.

1. **In the space below, summarize why the current rate of loss of biodiversity is a concern. In particular, you should address the following topics: a) why biodiversity is necessary and valuable to human populations; b) how the current rate of biodiversity loss compares to the normal background rate of extinction; c) how the current rate of biodiversity loss compares to the rate of extinction in previous mass extinctions.**

Writer's Name:

2. **Imagine that after telling someone else about the current rate of extinction, they respond by scoffing and suggest that extinctions don't matter because new species will evolve to replace them. How would you respond? In your response, be sure to include the following: a) how biodiversity originates due to mutations and natural selection; b) the time necessary for evolution by natural selection in comparison to the time it takes for a species to go extinct; c) the randomness of mutations and natural selection in regards to the pressure presented by changing environments.**

Writer's Name:

3. **What is the current rate of species loss per hour? Why is this not more noticeable to the average person if this is estimated rate is accurate?**

Writer's Name:

4. **Are all species at equal risk for extinction? In your response, be sure to address the following: a) geographical considerations; b) the rate at which ecosystem collapse can be observed; and c) the extinction vortex.**

Writer's Name:

5. **The United States was one of the first nations to develop stringent legal tools for preventing species extinctions. In the space below a) describe the primary legal tools that US federal agencies use to prevent extinctions within the US; b) assess the ways in which this approach has been successful; c) determine how these legal options could be made more effective.**

Writer's Name:

Appendix: Data Dives / Case Studies

Overview: Data Dives and Case Studies are exercises in which students are presented with data from experiments or scenarios, and are asked to identify trends and develop explanatory models in a process that is very similar to what actual scientists do on a regular basis.

Directions: Students should consider the data or scenario in their assigned groups. They should work with their group members to make sense of the information provided and try to determine the conclusions that can be drawn from it. Students may struggle with this, especially in their first attempts and particularly if your students have limited experience reading graphs and data tables. It may be necessary for you to project the data onto a large screen and guide students by explaining the steps that you would use to make sense of what is being reported. This may be difficult; just like explaining the steps of tying your shoes can be challenging because you rarely have to think about it, it can be exceptionally challenging for someone who is scientifically literate to identify the thought processes that they use to make sense of data. It may be helpful to jot down your ideas in advance and have them ready prior to the start of this class.

Students are likely to struggle to varying extents. That is ok! Be sure to float from group to group to assist. Be sure to remind group members to help each other out. It might ideal to assign groups with a mix of abilities. Encouraging struggling students to work with their better-prepared peers, and conversely, encouraging high performing students to advance their abilities by working with individuals with different skill sets helps to prepare students for the kinds of situations they will encounter in their careers and personal lives.

Plan to allow for about 15-20 minutes to introduce the activity and review how to interpret this information with your students. About a third to half of the class period should be reserved for allowing students to work in their individual groups. The remaining time should be reserved for intergroup or whole-class discussion so that students can engage in scientific debate and argumentation.

It would a good idea to remind students that the term *argumentation* is used differently between scientists and the general public. While argumentation generally has a negative connotation (such as a “heated argument”), argumentation among scientists is generally very good-natured and polite. The goal is not to “win” an argument but rather to expand the understanding of the phenomenon by all involved. Often scientists on opposing sides of an issue will both change their stance as a result of the improved understanding that results from engaging in argumentation. Similarly, students should not be trying to disprove each other or prove that they have the “right” answer. Rather, students should be examining the differences in their conclusions, the manner in which each conclusion was reached, and the similarities and agreements that exist among different conclusions.

Students may reach a conclusion that is not entirely supported by evidence. The temptation may be to point out errors in their reasoning. However, when students are struggling, they are also likely improving their abilities in evidence-based reasoning, which is one of the most important goals of this kind of instruction. Try to resist the urge to correct student errors; rather, try to probe their understanding and challenge them to re-examine the evidence to check the validity of their conclusions and the conclusions of other groups. Consider using the 9 Talk Moves (next page) to support productive classroom dialogue.

Remember – students should re-visit their explanations and models repeatedly over the course the week. If they don’t get it right on the first try, they will have more opportunities to do so.

Goals for Productive Discussions and Nine Talk Moves

Goal: Individual students share, expand and clarify their own thinking

1. Time to Think:

Partner Talk

Writing as Think Time

Wait Time

2. Say More: "Can you say more about that?" "What do you mean by that?" "Can you give an example?"

3. So, Are You Saying…?:
"So, let me see if I've got what you're saying. Are you saying…?" (always leaving space for the original student to agree or disagree and say more)

Goal: Students listen carefully to one another

4. Who Can Rephrase or Repeat?

"Who can repeat what Javon just said or put it into their own words?" (After a partner talk) "What did your partner say?"

Goal: Students deepen their reasoning

5. Asking for Evidence or Reasoning:

"Why do you think that?" "What's your evidence?" "How did you arrive at that conclusion?" "Is there anything in the text that made you think that?"

6. Challenge or Counterexample:

"Does it always work that way?" "How does that idea square with Sonia's example?"
"What if it had been a copper cube instead?"

Goal: Students think with others

7. Agree/Disagree and Why?:

"Do you agree/disagree? (And why?)" "Are you saying the same thing as Jelya or something different, and if it's different, how is it different?" "What do people think about what Vannia said?"
"Does anyone want to respond to that idea?"

8. Add On:

"Who can add onto the idea that Jamal is building?"
"Can anyone take that suggestion and push it a little further?"

9. Explaining What Someone Else Means:

"Who can explain what Aisha means when she says that?" "Who thinks they could explain in their words why Simon came up with that answer?" "Why do you think he said that?"

Source: https://inquiryproject.terc.edu/shared/pd/TalkScience_Primer.pdf

Appendix: Habitat Extinction Risk Assessment

Overview: In this activity, students will be visiting a habitat near your classroom and performing a risk assessment to determine if this habitat is at risk for extinctions due to habitat loss, invasive species, pollution, and/or overharvesting.

Materials: student smart phones or other personal devices; internet access; computer & projector; state department of natural resources publications on invasive species (with photos for ID), hunting/fishing regulations, and state pollutants; local histories in regard to human development and urban sprawl; pens/pencils.

Directions: a school forest or prairie would be ideal for this activity, but any habitat near your classroom to which you have access will be an option. If you lack this option, you may choose to use a satellite image of a local habitat and scale back the activity to focus only on habitat loss and reports regarding invasive species, hunting and fishing, and pollutants.

If you are able to visit a habitat, the distance of the habitat from your classroom may limit the extent to which your students can complete all components of this lab. If your habitat is a considerable walking distance, you may opt to limit the number of considerations that your students assess. For example, you could assign two considerations per group and divide the considerations equally across all groups. You may also want to use time on the previous day to go over the printed and internet sources in regard to urban sprawl, invasive species, pollutants, and overharvesting to allow for more time if needed.

Because students have not yet covered these topics in detail, their ability to accurately assess these questions will be limited. This is ok. The purpose of this lab is to introduce students to these concepts and to begin to prompt them to wonder and ask questions. This will prepare students to engage in discussions and investigations pertaining to these topics in more detail as they come up in the following weeks.

Be sure to remind students to dress appropriately and to be aware of the weather forecasts for the day of the activity. Make sure that administrators and parents are informed in advance; your school board or administrators may require permission slips to leave the school building. Make sure to take into account students with special needs and students with medical considerations (particularly those with stinging allergies). You should carry a cell phone or other means of communication while outside of the school building, and school administrators and secretaries should know how to reach you on this device.

If time allows, it would be ideal to have students report their findings and conclusions and discuss the validity of their conclusions, as well as their level of confidence in their findings. However, this likely will not be feasible and may have to be postponed or skipped.

Appendix: Review and Asssessment

Introduction: In this section, we will discuss strategies to guide your students during review and assessment for a vocabulary-intensive unit.

While recent reforms to science education (as outlined by the NRC's *K12 Framework* and NGSS) minimize the emphasis on having students learn vocabulary, we have found that we cannot completely eliminate vocabulary from ecological instruction for a number of reasons. Most importantly, we have found that in order for students to sufficiently engage in reasoning and sense-making about ecological phenomena, they need to have an appropriate language with which to develop explanations and solutions.

However, in the FACTS curriculum, we view vocabulary as a *means to an end* and not as a central objective to the curriculum. In other words, we don't care very much whether students have memorized the definitions of terms, but whether they can accurately use those terms to describe and understand phenomena, and ultimately create evidence-based arguments, explanations, and solutions. We view vocabulary as part of a "sense-making toolkit" that enables students to organize their reasoning and argumentation.

As such, we recommend that you provide students with opportunities to practice mastering the vocabulary in this course while also recognizing that mastery of vocabulary is a secondary objective in these units. This means that assessing vocabulary can work as a formative assessment but is not ideal by itself as a summative assessment. The primary goal of this curriculum is to enable valid evidence-based reasoning and sense-making, and your summative assessments should reflect this.

There are a few strategies you might considering adopting to support these objectives:

- While multiple-choice assessments are provided in the weekly packets, we take the stance that these options should not be used by themselves as a final summative assessment.
    - You might consider assigning this as optional homework, allowing students to use a 3x5 card with handwritten notes, and/or assigning completion points in lieu of scores based on the percent correct.
- Teachers have also created hybrids of the multiple choice and short answer assessments, selecting some questions from each option. Their experiences suggest that the multiple-choice assessments help to prepare students for the more intellectually rigorous short answer questions.
- You might also consider having a space on a chalkboard/dry-erase board for publicly posting course vocabulary or hanging a large sheet of paper and adding vocabulary and definitions if students start to struggle.
- Teachers have also used vocabulary practice as an option for a bell-ringer activity, using options such as short, ungraded online quizzes to start class.

You as the instructor are best positioned to decide what will be most effective for your classroom. Feel free to use or disregard these suggestions as you see fit. However, we do strongly recommend that you avoid positioning memorization of vocabulary as one of the primary objectives of this course, and instead emphasize valid reasoning and sense-making about ecological phenomena as your top priority.