ENVIROATLAS

EDUCATIONAL CURRICULUM

CONNECTING ECOSYSTEMS AND HUMAN HEALTH

MODULE DESIGNED FOR 4TH-12TH GRADERS

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PREFACE

The following lesson plan module was created as part of a larger curriculum of activities for educational use to introduce students to *EnviroAtlas* and the concepts of watersheds, pollution, connections between the environment and human health, greenways, and using maps in decision-making. **This lesson plan specifically addresses human health, ecosystem services, ecosystems, and the environment.** Additional lesson plan modules are available and forthcoming to address a variety of other topics directed at a range of grade-levels and ages.

There is also an **Educational Overview** document that outlines some of the tools in *EnviroAtlas* for educators who wish to design their own lesson plans around the available *EnviroAtlas* tools. We encourage you to look over the Educational Overview document to determine how *EnviroAtlas* can best meet your needs. All Educational materials can be found here: https://www.epagov/enviroatlas/enviroatlas-educational-materials

For questions regarding this case study and supplemental materials, please contact the *EnviroAtlas* Team at EnviroAtlas@epa.gov.

While this document has been reviewed and approved by the U.S. Environmental Protection Agency, its contents do not necessarily reflect the views and policies of the Agency.

Note: This document is an updated version of the "Connecting Ecosystems and Human Health" module and replaces EPA Report #EPA/600/R-17/310. The following change was made:

- All notecards for the "String Activity" have been appended to the end of the document. Previously they were only available online.

ACKNOWLEDGMENTS

These educational materials were developed though the joint efforts of multiple contributors. At the time of publication, 504 participants, of which 408 were students, had participated in these specific Eco-Health activities, thus contributing to their ongoing improvement.

Thanks to Jennifer Cypra who worked on making the existing notecards in the *String Activity* usable for upper elementary students and contributed heavily to the Elementary portion of this lesson. Jen is a K-5 AIG (Academically and Intellectually Gifted) teacher who was an EPA Kenan Fellow during the summer of 2017.

Thanks also to our non-classroom teacher reviewers, Jessica Daniel: Environmental Specialist, US EPA National Exposure Research Laboratory, Kelly Witter: Director of STEM Outreach, US EPA National Exposure Research Laboratory and Lauren Bamford: US EPA Student Services Contractor. Their feedback was extremely valuable in the completion of this product.

Lastly, thanks to our classroom teachers as well as their students for carrying out and reviewing this *EnviroAtlas* Lesson Plan. We learned much from these pilot tests and utilized the students' and teachers' feedback to adjust and edit the Lesson Plan.

- Alex LeMay, 8th grade Science teacher, *Durham School of the Arts (2017)*
- Kristin Riley, AP Environmental Science/Earth Science teacher, *Orange High School (2017)*
- Jennifer Cypra, K-5 AIG teacher, *Grady A. Brown Elementary School* (2017)

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Lesson Plan

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Connecting ecosystems and human health

A lesson plan module that gets students outdoors, online, and thinking about connections

This lesson can be done with or without internet.

Suggested Grades: 4-12

Suggested Topics: human health, ecosystems, ecosystem services, systems, connections, interdependence

Key Concept: Scientific literature shows that there are multiple linkages between the environment and human health outcomes.

Time Considerations
Prep Time: 30 minutes
Outdoors: up to teacher (at least 10 minutes recommended)
Eco-Health Relationship Browser: 50-70 minutes

Materials: computer(s), internet, speakers, notecards (provided), yarn

NGSS Standards *(State Standards in back)*: 4ESS3-1, 4ESS3-2, 3-5ETSI-1, 3-5ETSI-2, MS-LS2-4, MS-LS2-5, HS-ESS2-2, HS-ESS2-5, HS-ESS3-1, HS-ESS3-3, HS-ESS3-4, HS-ESS3-6. NGSS Science & Engineering Practices: 1, 4, 7, 8.

Learning Objectives

By the end of this lesson module, students will be able to:

- Define, describe, and explain ***ecosystem services*.**
- Describe characteristics of ecosystems, including local ecosystems on or near their school grounds (ecosystem type will vary based on outdoor availability near the school, such as: forested area, creek, pond, meadow, field, etc.).
- Describe the relationships of ecosystems in their local area and human health.
- Support their explanations with scientific evidence.

Key Words/Vocabulary

aesthetics	benefit	biodiversity	conservation
ecosystem	ecosystem services		habitat
human health	mitigation	recreation	

Summary

This module follows the **BSCS 5E model** to promote student discovery and learning about the complex interactions between the environment, ecosystem services, and human health outcomes.

This module incorporates an outdoor lesson, an optional hands-on lesson, and a web-based tool developed by the US Environmental Protection Agency (EPA) called the ***Eco-Health Relationship Browser***. The *Eco-Health Relationship Browser* is an easy-to-use, interactive tool that illustrates scientific evidence for linkages between human health

and ecosystem services, which are the benefits that humans receive from nature. The tool links ecosystems (including urban ecosystems), ecosystem services, and human health outcomes[1].

Students are prompted first to explore the concept of ecosystem services, then to examine their own local environment outdoors and how it may contain ecosystem services, and finally to consider the relationships between ecosystem services and human health.

ECOSYSTEM SERVICES

Ecosystem goods and services, often shortened to ecosystem services (ES), are the benefits that humans receive from nature. These benefits underpin almost every aspect of human well-being, including our food and water, security, health, and economy.

[1] The Eco-Health Relationship Browser currently includes six ecosystem services that relate beneficially to human health issues, as reported in the scientific literature. The web tool highlights linkages that may be unfamiliar to the general population; it does not document well-known associations between public health and ecosystem "goods" such as food, fiber, and other materials. Terms to describe ecosystem services are not standardized and may vary slightly across reference materials.

At-a-glance Summary

Teaching Strategies	Student/teacher actions
Engage, Option 1: Videos	Students are prompted to consider the concept of ecosystem services by viewing one to three videos and answering corresponding questions to help explain and clarify the concept of ecosystem services. Video #1: (2:14 minutes) EnviroAtlas: Connecting People, Ecosystems, Health, and the Economy Video #2: (3:52 minutes) Ecosystem Services 101 with Hank, Video #3: Ecosystem services (9:02 minutes).
Engage, Option 2: What Am I?	Students wear the Eco-Health notecards hanging on their backs. Asking their classmates only yes or no questions, students try to guess what the card is on their backs.
Explore	**Outdoors Lesson:** Students walk to a spot on campus outdoors. Students are asked questions to explore the various interactions of the ecosystem and to describe ecosystem services in their local community. **Eco-Health Relationship Browser Lesson:** Students investigate the connections between human health and the environment using a handout and the *Eco-Health Relationship Browser* online.
Explain	**Outdoors Lesson:** While outdoors, the teacher asks leading questions and the students discuss the local aspects of ecosystem services. Students evaluate and explain how the environment is the life-support system for humans, then students answer questions on the handout. **Eco-Health Relationship Browser Lesson:** Students choose two human health outcomes that are of interest to them from the listed human health outcomes on the *Eco-Health Relationship Browser* and present the details of the connections between ecosystem services and human health to neighboring groups (pair-share).
Elaborate	**String Lesson:** Students use the provided human health notecards and physical pieces of string to visualize the relationships between ecosystems, ecosystem services and human health. Students discuss associations.
Evaluate	Teacher can evaluate student understanding during the two portions of student presentations as well as after students complete the handout. There are two versions of the handout.

Time Considerations

5E Stage	Part of Lesson	Suggested Time
Engage	Videos	15 minutes
Explore	Outdoors	10-60 minutes
Explore & Explain	Online Eco-Health Browser	15-20 minutes
Elaborate	Eco-Health String Exercise	20-45 minutes
Evaluate	*Handout: could be homework if out of time*	

Teacher Preparation

General:

Students should have a basic understanding of environmental concepts (what an ecosystem is, etc.) and human health (knowledge of certain organ systems would help, but is not necessary for the success of the lesson).

Part 1, Engage, Option 1: Videos

1. Either assign the videos for homework or set up the video(s) on the teacher computer and make sure that internet connection is good enough to stream the video(s). URLs for videos: EnviroAtlas: Connecting People, Ecosystems, Health, and the Economy: https://www.youtube.com/watch?v=ZMU8ZLsCmUM, **Ecosystem Services 101 with Hank:** https://www.youtube.com/watch?v=N2whWWYSh6M, **Ecosystem Services:** https://www.youtube.com/watch?v=BCH1Gre3Mg0
2. Print student handouts, ***Connecting ecosystems and human health.***

Part 1, Engage, Option 2: What Am I?

1. Set up supplies (print, cut and laminate [*optional*] notecards. Tie string to the notecards.).
2. Select which human health outcome cards that you're going to use.
3. Write the ecosystem services, ecosystems, and/or human health outcomes that you're going to use on the white board so that students know what their options are.
4. Pick a space large enough for all students to mingle and ask each other questions about the cards on their backs.

Part 2: Explore, Outdoors Lesson

1. Choose a location outdoors, on the school grounds, and within walking distance that can be investigated safely with students.
2. Make sure the trip outside of the classroom is approved through all required channels.
3. Print teacher handout, ***"Teacher Handout: Getting Outdoors."***

Part 2: Explore and Part 3: Explain, *Eco-Health Relationship Browser*

1. Acquire supplies (computers [group computers will work fine], internet connection, links to websites [Note to teachers: links are embedded within student handouts: *make handouts available online to be clicked if students have printed handouts*]).

2. If students will be working in small groups, make student groups. You can let students self-select their groups based on their interests in specific ecosystem services if you wish (example: Air Quality, Water Quality, etc.)

Note to the teacher: There is an *Eco-Health Relationship Browser* data '*cheat sheet*' online so that you can access the connections and the 500+ citations with abstracts in a table-format: *https://enviroatlas.epa.gov/enviroatlas/Tools/EcoHealth_RelationshipBrowser/relationBrowser.xml*

Part 4: Elaborate, *Eco-Health Relationship Browser & String Exercise*

1. Be sure that you are familiar with the *Eco-Health Relationship Browser* so that you can assist students as they explore the tool.
2. Consider watching the Eco-Health Relationship Browser demo video for help (2:00 minutes). You can even show the demo video for the students if you think that it will help them to get acquainted with the tool.
3. ***String exercise***. Set up supplies (print, cut and laminate [*optional*] notecards, then add strings to each notecard so that students can wear the cards around their necks [*optional—students can also just hold the cards if you don't have time*]).
4. Pick a space large enough for all students to stand shoulder-to-shoulder in a circle.
5. Guide the students through the string exercise. Another option is for students to remain in their seats and discuss the notecards while the teacher draws the "web" of connections on the board.

Part 5: Evaluate

1. Be prepared to navigate around the room and help students think about the Evaluation questions. Prompt students to think more deeply about the connections between ecosystem services and human health. Encourage students to respond thoughtfully about the last question, piecing together their experiences outdoors and the connections they learned about from the browser.

Procedure

Engage, Option 1: Videos—15 MINUTES

1. Introduce ecosystem services (*benefits that humans receive from nature*). Play the following video(s) for the students: Video #1: (2:14 minutes) EnviroAtlas: Connecting People, Ecosystems, Health, and the Economy Video #2: (3:52 minutes) Ecosystem Services 101 with Hank and/or Video #3: (9:02 minutes) Ecosystem services. Allow students time during the videos to answer questions.

Engage, Option 2: What Am I?—15 MINUTES

1. Notecards are also available online. Select which notecards you are going to use based on the number of students in your classroom. Write the names of the notecards that you selected on the board so that students know what the possibilities are while they are making their guesses during the exercise.
2. Place the notecards around students' necks so that the cards are on the students' backs. Make sure that students can't see which cards they have.
3. Have students ask each other yes or no questions until they determine which cards they have on their backs.

   Example for Forests:

   - *Do I have buildings? No.*
   - *Do I help the environment? Yes.*
   - *Do I contain water? Yes/Maybe.*
   - *Do I contain trees? Yes.*
   - *Am I "Wetlands"? No.*
   - *Do people hike and camp where I am? Yes.*
   - ***Am I "Forests"? Yes.***

Explore, Outdoors Lesson—TEACHER'S CHOICE FOR TIME (10-60 MINUTES)

This activity invites students to explore their local environment and their ecosystem by walking outdoors to a location of the teacher's choosing. The location could be anywhere on campus that relates to ecosystem services, including, but not limited to: a stream, creek, garden, wooded area, field, meadow, walking trail, urban greenspace, etc.

The goal of this portion of the lesson is to **connect students to their local environment** and encourage them to **think about and interact with their local environment**. The lack of opportunity for outdoor experiences has been associated with declines in independent thinking and problem-solving abilities (Louv, 2005), so this portion of the lesson serves to a) directly connect the students to the subject matter and b) strengthen their intellectual development via interaction with nature.

1. Safely walk with students to a spot on campus outdoors that pertains either to "Recreation and Physical Activity" or to "Aesthetics & Engagement with Nature" (i.e. a walking trail through the woods, a wooded area, a sports field, a playground, a meadow or field, etc.). If none of these spaces are available, perhaps you can hang a

bird feeder outdoors somewhere and you all can go to the bird feeder to observe and discuss this portion of the lesson.

2. Ask the students questions to explore the various interactions of the ecosystem and to consider ecosystem services. Sample questions can be found later in this document.

Explore and Explain, *Eco-Health Relationship Browser*—15-20 MINUTES

1. Go through some of the first steps with the students to help them navigate to the website. You can do this with the Student Instruction Sheet or instructions written on a white board (see Photo 1 for an example of what one teacher did).
2. Let students explore the *Eco-Health Relationship Browser* using the Student Instruction Sheet and their Student Handout.
3. *Optional:* Once students have finished filling in their charts, have students (or student groups) present their human health impacts to the class. If computers are available, students can make a quick PowerPoint presentation to present.

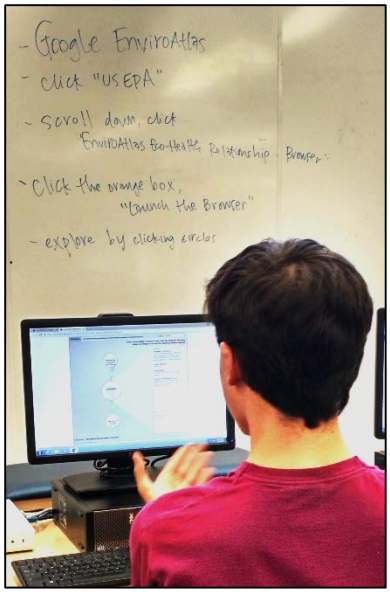
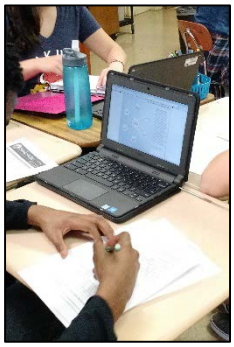


Photo 1: Instructions for using the Browser written on the board.



Photos 2 and 3: Students can use computers in a computer lab (top) or their own classroom laptops if available (left).

Elaborate—20-45 MINUTES (*can be extended or shortened as necessary*)

String Exercise—*a visual and hands-on way for students to see connections between human health and ecosystem services (see Figures and Photos below for visuals)*

Option	Time	Description	Benefits
***Interactive Demo**	**Round One:** 10-15 minutes **Round Two:** 10-20+ minutes	Students wear notecards with information and use an actual ball of yarn to draw connections between ecosystems, ecosystem services, and human health outcomes.	Great visual, interactive and hands-on, thought-provoking, gets students moving and potentially outdoors.
Discussion at desks	**Round One:** 10 minutes **Round Two:** 10+ minutes	Students still get the notecards, but remain seated at their desks for discussion of interconnections—no yarn.	Good when space does not allow for interactive demo.

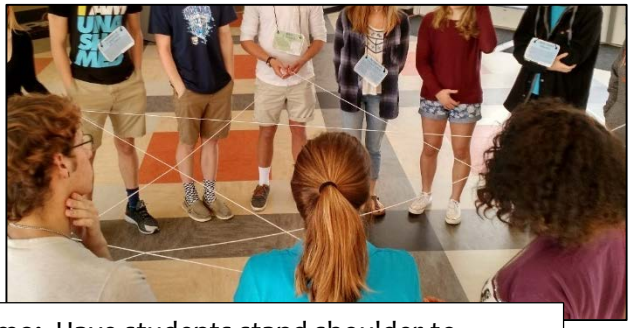
***The lesson is written for **the Interactive Demo**, although there is a short section on how to adapt the lesson to be a short discussion at desks if that is the teacher's preference.*

Round One—Connecting Ecosystems to Ecosystem Services—10-15 minutes

Option one: Interactive Demo. Suggested class size: 15-30; allow more time for more students.

Round One can be completed either prior to the computer session as an exploratory session or after the computer session.

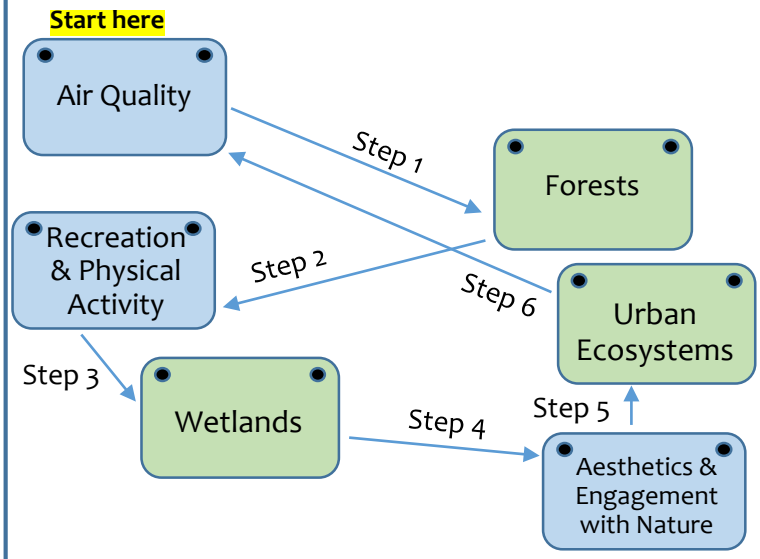
1. Give students either a green notecard (ecosystem) or a blue notecard (ecosystem service). Since there are fewer of these cards, students may have to be in pairs or groups of three. Pre-made notecards are available in this packet. Review or teach the vocabulary term "mitigation" at this time.
2. If students are in a small group per notecard, have the students spend a few moments with their partner or small group reading their card and discussing how their notecard relates to ecosystems and/or ecosystem services.



Photos 4 and 5. **Round One, Interactive Demo:** Have students stand shoulder-to-shoulder and wear the green and blue cards to make connections.

3. Have all of the students stand in a tight, shoulder-to-shoulder circle and wear their notecards (see Photos 4 and 5).
4. Start with an **ecosystem service (blue card)**. Give that student the ball of yarn. For this example, we'll use **"Air Quality."** Have the student read or summarize their card to the group. Have the student describe what they know about how **Air Quality** is related to an **ecosystem** (such as **Forests**, for example).
   Have that student start with the ball of yarn and pass the yarn to an **ecosystem** (**Forests**, in this example) that is connected to their **ecosystem service**.
5. Then, after the student holding the **ecosystem** (**Forests**, in this example) receives the ball of yarn, they hold on to the string and pass the ball of yarn to someone with another ecosystem service that is connected to **Forests** (**Recreation & Physical Activity**, for example [i.e. hiking, fishing, mountain biking, etc.]). Encourage discussion during the hand-offs.

The series below is an *example* of how the first few steps of the *String Exercise, Round One* might look. The blue arrows represent the string. *Keep in mind that yours may be different from this example.*



Note: The links should be from a blue card to a green card and then back to a blue card (ecosystem service → ecosystem → ecosystem service → ecosystem), etc.

6. **Recreation & Physical Activity** would then hold the string and pass the ball of yarn to another **ecosystem** that is related, such as **Wetlands.**
7. Continue until all of the students have made a connection somehow, being sure to make time for student discussion during the hand-offs.

If the yarn "dead ends," cut the string, have the student hold it, and re-start a new strand with a new ecosystem or ecosystem service. If this happens, remind the students that everything is not necessarily connected to everything else.

8. When all students have been involved in the connection, debrief with the class while students are still holding the yarn like a web. If you run out of time before all of the students have connected, make sure to address the students who did not get to read their cards. When they're done answering questions, the teacher can either roll the yarn back up or (if running out of time) cut the yarn, have students drop the yarn, and grab the yarn to be untangled later.

Round One—Connecting Ecosystems to Ecosystem Services—10-15 minutes

Option Two: Discussions at desks.

1. Give students either a green notecard (ecosystem) or a blue notecard (ecosystem service). Since there are fewer of these cards, students may have to be in pairs or groups of three. Pre-made notecards are available in this packet. Review or teach the vocabulary term "mitigation" at this time.
2. If students are in a small group per notecard, have the students spend a few moments with their partner or small group reading their card and discussing how their notecard relates to ecosystems and/or ecosystem services.
3. Write the ecosystems and ecosystem services on the board. Have students speak about their cards as you draw arrows to show the connections on the board (see Photo 6 for an example).
4. Go over the Debrief Questions with the class.

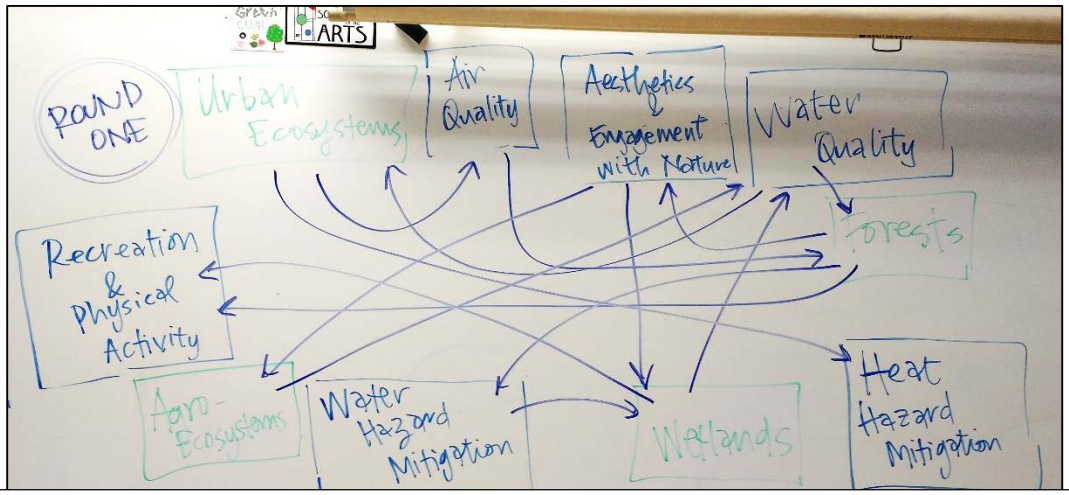


Photo 6. **Round One, Students at Desks:** As students discuss the connections, draw linking arrows on the board at the front of the room.

ROUND ONE – DEBRIEF QUESTIONS

For both options (Interactive Demo and Discussion at Desks)

The teacher should ask the students to discuss the following questions (for Option 1, while the students are still holding the string so that they can have a visual while they answer the questions):

- How important are ecosystems to ecosystem services?
- What is at least one way that you might think differently about ecosystems when you're outdoors or in a local ecosystem?
- What happens to the ecosystem services when the ecosystems get degraded?
- What is at least one thing that surprised you during **Round One**?

Round Two—Connecting Ecosystem Services to Human Health Outcomes—10-20+ minutes

Option One: Interactive Demo

Teaching Tip #1: Most teachers who piloted this lesson preferred for students to do the computer portion of the lesson using the Eco-Health Relationship Browser **prior to** completing **Round Two.**

Teaching Tip #2: If you have a small class and you want more students to have human health outcome cards, you can tie the blue ecosystem service cards to a chair (see example in the photo to the right) and then hand out more human health outcome notecards to the students.

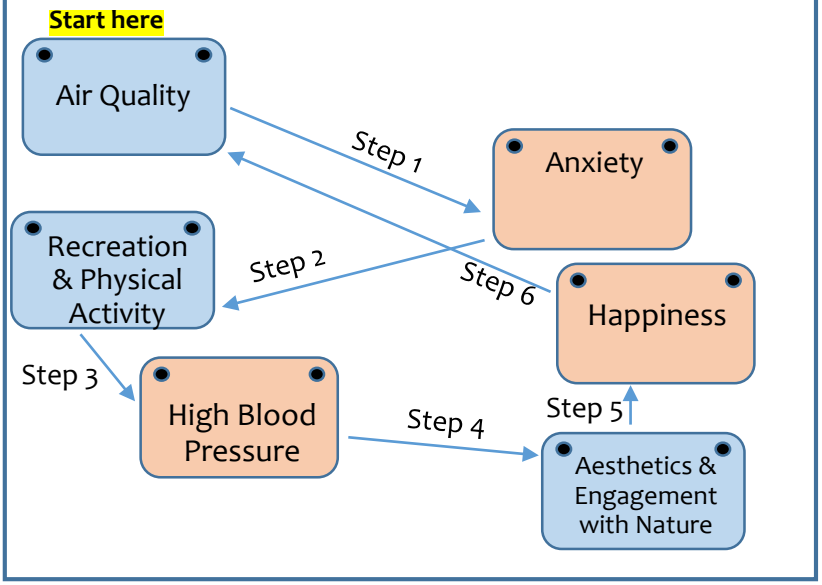
1. In this second round, give out the **blue cards** again for ecosystem services. The remaining students should receive **human health outcome** cards (orange cards). If possible, try to give students health outcome cards that match what they are already researching so that they can present on a human health outcome that is of interest to them.

   Note: There are two versions of the notecards with varying levels of information on them in this packet. One set has human health connections on the back and another set does not—teachers may want to use cards with less information for higher-level students, such as AP Environmental Science students, so that the students have to recall the connections themselves. Teachers of students

without internet will want to use the double-sided notecards with the Eco-Health connections on the backs of the cards.

2. Have all of the students stand in a circle and wear their notecards.
3. Start with an **ecosystem service (blue card)**. For this example, we'll use **"Air Quality."** Have the student read or summarize their card. If it does not have text, have the student describe what they know about how **Air Quality** can impact **human health** and how it is related to various **ecosystems**. Have that student start with the ball of yarn.

The series below is an example of how the first few steps of the *String Exercise, Round 2* might look. The blue arrows represent the string. *Keep in mind that yours may be different from this example.*



4. Students who have a **human health outcome** that is linked to **Air Quality** (such as Anxiety, for example) should volunteer to read their card. **Teacher: choose one of the students who volunteered to read or summarize their card.**
5. Have the student who read "**Air Quality**" pass the yarn ball to the student who volunteered or you chose (for example, Anxiety).
6. For this example, have the student holding the "Anxiety" card read their card and add any information that they researched using the Eco-Health Relationship Browser.
7. Then, have the student list the additional related ecosystem services **other** than Air Quality. In the Anxiety example, these are "Aesthetics & Engagement with Nature," "Heat Hazard Mitigation," and "Recreation & Physical Activity." If the only associated ecosystem service is **Air Quality**, then the student should read that.

8. Have the student pass the ball of yarn to a student that is wearing one of the ecosystem services cards that was just read.
   Note: The links should be from a blue card to an orange card and then back to a blue card (ecosystem service → human health outcome → ecosystem service → human health outcome), etc.
9. Repeat steps 4-8 until all of the human health outcome cards have been read and the yarn has connected at least once to all students.
10. When all students have been involved in the connection, debrief with the class.

Potential Teachable Moments in the String Activity:

1. ***Incorrect Assumptions:*** Students might try to "wing it" or make up connections that are not supported by scientific literature in the Eco-Health Browser (such as, "*Water Hazard Mitigation makes me stressed.*" While that may be true for that student, it is not one of the links in the Eco-Health Relationship Browser). Encourage students to use actual facts or statistics from their research or from the backs of their cards. Also encourage students to use the image on their card to confirm their connections.

2. ***Public Health terminology:*** **Round Two** presents a good time to discuss the differences between ***causation*** and ***correlation/association***. Just because greenness near a mother's home has a positive **correlation** with birth weight in newborns, it does not necessarily mean that the greenness **causes** a healthy-weight newborn. You could facilitate this discussion by having students brainstorm other reasons why the association might be present, factoring in other elements such as accessibility, demographics, etc.

3. ***Connections to Math/Statistics:*** **Round Two** also presents an opportunity to discuss the importance of sample size for studies. Next to each statistic or fact, there is an "n=##." Feel free to explain to students that *n* is equal to the number of subjects in the study. Have students discuss what implications that sample size might have for scientific research.

If the yarn "dead ends," or there are no student volunteers who have human health outcomes that match the given ecosystem service, cut the string, have the student hold it, and re-start a new strand with a new ecosystem or ecosystem service. If this happens, remind the students that everything is not necessarily connected to everything else.

Round Two—Connecting Ecosystem Services to Human Health Outcomes—10+ minutes

Option Two: Discussions at desks.

1. In this second round, give out the **blue cards** again for ecosystem services. The remaining students should receive **human health outcome** cards. If possible, try to give students health outcome cards that match what they are already researching so that they can present on a human health outcome that is of interest to them.
2. Allow students 2-3 minutes to read their cards and prepare a fact or statement to say when it is their turn.
3. Start with an ecosystem service (blue card, example: **Air Quality**). Say to the class:
    - **"Raise your hand if your health outcome is connected to Air Quality."** Go around the room and have the students say their health outcome. Pick one of them to explain how their card is connected to Air Quality. Then ask them to list another ecosystem service that they are connected to. Say to the class:
    - **"Raise your hand if your health outcome is connected to _____."** Repeat this process until most of the students have shared their health outcome and made a connection to an ecosystem service.

ROUND TWO – DEBRIEF QUESTIONS

For both options (Interactive Demo and Discussion at Desks)

The teacher should ask the students to discuss the following questions (for Option 1, while the students are still holding the string so that they can have a visual while they answer the questions):

- How important are ecosystems to human health? *Review some examples.*
- Is everything connected to everything else? *(No wrong answer; discuss why.)*
- If all of a sudden, **Air Quality** (or some other ecosystem service) was drastically decreased (*have the person or chair holding **Air Quality** let go of the strings*), how would that affect the rest of the system?
- How can two ecosystem services affect the same human health issue?
- What is at least one way that you might think differently about ecosystems when you're outdoors or in a local ecosystem?
- How can protecting the environment be important to you or the people you love on a personal level? Do you have anyone in your family with asthma? Arthritis? [Insert any health outcome here.] How could keeping ecosystems intact potentially help those family members?
- What is at least one thing that surprised you during **Round Two**?

Evaluate—An answer key to the handout is included in this module.

Hopefully, some of the teacher evaluation of student understanding has already taken place during the student discussions as part of the **Elaborate** portion of the lesson (the **String Exercise** is a great exercise for facilitating discussion among students).

In addition, the teacher can evaluate student understanding by looking over and grading the student handout.

EnviroAtlas
people health nature economy
Lesson Plan
www.epa.gov/enviroatlas

Connecting ecosystems and human health by getting outdoors

This activity invites students to explore their local environment by walking outdoors to a location of the teacher's choosing. The location could be anywhere on campus including, but not limited to: a stream, creek, wooded area, meadow, field, or garden.

The goal of this portion of the lesson is to **connect students to their local environment** and encourage them to think about and interact with their local environment. The lack of opportunity for outdoor experiences has been associated with declines in independent thinking and problem-solving abilities (Louv, 2006), so this portion of the lesson serves twin goals: 1) to directly connect the students to the subject matter and 2) to strengthen their intellectual development via interaction with nature.

If you live in an urban area and your outdoor resources are limited, you could also try a local urban park, baseball field, or soccer field (use the **field, meadow, or open area Additional Questions** below). If those are unavailable, take the students out to the local blacktop or basketball court, and have them lie on their backs and look at the clouds.

Before asking any questions of the students, once you get outside, make sure that all of the students feel comfortable and safe, prior to asking the questions below. It might help to give the students a little bit of time (5-10 minutes) to get their bearings and adjust to being outside. You can have them sit quietly and sketch, free-write, or just observe for 5-10 minutes prior to asking them questions, for example.

***Note to the teacher*:** Students that don't spend a lot of time outdoors might have a more difficult time with this exercise on days when the weather is poor. If you have a group that might not spend a lot of time outdoors, try to do this exercise on a nice, sunny, warm day. This will be beneficial for both you and the students.

Guiding Questions: General

- Where are we located on or off campus right now?
- Take a deep breath. How do you feel being in the environment quietly for 5-10 minutes?
- How do you think that the environment that we are in right now could have a positive impact on human health?
- How could human disruption of this environment (like pollution, for example) have a negative impact on human health?
- How much time per day do you usually spend outdoors (including sports, P.E. class, etc.)?
- Does being in the environment make you feel more or less [calm/stressed/anxious/happy/peaceful/relaxed]?
- Are there any local areas in your town where you spend time outdoors (local greenway, local trail in the woods, a park, etc.)? Do you enjoy spending time there? Why or why not? If not, what might make you able to enjoy yourself more in those places?
- Some topics that you could ask the students about include:
    - **Air Quality:** Clean air, air pollution—What are sources of air pollution?
    - **Water Quality:** Drinking water contamination, potential sources of local water pollution—What are potential sources of water contamination?
    - **Heat Hazard Mitigation:** How do you feel in the middle of summer when it is very hot outside? How might heat affect human health?
    - **Water Hazard Mitigation:** Have areas locally experienced any floods recently? What was that like?
    - **Aesthetics & Engagement with Nature:** What is the difference between walking in a park or on a greenway versus walking through a parking lot? Do you ever look at images of nature? How does that make you feel?
    - **Recreation & Physical Activity:** What do you most enjoy doing outdoors?

Feel free to add questions as you wish.
Encourage students to elaborate and be as specific as possible.

Louv, R. (2006). *Last child in the woods: Saving our children from nature-deficit disorder*: Chapel Hill, NC: Algonquin Books of Chapel Hill.

Eco-Health Relationship Browser Data, Teacher's Guide

All connections can be found online at the following website:
https://enviroatlas.epa.gov/enviroatlas/Tools/EcoHealth_RelationshipBrowser/relationBrowser.xml

Resources *(on following pages)*

EnviroAtlas
people health nature economy
Lesson Plan Standards
www.epa.gov/enviroatlas

STATE EDUCATIONAL STANDARDS

4th GRADE, ALL 50 STATES & DC

These Standards have been collected from individual State websites (1/2017). They have been connected to themes that are available in an EPA tool called *EnviroAtlas*.

State (last updated on this chart, Standards adoption year)	**4th grade Science Educational Standards that apply to the "Connecting ecosystems and human health" module**
AL (1/2017, 2015)	12. Evaluate engineered solutions to a problem created by environmental changes and any resulting impacts on the types and density of plant and animal populations living in the environment (e.g., replanting of sea oats in coastal areas due to destruction by hurricanes, creating property development restrictions in vacation areas to reduce displacement and loss of native animal populations).
AK (1/2017, 2012)	None.
AZ (1/2017, 2005)	Strand 3, Concept 1: PO 1. Describe how natural events and human activities have positive and negative impacts on environments (e.g., fire, floods, pollution, dams). PO 2. Evaluate the consequences of environmental occurrences that happen either rapidly (e.g., fire, flood, tornado) or over a long period of time (e.g., drought, melting ice caps, the greenhouse effect, erosion). Strand 3, Concept 3: PO 3. Analyze the effect that limited resources (e.g., natural gas, minerals) may have on an environment. PO 4. Describe ways in which resources can be conserved (e.g., by reducing, reusing, recycling, finding substitutes).
AR (1/2017, 2005)	ESS.8.4.2 Analyze the impact of using natural resources. ESS.8.4.5 Evaluate the impact of Arkansas' natural resources on the economy, including but not limited to • farming • timber • tourism • hunting • fishing ESS.8.4.6 Evaluate human use of Arkansas' natural resources on the environment, including but not limited to • mining • clear cutting • dredging
CA (1/2017, 2009)	**4-ESS3-1.** Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. **4-ESS3-2.** Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans. **3-5-ETS1-1.** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. **3-5-ETS1-2.** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

CO (1/2017, 2009)	Standard 2, Life Science, Concept 3: There is interaction and interdependence between and among living and nonliving components of ecosystems.
CT (1/2017, 2015)	NGSS (see CA above).
DC	NGSS (see CA above).
DE (1/2017, 2013)	NGSS (see CA above).
FL (1/2017, 2014)	SC.4.L.17.4, Recognize ways plants and animals, including humans, can impact the environment. A. Plants and animals, including humans, interact with and depend upon each other and their environment to satisfy their basic needs. B. Both human activities and natural events can have major impacts on the environment.
GA (1/2017, new standards up 2017-2018)	S4L1. Obtain, evaluate, and communicate information about the roles of organisms and the flow of energy within an ecosystem. c. Design a scenario to demonstrate the effect of a change on an ecosystem. (Clarification statement: Include living and non-living factors in the scenario.)
HI (1/2017, 2005)	None.
ID (1/2017, 2016)	None.
IL (1/2017, 2011)	NGSS (see CA above).
IN (1/2017, 2016)	4.ESS.4 Develop solutions that could be implemented to reduce the impact of humans on the natural environment and the natural environment on humans. 3-5.E.2 Construct and compare multiple plausible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
IA (1/2017, 2016)	4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.
KS (1/2017, 2013)	NGSS (see CA above).
KY (1/2017, 2013)	4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.
LA (1/2017, 2016)	72. Predict and describe consequences of the removal of one component in a balanced ecosystem (e.g., consumer, herbivores, nonliving component) (SE-E-A2).
ME (1/2017, 2013)	NGSS (see CA above).
MD (1/2017, 2013)	NGSS (see CA above).

MA (1/2017, 2016)	None.
MI (1/2017, 2015)	NGSS (see CA above).
MN (1/2017, 2009)	4.1.2.2.2. Engineering design is the process of identifying problems, developing multiple solutions, selecting the best possible solution, and building the product.
MS (1/2017, 2010)	4d. Describe how human activities have decreased the capacity of the environment to support some life forms. (DOK 2) • Reducing the amount of forest cover • Increasing the amount of chemicals released into the atmosphere • Farming intensively
MO (1/2017, 2008)	Strand 4: A, Grade 4: b. Identify and describe different environments (i.e. pond, forest, prairie) support the life of different types of plants and animals. Strand 4: D, Grade 4: a. Identify examples in Missouri where human activity has had a beneficial or harmful effect on other organisms (e.g., feeding birds, littering vs. picking up trash, hunting/conservation of species, paving/restoring green space)
MT (1/2017, 2016)	1.1 develop the abilities necessary to safely conduct scientific inquiry, including (a step-by-step sequence is not implied): (a) asking questions about objects, events, and organisms in the environment, (b) planning and conducting simple investigations 1.6 identify how observations of nature form an essential base of knowledge among the Montana American Indians 5.2 describe a scientific or technological innovation that impacts communities, cultures, and societies 5.3 simulate scientific collaboration by sharing and communicating ideas to identify and describe problems 5.4 use scientific knowledge to make inferences and propose solutions for simple environmental problems
NE (1/2017, 2010)	5.1.1.f Develop a reasonable explanation based on collected data. 5.1.1.g Share information, procedures, and results with peers and/or adults. 5.3.3 Students will describe relationships within an ecosystem. 5.3.3.d Recognize all organisms cause changes, some beneficial and some detrimental, in the environment where they live.
NV (1/2017, 2014)	NGSS (see CA above).
NH (1/2017, 2016)	S:SPS1:4:1.7 Ask questions about objects, organisms and events in their local environment.

	S:SPS1:4:1.8 Pose questions to investigate and practical problems to solve. S:SPS1:4:5.2 Determine if an observation or measurement supports a given scientific explanation. S:SPS2:4:2.1 Demonstrate that if something consists of many parts, the parts usually influence one another. S:SPS2:4:4.2 Understand that some changes are so slow or so fast that they are hard to see. S:SPS3:4:1.1 Be able to complete an assigned task when given a specific role in a group. S:SPS3:4:1.2 Communicate ideas to others. S:SPS3:4:1.3 Give specific feedback about work of others. S:SPS3:4:2.1 Demonstrate a basic conservation action such as recycling or a schoolyard habitat project. S:SPS3:4:2.2 Develop questions based upon their observations about the natural world and design a simple investigation. S:SPS3:4:2.3 Develop questions that help them learn about the environment; and design and conduct simple investigations. S:SPS3:4:2.4 Locate and collect information about the environment and environmental and natural resources topics. S:SPS3:4:2.5 Use reliable information to answer questions. S:SPS3:4:2.6 Organize information to search for relationships and patterns concerning the environment and environmental topics. S:SPS3:4:2.7 Identify and investigate issues in their local environments and communities. S:SPS4:4:1.1 Access information from a variety of media sources (e.g., Internet, CD-ROM programs, print resources). S:SPS4:4:1.3 Analyze and compare data from a variety of age-appropriate sources such as newspapers and websites. S:SPS4:4:2.1 Use a variety of tools and formats (oral presentations, journals, and multimedia presentations) to summarize and communicate the results of observations. S:SPS4:4:6.1 Plan and conduct a scientific investigation in group settings. S:SPS4:4:6.2 Engage in group decision making activities. S:SPS4:4:6.3 Role-play different points of view on an issue.
NJ (1/2017, 2013)	NGSS (see CA above).
NM (1/2017, 2009)	Strand I: Scientific Thinking and Practice Standard I: K-4 Benchmark II: Use scientific thinking and knowledge and communicate findings. 1. Communicate ideas and present findings about scientific investigations that are open to critique from others.

	Strand II: Content of Science Standard II (Life Science): Understand the properties, structures, and processes of living things and the interdependence of living things and their environments. Strand III: Science and Society Standard I: K-4 Benchmark I: 1. Know that science has identified substances called pollutants that get into the environment and can be harmful to living things.
NY (1/2017, 2015)	NGSS (see CA above).
NC (1/2017, 2011)	4.L.1.1. Give examples of changes in an organism's environment that are beneficial to it and some that are harmful. 4.L.1.3. Explain how humans can adapt their behavior to live in changing habitats (e.g. recycling wastes, establishing rain gardens, planting trees and shrubs to prevent flooding and erosion).
ND (1/2017, 2014)	4.1.1. Explain changes in the real world using a model (e.g., erosion, volcano, stream table, wing designs for airplanes) 4.6.1. Evaluate the effects of technology on people and the environment (e.g., new construction, oil drilling, electric cars) 4.7.1. Identify consequences of natural and human induced environmental changes (e.g., erosion, tsunami, deforestation) 4.7.2. Identify ways in which science and technology have greatly improved human lives (e.g., food quality and quantity, transportation, health, sanitation, communication) 4.8.1. Identify a variety of careers in the field of science
OH (1/2017, 2014)	Ohio State Science Standards are not numbered or coded in any way: Earth's surface has specific characteristics and landforms that can be identified.
OK (1/2017, 2014)	4-ESS2-2 Students who demonstrate understanding can: Analyze and interpret data from maps to describe patterns of Earth's features. 4-ESS3-1 Students who demonstrate understanding can: Obtain and combine information to describe that energy and fuels are derived from renewable and non-renewable resources and how their uses affect the environment. 4-ESS3-2 Students who demonstrate understanding can: Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.
OR (1/2017, 2014)	NGSS (see CA above).
PA (1/2017, 2002)	3.3.4.A4 Recognize Earth's different water resources, including both fresh and saltwater. 3.4.4.B1 Describe how **technology** affects humans in various ways.

	3.4.4.B2 Explain how the use of **technology** affects the environment in good and bad ways.
RI (1/2017, 2013)	NGSS (see CA above).
SC (1/2017, 2014)	**4.S.1A.1** Ask questions that can be (1) answered using scientific investigations or (2) used to refine models, explanations, or designs. **4.S.1A.2** Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others. **4.S.1A.4** Analyze and interpret data from informational texts, observations, measurements, or investigations using a range of methods (such as tabulation or graphing) to (1) reveal patterns and construct meaning or (2) support explanations, claims, or designs. **4.S.1A.6** Construct explanations of phenomena using (1) scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams. **4.S.1A.8** Obtain and evaluate informational texts, observations, data collected, or discussions to (1) generate and answer questions, (2) understand phenomena, (3) develop models, or (4) support explanations, claims, or designs. Communicate observations and explanations using the conventions and expectations of oral and written language.
SD (1/2017, 2015)	4-ESS2-2 Analyze and interpret data from maps to describe patterns of Earth's features. 4-ESS3-1 Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. 4-ESS3-2 Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.
TN (1/2017, 2009)	GLE 0407.Inq.1 Explore different scientific phenomena by asking questions, making logical predictions, planning investigations, and recording data. GLE 0407.T/E.1 Describe how tools, technology, and inventions help to answer questions and solve problems. GLE 0407.T/E.2 Recognize that new tools, technology, and inventions are always being developed. GLE 0407.T/E.3 Identify appropriate materials, tools, and machines that can extend or enhance the ability to solve a specified problem. GLE 0407.T/E.4 Recognize the connection between scientific advances, new knowledge, and the availability of new tools and technologies. GLE 0407.T/E.5 Apply a creative design strategy to solve a particular problem generated by societal needs and wants. GLE 0407.2.1 Analyze the effects of changes in the environment on the stability of an ecosystem.

	GLE 0407.7.2 Evaluate how some earth materials can be used to solve human problems and enhance the quality of life.
TX (1/2017, 2014)	112.15. a3. The study of elementary science includes planning and safely implementing classroom and outdoor investigations using scientific processes, including inquiry methods, analyzing information, making informed decisions, and using tools to collect and record information, while addressing the major concepts and vocabulary, in the context of physical, earth, and life sciences. Districts are encouraged to facilitate classroom and outdoor investigations for at least 50% of instructional time. 112.15.a4A-B. (A) Within the natural environment, students know that earth materials have properties that are constantly changing due to Earth's forces. The students learn that the natural world consists of resources, including renewable and nonrenewable, and their responsibility to conserve our natural resources for future generations. They will also explore Sun, Earth, and Moon relationships. The students will recognize that our major source of energy is the Sun. (B) Within the living environment, students know and understand that living organisms within an ecosystem interact with one another and with their environment. The students will recognize that plants and animals have basic needs, and they are met through a flow of energy known as food webs. Students will explore how all living organisms go through a life cycle and that adaptations enable organisms to survive in their ecosystem. 112.15b9(B). Describe the flow of energy through food webs, beginning with the Sun, and predict how changes in the ecosystem affect the food web such as a fire in a forest.
UT (1/2017, 3-6: 2002)	**Standard 5, Objective 1:** Describe the physical characteristics of Utah's wetlands, forests, and deserts. **Standard 5, Objective 2:** Describe the common plants and animals found in Utah environments and how these organisms have adapted to the environment in which they live.
VT (1/2017, 2013)	NGSS (see CA above).
VA (1/2017, 2016)	**4.1a-m.** The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which *a) distinctions are made among observations, conclusions, inferences, and predictions;* *b) objects or events are classified and arranged according to characteristics or properties;* *c) appropriate instruments are selected and used to measure length, mass, volume, and temperature in metric units;* *d) appropriate instruments are selected and used to measure elapsed time;*

	e) predictions and inferences are made, and conclusions are drawn based on data from a variety of sources; *f) independent and dependent variables are identified;* *g) constants in an experimental situation are identified;* *h) hypotheses are developed as cause and effect relationships;* *i) data are collected, recorded, analyzed, and displayed using bar and basic line graphs;* *j) numerical data that are contradictory or unusual in experimental results are recognized;* *k) data are communicated with simple graphs, pictures, written statements, and numbers;* *l) models are constructed to clarify explanations, demonstrate relationships, and solve needs; and* *m) current applications are used to reinforce science concepts.* **4.5b,d,f.** The student will investigate and understand how plants and animals, including humans, in an ecosystem interact with one another and with the nonliving components in the ecosystem. Key concepts include *b) organization of populations, communities, and ecosystems and how they interrelate;* *d) habitats and niches; and* *f) influences of human activity on ecosystems.* **4.9a-d.** The student will investigate and understand important Virginia natural resources. Key concepts include *a) watersheds and water resources;* *b) animals and plants;* *c) minerals, rocks, ores, and energy sources; and* *d) forests, soil, and land.*
WA (1/2017, 2009)	NGSS (see CA above).
WV (1/2017, 2016)	NGSS (see CA above).
WI (1/2017, 2012)	By the end of **grade four**, students will: **A.4.1** When conducting science investigations, ask and answer questions that will help decide the general areas of science being addressed **A.4.2** When faced with a science-related problem, decide what evidence, models, or explanations previously studied can be used to better understand what is happening now **A.4.3** When investigating a science-related problem, decide what data can be collected to determine the most useful explanations **A.4.4** When studying science-related problems, decide which of the science themes are important **A.4.5** When studying a science-related problem, decide what changes over time are occurring or have occurred

	C.4.1 Use the vocabulary of the unifying themes to ask questions about objects, organisms, and events being studied **C.4.2** Use the science content being learned to ask questions, plan investigations, make observations, make predictions, and offer explanations **C.4.3** Select multiple sources of information to help answer questions selected for classroom investigations **C.4.4** Use simple science equipment safely and effectively, including rulers, balances, graduated cylinders, hand lenses, thermometers, and computers, to collect data relevant to questions and investigations **C.4.5** Use data they have collected to develop explanations and answer questions generated by investigations **C.4.6** Communicate the results of their investigations in ways their audiences will understand by using charts, graphs, drawings, written descriptions, and various other means, to display their answers **C.4.7** Support their conclusions with logical arguments **C.4.8** Ask additional questions that might help focus or further an investigation **F.4.1** Discover how each organism meets its basic needs for water, nutrients, protection, and energy in order to survive **F.4.4** Using the science themes, develop explanations for the connections among living and non-living things in various environments **H.4.2** Using the science themes, identify local and state issues that are helped by science and technology and explain how science and technology can also cause a problem. **H.4.3** Show how science has contributed to meeting personal needs, including hygiene, nutrition, exercise, safety, and health care **H.4.4** Develop a list of issues that citizens must make decisions about and describe a strategy for becoming informed about the science behind these issues
WY (1/2017, 2016)	**4-ESS3-1.** Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. **4-ESS3-2.** Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans. **3-5-ETS1-1.** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. **3-5-ETS1-2.** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

EnviroAtlas
people health nature economy
Lesson Plan Standards
www.epa.gov/enviroatlas

STATE EDUCATIONAL STANDARDS

5th GRADE, ALL 50 STATES & DC

These Standards have been collected from individual State websites (1/2017). They have been connected to themes that are available in an EPA tool called *EnviroAtlas*.

State (last updated on this chart, Standards adoption year)	**5th grade Science Educational Standards that apply to the "Connecting ecosystems and human health" module**
AL (1/2017, 2015)	11. Create a model to illustrate the transfer of matter among producers; consumers, including scavengers and decomposers; and the environment. 17. Design solutions, test, and revise a process for cleaning a polluted environment (e.g., simulating an oil spill in the ocean or a flood in a city and creating a solution for containment and/or cleanup). 16. Collect and organize scientific ideas that individuals and communities can use to protect Earth's natural resources and its environment (e.g., terracing land to prevent soil erosion, utilizing no-till farming to improve soil fertility, regulating emissions from factories and automobiles to reduce air pollution, recycling to reduce overuse of landfill areas).
AK (1/2017, 2012)	[5] SE3.1 describing the various effects of an innovation (e.g., snow machines, airplanes, immunizations) on the safety, health, and environment of the local community (L) [5] SE1.1 identifying a community problem or issue and describing the information needed to develop a scientific solution (L)
AZ (1/2017, 2005)	Strand 3, Concept 1: PO 1. Explain the impacts of natural hazards on habitats (e.g., global warming, floods, asteroid or large meteor impacts). PO 2. Propose a solution, resource, or product that addresses a specific human, animal, or habitat need. PO 3. Evaluate the possible strengths and weaknesses of a proposed solution to a specific problem relevant to human, animal, or habitat needs.
AR (1/2017, 2005)	LS.4.5.4 Evaluate food webs under conditions of stress: • overgrazing • overpopulation • natural disaster • introduction of nonnative species • human impact/urban development LS.4.5.16 Evaluate positive and negative human effects on ecosystems
CA (1/2017, 2009)	**5-ESS2-1.** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. **5-ESS3-1.** Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment. **3–5-ETS1-1.** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

	3–5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
CO (1/2017, 2009)	None.
CT (1/2017, 2015)	NGSS (see CA above).
DC	NGSS (see CA above).
DE (1/2017, 2013)	NGSS (see CA above).
FL (1/2017, 2014)	SC.5.N.1.1, Define a problem, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types such as: systematic observations, experiments requiring the identification of variables, collecting and organizing data, interpreting data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.
GA (1/2017, new standards up 2017-2018)	None.
HI (1/2017, 2005)	None.
ID (1/2017, 2016)	Goal 5.1: Understand Common Environmental Quality Issues, Both Natural and Human Induced 5.S.5.1.1 Identify issues for environmental studies. CL: E Content Limit: Content should be limited to events in the local school or community environment. For example: Food waste from the hot lunch program, storm runoff entering a local stream, and the impact of wild fires. Goal 5.2: Understand the Relationship between Science and Technology 5.S.5.2.1 Describe how science and technology are part of a student's life. CL:D Content Limit: Technology may include that which is available within a school. 5.S.5.2.2 List examples of science and technology. CL: B Content Limit: Science is the process that increases and informs our knowledge of the natural world. Technology is the tool we use to advance our scientific knowledge.
IL (1/2017, 2011)	NGSS (see CA above).
IN (1/2017, 2016)	5.ESS.3 Investigate ways individual communities within the United States protect the Earth's resources and environment. 5.ESS.4 Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

	3-5.E.1 Identify a simple problem with the design of an object that reflects a need or a want. Include criteria for success and constraints on materials, time, or cost. 3-5.E.2 Construct and compare multiple plausible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
IA (1/2017, 2016)	5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. 5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
KS (1/2017, 2013)	NGSS (see CA above).
KY (1/2017, 2013)	5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. 5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment. ESS3.C: Human Impacts on Earth Systems • Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1)
LA (1/2017, 2016)	**Science as Inquiry:** 2. Identify problems, factors, and questions that must be considered in a scientific investigation (SI-M-A1) 3. Use a variety of sources to answer questions (SI-M-A1) 4. Design, predict outcomes, and conduct experiments to answer guiding questions (SIM-A2) **Understanding Scientific Inquiry**: 38. Explain that, through the use of scientific processes and knowledge, people can solve problems, make decisions, and form new ideas (SI-M-B6) **Physical Science:** 26. Identify and describe ecosystems of local importance (LS-M-C3) **Science and the Environment:** 49. Identify and give examples of pollutants found in water, air, and soil (SE-M-A3) 50. Describe the consequences of several types of human activities on local ecosystems (e.g., polluting streams, regulating hunting, introducing nonnative species) (SE-MA4)
ME (1/2017, 2013)	NGSS (see CA above).
MD (1/2017, 2013)	NGSS (see CA above).
MA (1/2017, 2016)	5-ESS3-1. Obtain and combine information about ways communities reduce human impact on the Earth's resources and environment by changing an agricultural, industrial, or community practice or process.

MI (1/2017, 2015)	NGSS (see CA above).
MN (1/2017, 2009)	5.3.4.1.3. In order to maintain and improve their existence humans interact with and influence Earth systems. 5.4.2.1.1. Natural systems have many components that interact to maintain the living system 5.4.2.1.2. Natural systems have many parts that interact to maintain the living system 5.4.4.1.1. Humans change environments in ways that can be either beneficial or harmful to themselves and other organisms.
MS (1/2017, 2010)	4d. Describe changes caused by humans on the environment and natural resources and cite evidence from research of ways to conserve natural resources in the United States, including (but not limited to) Mississippi. Examples of Mississippi efforts include the following: (DOK 2) • Associated Physics of America, a private company located in Greenwood Mississippi, develops ways to convert a variety of agricultural products into efficient, environment-friendly and cost-effective energy sources. • The Natural Resource Enterprises (NRE) Program of the Department of Wildlife and Fisheries and the Cooperative Extension Service at MSU educate landowners in the Southeast about sustainable natural resource enterprises and compatible habitat management practices. • The Engineer Research and Development Center of the Vicksburg District of the U.S. Army Corps of Engineers provides quality engineering and other professional products and services to develop and manage the Nation's water resources, reduce flood damage, and protect the environment.
MO (1/2017, 2008)	GLE's: Strand 3, DOK Ca. Compare the major organs/organ systems (e.g. support, reproductive, digestive, transport/circulatory , excretory, response) that perform similar functions for animals belonging to different vertebrate classes. Strand 5, Aa-c. a. Explain how major bodies of water are important natural resources for human activity(e.g., food recreation, habitat, irrigation, solvent, transportation) b. Describe how human needs and activities (e.g., irrigation damming of rivers, waste management, sources of drinking water) have affected the quantity and quality of major bodies of fresh water c. Propose solutions to problems related to water quality and availability that result from human activity.
MT (1/2017, 2016)	Benchmarks at end of 4th grade, 8th grade, and upon graduation from high school
NE (1/2017, 2010)	5.1.1.f Develop a reasonable explanation based on collected data. 5.1.1.g Share information, procedures, and results with peers and/or adults. 5.3.3 Students will describe relationships within an ecosystem.

	5.3.3.d Recognize all organisms cause changes, some beneficial and some detrimental, in the environment where they live.
NV (1/2017, 2014)	NGSS (see CA above).
NH (1/2017, 2016)	Separated into GSEs (Grade Span Expectations), 5-6 (so, "By the end of Grade 6, all students will…"
NJ (1/2017, 2013)	NGSS (see CA above).
NM (1/2017, 2009)	Strand II: Content of Science Standard II (Life Science): 5-8 Benchmark I: 4. Describe how human activity impacts the environment.
NY (1/2017, 2015)	NGSS (see CA above).
NC (1/2017, 2011)	5.L.2.1. Compare the characteristics of several common ecosystems, including estuaries and salt marshes, oceans, lakes and ponds, forests, and grasslands. 5.L.2.3. Infer the effects that may result from the interconnected relationship of plants and animals to their ecosystem.
ND (1/2017, 2014)	5.1.2. Explain how changes alter the balance within a system (e.g., the effects of limited resources on populations, global climate change, flood, drought) 5.7.2. Explain ways humans benefit from Earth's resources (e.g., air, water, soil, food, fuel, building materials)
OH (1/2017, 2014)	Ohio State Science Standards are not numbered or coded in any way: Organisms perform a variety of roles in an ecosystem.
OK (1/2017, 2014)	5-LS2-1 Students who demonstrate understanding can: Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. 5-LS2-2 Students who demonstrate understanding can: Use models to explain factors that upset the stability of local ecosystems. 5-ESS3-1 Students who demonstrate understanding can: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
OR (1/2017, 2014)	NGSS (see CA above).
PA (1/2017, 2002)	3.3.5.A2 Describe the usefulness of Earth's physical resources as raw materials for the human made world. 3.4.5.B1 Explain how the use of technology can have unintended consequences. 3.4.5.B2 Describe how waste may be appropriately recycled or disposed of to prevent unnecessary harm to the environment.

RI (1/2017, 2013)	NGSS (see CA above).
SC (1/2017, 2014)	**5.S.1A.1** Ask questions used to (1) generate hypotheses for scientific investigations or (2) refine models, explanations, or designs. **5.S.1A.2** Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others. **5.S.1A.4** Analyze and interpret data from informational texts, observations, measurements, or investigations using a range of methods (such as tabulation or graphing) to (1) reveal patterns and construct meaning or (2) support hypotheses, explanations, claims, or designs. **5.S.1A.6** Construct explanations of phenomena using (1) scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams. **5.S.1A.8** Obtain and evaluate informational texts, observations, data collected, or discussions to (1) generate and answer questions, (2) understand phenomena, (3) develop models, or (4) support hypotheses, explanations, claims, or designs. Communicate observations and explanations using the conventions and expectations of oral and written language. **5.E.3A.1** Construct explanations of how different landforms and surface features result from the location and movement of water on Earth's surface through watersheds (drainage basins) and rivers. **5.E.3B.3** Construct scientific arguments to support claims that human activities (such as conservation efforts or pollution) affect the land and oceans of Earth. **5.E.3B.4** Define problems caused by natural processes or human activities and test possible solutions to reduce the impact on landforms and the ocean shore zone. **5.L.4B.4** Construct scientific arguments to explain how limiting factors (including food, water, space, and shelter) or a newly introduced organism can affect an ecosystem.
SD (1/2017, 2015)	5-ESS3-1 Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
TN (1/2017, 2009)	GLE 0507.T/E.1 Describe how tools, technology, and inventions help to answer questions and solve problems. GLE 0507.T/E.2 Recognize that new tools, technology, and inventions are always being developed. GLE 0507.T/E.3 Identify appropriate materials, tools, and machines that can extend or enhance the ability to solve a specified problem. GLE 0507.T/E.4 Recognize the connection between scientific advances, new knowledge, and the availability of new tools and technologies.

	GLE 0507.2.3 Establish the connections between human activities and natural disasters and their impact on the environment.
TX (1/2017, 2014)	112.16.a3. The study of elementary science includes planning and safely implementing classroom and outdoor investigations using scientific processes, including inquiry methods, analyzing information, making informed decisions, and using tools to collect and record information, while addressing the major concepts and vocabulary, in the context of physical, earth, and life sciences. Districts are encouraged to facilitate classroom and outdoor investigations for at least 50% of instructional time. 112.16.b9A. Observe the way organisms live and survive in their ecosystem by interacting with the living and non-living elements. 112.16.b9C. Predict the effects of changes in ecosystems caused by living organisms, including humans, such as the overpopulation of grazers or the building of highways.
UT (1/2017, K-2: 2010, 3-6: 2002, 7-8: 2003, 9-12: 2003, Earth Science: 2012)	None.
VT (1/2017, 2013)	NGSS (see CA above).
VA (1/2017, 2016)	**5.1a-k.** The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which *a) items such as rocks, minerals, and organisms are identified using various classification keys;* *b) estimates are made and accurate measurements of length, mass, volume, and temperature are made in metric units using proper tools;* *c) estimates are made and accurate measurements of elapsed time are made using proper tools;* *d) hypotheses are formed from testable questions;* *e) independent and dependent variables are identified;* *f) constants in an experimental situation are identified;* *g) data are collected, recorded, analyzed, and communicated using proper graphical representations and metric measurements;* *h) predictions are made using patterns from data collected, and simple graphical data are generated;* *i) inferences are made and conclusions are drawn;* *j) models are constructed to clarify explanations, demonstrate relationships, and solve needs; and*

	k) current applications are used to reinforce science concepts. **5.6c.** The student will investigate and understand characteristics of the ocean environment. Key concepts include *c) ecological characteristics.* **5.7g.** The student will investigate and understand how Earth's surface is constantly changing. Key concepts include: *g) human impact.*
WA (1/2017, 2009)	NGSS (see CA above).
WV (1/2017, 2016)	NGSS (see CA above).
WI (1/2017, 2012)	**A.8.1** Develop their understanding of the science themes by using the themes to frame questions about science-related issues and problems. **A.8.3** Defend explanations and models by collecting and organizing evidence that supports them and critique explanations and models by collecting and organizing evidence that conflicts with them. **A.8.5** Show how models and explanations, based on systems, were changed as new evidence accumulated (the effects of constancy, evolution, change, and measurement should all be part of these explanations). **C.8.1** Identify questions they can investigate using resources and equipment they have available **C.8.2** Identify data and locate sources of information including their own records to answer the questions being investigated **C.8.3** Design and safely conduct investigations that provide reliable quantitative or qualitative data, as appropriate, to answer their questions **C.8.4** Use inferences to help decide possible results of their investigations, use observations to check their inferences **C.8.5** Use accepted scientific knowledge, models, and theories to explain their results and to raise further questions about their investigations **C.8.6** State what they have learned from investigations, relating their inferences to scientific knowledge and to data they have collected **C.8.7** Explain their data and conclusions in ways that allow an audience to understand the questions they selected for investigation* and the answers they have developed **C.8.8** Use computer software and other technologies to organize, process, and present their data **C.8.9** Evaluate, explain, and defend the validity of questions, hypotheses, and conclusions to their investigations **C.8.10** Discuss the importance of their results and implications of their work with peers, teachers, and other adults

	C.8.11 Raise further questions which still need to be answered **F.8.8** Show through investigations how organisms both depend on and contribute to the balance or imbalance of populations and/or ecosystems, which in turn contribute to the total system of life on the planet **F.8.9** Explain how some of the changes on the earth are contributing to changes in the balance of life and affecting the survival or population growth of certain species **F.8.10** Project how current trends in human resource use and population growth will influence the natural environment, and show how current policies affect those trends. **G.8.2** Explain how current scientific and technological discoveries have an influence on the work people do and how some of these discoveries also lead to new careers **G.8.3** Illustrate the impact that science and technology have had, both good and bad, on careers, systems, society, environment, and quality of life **G.8.4** Propose a design (or re-design) of an applied science model or a machine that will have an impact in the community or elsewhere in the world and show how the design (or re-design) might work, including potential side-effects **G.8.5** Investigate a specific local problem to which there has been a scientific or technological solution, including proposals for alternative courses of action, the choices that were made, reasons for the choices, any new problems created, and subsequent community satisfaction **G.8.6** Use current texts, encyclopedias, source books, computers, experts, the popular press, or other relevant sources to identify examples of how scientific discoveries have resulted in new technology **G.8.7** Show evidence of how science and technology are interdependent, using some examples drawn from personally conducted investigations **H.8.1** Evaluate the scientific evidence used in various media (for example, television, radio, Internet, popular press, and scientific journals) to address a social issue, using criteria of accuracy, logic, bias, relevance of data, and credibility of sources **H.8.2** Present a scientific solution to a problem involving the earth and space, life and environmental, or physical sciences and participate in a consensus-building discussion to arrive at a group decision **H.8.3** Understand the consequences of decisions affecting personal health and safety
WY (1/2017, 2016)	**5-ESS3-1.** Obtain and combine information about ways individual communities use science ideas to conserve Earth's resources and environment.

EnviroAtlas
people health nature economy
Lesson Plan Standards
www.epa.gov/enviroatlas

STATE EDUCATIONAL STANDARDS

6TH GRADE, ALL 50 STATES & DC

These Standards have been collected from individual State websites (1/2017). They have been connected to themes that are available in an EPA tool called *EnviroAtlas*.

State (last updated on this chart, Standards adoption year)	**6th grade Science Educational Standards that apply to the "Connecting ecosystems and human health" module**
AL (1/2017, 2015)	14. Analyze and interpret data (e.g., tables, graphs, maps of global and regional temperatures; atmospheric levels of gases such as carbon dioxide and methane; rates of human activities) to describe how various human activities (e.g., use of fossil fuels, creation of urban heat islands, agricultural practices) and natural processes (e.g., solar radiation, greenhouse effect, volcanic activity) may cause changes in local and global temperatures over time. 16. Implement scientific principles to design processes for monitoring and minimizing human impact on the environment (e.g., water usage, including withdrawal of water from streams and aquifers or construction of dams and levees; land usage, including urban development, agriculture, or removal of wetlands; pollution of air, water, and land).
AK (1/2017, 2012)	The student demonstrates an understanding that interactions with the environment provide an opportunity for understanding scientific concepts by [6] SA3.1 gathering data to build a knowledge base that contributes to the development of questions about the local environment (e.g., moose browsing, trail usage, river erosion) (L)
AZ (1/2017, 2005)	**Concept 2:** Science and Technology in Society. Develop viable solutions to a need or problem. PO 1. Propose viable methods of responding to an identified need or problem. PO 2. Compare possible solutions to best address an identified need or problem. PO 3. Design and construct a solution to an identified need or problem using simple classroom materials. PO 4. Describe a technological discovery that influences science. **Concept 3:** Populations of Organisms in an Ecosystem. Analyze the relationships among various organisms and their environment. PO 1. Explain that sunlight is the major source of energy for most ecosystems. PO 2. Describe how the following environmental conditions affect the quality of life: • water quality • climate • population density • smog
AR (1/2017, 2005)	None.
CA (1/2017, 2009)	**MS-LS2-4.** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. **MS-LS2-5.** Evaluate competing design solutions for maintaining biodiversity and ecosystem services. **MS-ESS3-5.** Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

	MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. **MS-ESS3-4.** Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. **MS-ETS1-1.** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-2.** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **MS-ETS1-3.** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. **MS-ETS1-4.** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
CO (1/2017, 2009)	3. Earth Systems Science, 3. Earth's natural resources provide the foundation for human society's physical needs. Many natural resources are nonrenewable on human timescales, while others can be renewed or recycled
CT (1/2017, 2015)	NGSS (see CA above).
DC	NGSS (see CA above).
DE (1/2017, 2013)	NGSS (see CA above).
FL (1/2017, 2014)	SC.6.N.1.1 Define a problem from the sixth grade curriculum, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigation of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.
GA (1/2017, new standards up 2017-2018)	None.
HI (1/2017, 2005)	None.
ID (1/2017, 2016)	Goal 5.1: Understand Common Environmental Quality Issues, Both Natural and Human Induced 6.S.5.1.1 Identify issues for environmental studies. (626.01.a) Goal 5.2: Understand the Relationship between Science and

	Technology 6.S.5.2.1 Describe how science and technology are part of our society. (625.01.a) 6.S.5.2.2 Describe how science and technology are interrelated. (625.01.b)
IL (1/2017, 2011)	NGSS (see CA above).
IN (1/2017, 2016)	6.LS.5 Research invasive species and discuss their impact on ecosystems.
IA (1/2017, 2016)	NGSS (see CA above).
KS (1/2017, 2013)	NGSS (see CA above).
KY (1/2017, 2013)	LS2.C: Ecosystem Dynamics, Functioning, and Resilience Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (08-LS2-4) 08-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services. LS2.C: Ecosystem Dynamics, Functioning, and Resilience Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (08-LS2-5) LS4.D: Biodiversity and Humans Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. (secondary to 08-LS2-5) ETS1.B: Developing Possible Solutions There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (secondary to 08-LS2-5) 08-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
LA (1/2017, 2016)	**Science and the Environment** 45. Describe methods for sustaining renewable resources (SE-M-A6) 46. Identify ways people can reuse, recycle, and reduce the use of resources to improve and protect the quality of life (SE-M-A6) 47. Illustrate how various technologies influence resource use in an ecosystem (e.g., forestry management, soil conservation, fishery improvement) (SE-M-A8)
ME (1/2017, 2013)	NGSS (see CA above).
MD (1/2017, 2013)	NGSS (see CA above).

MA (1/2017, 2016)	6.MS-ETS1-6(MA). Communicate a design solution to an intended user, including design features and limitations of the solution
MI (1/2017, 2015)	NGSS (see CA above).
MN (1/2017, 2009)	6.1.2.2.1. Engineering design is the process of devising products, processes and systems that address a need, capitalize on an opportunity, or solve a specific problem.
MS (1/2017, 2010)	4d. Summarize the causes and effects of pollution on people and the environment (e.g., air pollution, ground pollution, chemical pollution) and justify how and why pollution should be minimized. (DOK 1)
MO (1/2017, 2015)	Strand 4, D a-c. a. Describe beneficial and harmful activities of organisms, including humans (e.g., deforestation, overpopulation, water and air pollution, global warming, restoration of natural environments, river bank/coastal stabilization, recycling, channelization, reintroduction of species, depletion of resources), and explain how these activities affect organisms within an ecosystem b. Predict the impact (beneficial or harmful) of a natural environmental change (e.g., forest fire, flood, volcanic eruption, avalanche) on the organisms in an ecosystem c. Describe possible solutions to potentially harmful environmental changes within an ecosystem
MT (1/2017, 2016)	Benchmarks at end of 4th grade, 8th grade, and upon graduation from high school
NE (1/2017, 2010)	8.1.1.g Evaluate predictions, draw logical inferences based on observed patterns/relationships, and account for non-relevant information. 8.3.3.g Identify positive and negative effects of natural and human activity on an ecosystem
NV (1/2017, 2014)	NGSS (see CA above).
NH (1/2017, 2016)	S:SPS1:6:1.2 Plan observations based on a given purpose. S:SPS1:6:1.8 Ask questions about relationships between and among observations. S:SPS2:6:2.1 Recognize that thinking about things as systems means looking for how every part relates to others. S:SPS2:6:4.1 Understand that things change in steady, repetitive, or irregular ways, or sometimes in more than one way at the same time; often the best way to tell which kinds of change are happening is to make a table or graph of measurements. S:SPS2:6:4.2 Discover how a system may stay the same because nothing is happening or because things are happening that exactly balance each other out. S:SPS3:6:1.1 Work effectively within a cooperative group setting, accepting and executing assigned roles and responsibilities. S:SPS3:6:1.2 Work collectively within a group toward a common goal. S:SPS3:6:1.3 Demonstrate respect of one another's abilities and contributions to the group.

	S:SPS3:6:2.1 Develop, focus and explain questions about the environment and do environmental investigations. S:SPS3:6:2.2 Design environmental investigations to answer particular questions. S:SPS3:6:2.3 Explore evidence that human-caused changes have consequences for the immediate environment as well as for other places and future times. S:SPS3:6:2.4 Explore how humans shape and control the environment while creating knowledge and developing new technologies. S:SPS3:6:2.5 Investigate environmental and resource management issues at scales that range from local to national to global.
NJ (1/2017, 2013)	NGSS (see CA above).
NM (1/2017, 2009)	None.
NY (1/2017, 2015)	NGSS (see CA above).
NC (1/2017, 2011)	6.E.2.4. Conclude that the good health of humans requires: monitoring the lithosphere, maintaining soil quality and stewardship.
ND (1/2017, 2014)	6.2.4. Use appropriate tools and techniques to gather and analyze data. 6.6.2. Design a product or solution to a problem given constraints (e.g., limits of time, costs, materials and environmental factors) 6.6.3. Explain the relationship between science and technology 6.7.2. Explain how recycling and conservation affect populations, resources, and the environment
OH (1/2017, 2014)	Ohio State Science Standards are not numbered or coded in any way: Living systems at all levels of organization demonstrate the complementary nature of structure and function.
OK (1/2017, 2014)	**MS-LS2-1** Students who demonstrate understanding can: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. **MS-LS2-2** Students who demonstrate understanding can: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. **MS-LS2-4** Students who demonstrate understanding can: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. **MS-LS2-5** Students who demonstrate understanding can: Evaluate competing design solutions for maintaining biodiversity and ecosystem services. **MS-ESS3-3** Students who demonstrate understanding can: Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.

OR (1/2017, 2014)	NGSS (see CA above).
PA (1/2017, 2002)	3.3.6.A1 Recognize and interpret various mapping representations of Earth's common features. 3.4.6.B1 Describe how economic, political, and cultural issues are influenced by the development and use of **technology.**
RI (1/2017, 2013)	NGSS (see CA above).
SC (1/2017, 2014)	**6.S.1A.1** Ask questions to (1) generate hypotheses for scientific investigations, (2) refine models, explanations, or designs, or (3) extend the results of investigations or challenge claims. **6.S.1A.2** Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others. **6.S.1A.4** Analyze and interpret data from informational texts, observations, measurements, or investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning or (2) support hypotheses, explanations, claims, or designs. **6.S.1A.6** Construct explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams. **6.S.1A.8** Obtain and evaluate scientific information to (1) answer questions, (2) explain or describe phenomena, (3) develop models, (4) evaluate hypotheses, explanations, claims, or designs or (5) identify and/or fill gaps in knowledge. Communicate using the conventions and expectations of scientific writing or oral presentations by (1) evaluating grade-appropriate primary or secondary scientific literature, or (2) reporting the results of student experimental investigations. **6.E.2A.3** Construct explanations of the processes involved in the cycling of water through Earth's systems (including transpiration, evaporation, condensation and crystallization, precipitation, and downhill flow of water on land).
SD (1/2017, 2015)	MS-LS2-1 Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. MS-LS2-2 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. MS-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. MS-LS2-5 Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

	MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
TN (1/2017, 2009)	GLE 0607.Inq.5 Communicate scientific understanding using descriptions, explanations, and models. GLE 0607.2.3 Draw conclusions from data about interactions between the biotic and abiotic elements of a particular environment. GLE 0607.2.4 Analyze the environments and the interdependence among organisms found in the world's major biomes.
TX (1/2017, 2014)	112.18a(3) Grade 6 science is interdisciplinary in nature; however, much of the content focus is on physical science. National standards in science are organized as multi-grade blocks such as Grades 5-8 rather than individual grade levels. In order to follow the grade level format used in Texas, the various national standards are found among Grades 6, 7, and 8. Recurring themes are pervasive in sciences, mathematics, and technology. These ideas transcend disciplinary boundaries and include change and constancy, patterns, cycles, systems, models, and scale. 112.18b(12)(F) diagram the levels of organization within an ecosystem, including organism, population, community, and ecosystem.
UT (1/2017, K-2: 2010, 3-6: 2002, 7-8: 2003, 9-12: 2003, Earth Science: 2012)	None.
VT (1/2017, 2013)	NGSS (see CA above).
VA (1/2017, 2016)	**6.1a-j.** The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which *a) observations are made involving fine discrimination between similar objects and organisms; b) precise and approximate measurements are recorded;* *c) scale models are used to estimate distance, volume, and quantity;* *d) hypotheses are stated in ways that identify the independent and dependent variables;* *e) a method is devised to test the validity of predictions and inferences;* *f) one variable is manipulated over time, using many repeated trials;*

	g) data are collected, recorded, analyzed, and reported using metric measurements and tools; h) data are analyzed and communicated through graphical representation; *i) models and simulations are designed and used to illustrate and explain phenomena and systems; and* *j) current applications are used to reinforce science concepts.* **6.7a-g.** The student will investigate and understand the natural processes and human interactions that affect watershed systems. Key concepts include *a) the health of ecosystems and the abiotic factors of a watershed;* *b) the location and structure of Virginia's regional watershed systems;* *c) divides, tributaries, river systems, and river and stream processes;* *d) wetlands;* *e) estuaries;* *f) major conservation, health, and safety issues associated with watersheds; and* *g) water monitoring and analysis using field equipment including hand-held technology.* **6.9** The student will investigate and understand public policy decisions relating to the environment. Key concepts include *a) management of renewable resources;* *b) management of nonrenewable resources;* *c) the mitigation of land-use and environmental hazards through preventive measures; and* *d) cost/benefit tradeoffs in conservation policies.*
WA (1/2017, 2009)	NGSS (see CA above).
WV (1/2017, 2016)	NGSS (see CA above).
WI (1/2017, 2012)	**A.8.1** Develop their understanding of the science themes by using the themes to frame questions about science-related issues and problems. **A.8.3** Defend explanations and models by collecting and organizing evidence that supports them and critique explanations and models by collecting and organizing evidence that conflicts with them. **A.8.5** Show how models and explanations, based on systems, were changed as new evidence accumulated (the effects of constancy, evolution, change, and measurement should all be part of these explanations). **C.8.1** Identify questions they can investigate using resources and equipment they have available

	C.8.2 Identify data and locate sources of information including their own records to answer the questions being investigated **C.8.3** Design and safely conduct investigations that provide reliable quantitative or qualitative data, as appropriate, to answer their questions **C.8.4** Use inferences to help decide possible results of their investigations, use observations to check their inferences **C.8.5** Use accepted scientific knowledge, models, and theories to explain their results and to raise further questions about their investigations **C.8.6** State what they have learned from investigations, relating their inferences to scientific knowledge and to data they have collected **C.8.7** Explain their data and conclusions in ways that allow an audience to understand the questions they selected for investigation* and the answers they have developed **C.8.8** Use computer software and other technologies to organize, process, and present their data **C.8.9** Evaluate, explain, and defend the validity of questions, hypotheses, and conclusions to their investigations **C.8.10** Discuss the importance of their results and implications of their work with peers, teachers, and other adults **C.8.11** Raise further questions which still need to be answered **F.8.8** Show through investigations how organisms both depend on and contribute to the balance or imbalance of populations and/or ecosystems, which in turn contribute to the total system of life on the planet **F.8.9** Explain how some of the changes on the earth are contributing to changes in the balance of life and affecting the survival or population growth of certain species **F.8.10** Project how current trends in human resource use and population growth will influence the natural environment, and show how current policies affect those trends. **G.8.2** Explain how current scientific and technological discoveries have an influence on the work people do and how some of these discoveries also lead to new careers **G.8.3** Illustrate the impact that science and technology have had, both good and bad, on careers, systems, society, environment, and quality of life **G.8.4** Propose a design (or re-design) of an applied science model or a machine that will have an impact in the community or elsewhere in the world and show how the design (or re-design) might work, including potential side-effects

	G.8.5 Investigate a specific local problem to which there has been a scientific or technological solution, including proposals for alternative courses of action, the choices that were made, reasons for the choices, any new problems created, and subsequent community satisfaction **G.8.6** Use current texts, encyclopedias, source books, computers, experts, the popular press, or other relevant sources to identify examples of how scientific discoveries have resulted in new technology **G.8.7** Show evidence of how science and technology are interdependent, using some examples drawn from personally conducted investigations **H.8.1** Evaluate the scientific evidence used in various media (for example, television, radio, Internet, popular press, and scientific journals) to address a social issue, using criteria of accuracy, logic, bias, relevance of data, and credibility of sources **H.8.2** Present a scientific solution to a problem involving the earth and space, life and environmental, or physical sciences and participate in a consensus-building discussion to arrive at a group decision **H.8.3** Understand the consequences of decisions affecting personal health and safety
WY (1/2017, 2016)	**MS-PS1-3.** Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. **MS-LS2-1.** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. **MS-LS2-2.** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. **MS-LS2-4.** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. **MS-LS2-5.** Evaluate competing design solutions for maintaining biodiversity and ecosystem services. **MS-ESS2-4.** Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. **MS-ESS3-3**. Apply scientific principles to design a method for monitoring, evaluating, and managing a human impact on the environment. **MS-ESS3-4.** Construct an argument supported by evidence for how changes in human population and per-capita consumption of natural resources impact Earth's systems. **MS-ETS2-2**. Develop a model defining and prioritizing the impacts of human activity on a particular aspect of the environment, identifying positive and negative consequences of the activity, both short and long-term, and

	investigate and explain how the ethics and integrity of scientists and engineers and respect for individual property rights might constrain future development.

STATE EDUCATIONAL STANDARDS

7th GRADE, ALL 50 STATES & DC

These Standards have been collected from individual State websites (1/2017). They have been connected to themes that are available in an EPA tool called *EnviroAtlas*.

State (last updated on this chart, Standards adoption year)	**7th grade Science Educational Standards that apply to the "Connecting ecosystems and human health" module**
AL (1/2017, 2015)	**9.** Engage in argument to defend the effectiveness of a design solution that maintains biodiversity and **ecosystem services** (e.g., using scientific, economic, and social considerations regarding purifying water, recycling nutrients, preventing soil erosion). **6.** Analyze and interpret data to provide evidence regarding how resource availability impacts individual organisms as well as populations of organisms within an ecosystem.
AK (1/2017, 2012)	The student demonstrates an understanding that interactions with the environment provide an opportunity for understanding scientific concepts by **[7] SA3.1** designing and conducting a simple investigation about the local environment (L)
AZ (1/2017, 2005)	**Concept 1:** Changes in Environments. Describe the interactions between human populations, natural hazards, and the environment. **PO 1.** Analyze environmental risks (e.g., pollution, destruction of habitat) caused by human interaction with biological or geological systems. **PO 2.** Analyze environmental benefits of the following human interactions with biological or geological systems: • reforestation • habitat restoration • construction of dams **PO 3.** Propose possible solutions to address the environmental risks in biological or geological systems.
AR (1/2017, 2005)	None.
CA (1/2017, 2009)	**MS-LS2-4.** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. **MS-LS2-5.** Evaluate competing design solutions for maintaining biodiversity and ecosystem services. **MS-ESS3-4**. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

	MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **NGSS Science and Engineering Practices (NGSS APPENDIX F):** 1. Asking questions (for science) and defining problems (for engineering). 4. Analyzing and interpreting data. 7. Engaging in argument from evidence. 8. Obtaining, evaluating, and communicating information.
CO (1/2017, 2009)	None.
CT (1/2017, 2015)	NGSS (see CA above).
DC (1/2017, 2013)	NGSS (see CA above).
DE (1/2017, 2013)	NGSS (see CA above).
FL (1/2017, 2014)	**SC.7.L.17.3** Describe and investigate various limiting factors in the local ecosystem and their impact on native populations, including food, shelter, water, space, disease, parasitism, predation, and nesting sites. **SC.7.N.1.1** Define a problem from the seventh grade curriculum, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigation of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.
GA (1/2017, new standards up 2017-2018)	**S7L4.** Obtain, evaluate, and communicate information to examine the interdependence of organisms with one another and their environments. c. Analyze and interpret data to provide evidence for how resource availability, disease, climate, and human activity affect individual organisms, populations, communities, and ecosystems.
HI (1/2017, 2005)	**SC.7.3.3.** Explain how biotic and abiotic factors affect the carrying capacity and sustainability of an ecosystem.
ID (1/2017, 2016)	**Goal 5.2:** Understand the Relationship between Science and Technology **7.S.5.2.1** Explain how science and technology are interrelated. (640.01.a) **7.S.5.2.2** Explain how science advances technology. (640.01.b)
IL (1/2017, 2011)	NGSS (see CA above).
IN (1/2017, 2016)	**7.ESS.7** Describe the positive and negative environmental impacts of obtaining and utilizing various renewable and nonrenewable energy resources in Indiana. Determine which energy resources are the most beneficial and efficient.

	6-8.E.1 Identify the criteria and constraints of a design to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
IA (1/2017, 2016)	NGSS (see CA above).
KS (1/2017, 2013)	NGSS (see CA above).
KY (1/2017, 2013)	**08-LS2-5**. Evaluate competing design solutions for maintaining biodiversity and ecosystem services. **LS2.C:** Ecosystem Dynamics, Functioning, and Resilience Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (08-LS2-5) **LS4.D:** Biodiversity and Humans Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. (secondary to 08-LS2-5) **08-ESS3-3.** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
LA (1/2017, 2016)	**Science and the Environment:** **35.** Identify resources humans derive from ecosystems (SE-M-A1) **36.** Distinguish the essential roles played by biotic and abiotic components in various ecosystems (SE-M-A1) **39**. Analyze the consequences of human activities on ecosystems (SE-M-A4) **43**. Identify and analyze the environmental impact of humans' use of technology (e.g., energy production, agriculture, transportation, human habitation) (SE-M-A8)
ME (1/2017, 2013)	NGSS (see CA above).
MD (1/2017, 2013)	NGSS (see CA above).
MA (1/2017, 2016)	**7.MS-ESS3-4.** Construct an argument supported by evidence that human activities and technologies can mitigate the impact of increases in human population and per capita consumption of natural resources on the environment. **7.MS-LS2-1.** Analyze and interpret data to provide evidence for the effects of periods of abundant and scarce resources on the growth of organisms and the size of populations in an ecosystem. **7.MS-LS2-6(MA).** Explain how changes to the biodiversity of an ecosystem—the variety of species found in the ecosystem—may limit the availability of resources humans use.

MI (1/2017, 2015)	NGSS (see CA above).
MN (1/2017, 2009)	**7.4.2.1.1.** Natural systems include a variety of organisms that interact with one another in several ways. **7.4.4.1.2.** Human activity can change living organisms and ecosystems.
MS (1/2017, 2010)	**4d.** Conclude why factors, such as lack of resources and climate can limit the growth of populations in specific niches in the ecosystem. (DOK 2) • Abiotic factors that affect population, growth, and size (quantity of light, water, range of temperatures, soil compositions) • Cycles of water, carbon, oxygen, and nitrogen in the environment • Role of single-celled organisms (e.g., phytoplankton) in the carbon and oxygen cycles
MO (1/2017, 2015)	**7.MS-ESS3-4**. Construct an argument supported by evidence that human activities and technologies can mitigate the impact of increases in human population and per capita consumption of natural resources on the environment.
MT (1/2017, 2016)	Benchmarks at end of 4th grade, 8th grade, and upon graduation from high school
NE (1/2017, 2010)	**8.1.1.g** Evaluate predictions, draw logical inferences based on observed patterns/relationships, and account for non-relevant information. **8.3.3.g** Identify positive and negative effects of natural and human activity on an ecosystem
NV (1/2017, 2014)	NGSS (see CA above).
NH (1/2017, 2016)	Separated into GSEs (Grade Span Expectations), 7-8 (so, "By the end of Grade 8, all students will…"
NJ (1/2017, 2013)	NGSS (see CA above).
NM (1/2017, 2009)	Strand II: Content of Science Standard II (Life Science): Understand the properties, structures, and processes of living things and the interdependence of living things and their environments. 5-8 Benchmark I: **Populations and Ecosystems** 1. Identify the living and nonliving parts of an ecosystem and describe the relationships among these components. 2. Explain biomes (i.e., aquatic, desert, rainforest, grasslands, tundra) and describe the New Mexico biome. 3. Explain how individuals of species that exist together interact with their environment to create an ecosystem (e.g., populations, communities, niches, habitats, food webs). 4. Explain the conditions and resources needed to sustain life in specific ecosystems. 5. Describe how the availability of resources and physical factors limit growth (e.g., quantity of light and water, range of temperature, composition

	of soil) and how the water, carbon, and nitrogen cycles contribute to the availability of those resources to support living systems. **Biodiversity** 6. Understand how diverse species fill all niches in an ecosystem.
NY (1/2017, 2015)	NGSS (see CA above).
NC (1/2017, 2011)	**7.E.1.6.** Conclude that the good health of humans requires: monitoring the atmosphere, maintaining air quality and stewardship.
ND (1/2017, 2014)	**7.7.3**. Explain how overpopulation affects organisms, resources, and environments (e.g., depletion of food resources, habitat availability, increased loss due to disease, parasites and predators
OH (1/2017, 2014)	Ohio State Science Standards are not numbered or coded in any way: -Matter is transferred continuously between one organism to another and between organisms and their physical environments. -In any particular biome, the number, growth and survival of organisms and populations depend on biotic and abiotic factors.
OK (1/2017, 2014)	None, very physics and solar-system based.
OR (1/2017, 2014)	NGSS (see CA above).
PA (1/2017, 2002)	**3.4.7.B1** Explain how the use of **technology** can have consequences that affect humans in many ways. **3.4.7.B2** Explain how decisions to develop and use **technologies** may be influenced by environmental and economic concerns.
RI (1/2017, 2013)	NGSS (see CA above).
SC (1/2017, 2014)	**7.S.1A.1** Ask questions to (1) generate hypotheses for scientific investigations, (2) refine models, explanations, or designs, or (3) extend the results of investigations or challenge claims. **7.S.1A.2** Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others. **7.S.1A.6** Construct explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams. **7.S.1A.8** Obtain and evaluate scientific information to (1) answer questions, (2) explain or describe phenomena, (3) develop models, (4) evaluate hypotheses, explanations, claims, or designs or (5) identify and/or fill gaps in

	knowledge. Communicate using the conventions and expectations of scientific writing or oral presentations by (1) evaluating grade-appropriate primary or secondary scientific literature, or (2) reporting the results of student experimental investigations. **7.EC.5A.1** Develop and use models to describe the characteristics of the levels of organization within ecosystems (including species, populations, communities, ecosystems, and biomes). **7.EC.5A.3** Analyze and interpret data to predict changes in the number of organisms within a population when certain changes occur to the physical environment (such as changes due to natural hazards or limiting factors). **7.EC.5B.3** Analyze and interpret data to predict how changes in the number of organisms of one species affects the balance of an ecosystem. **7.EC.5B.4** Define problems caused by the introduction of a new species in an environment and design devices or solutions to minimize the impact(s) to the balance of an ecosystem.
SD (1/2017, 2015)	**MS-LS2-1** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. **MS-LS2-2** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. **MS-LS2-4** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. **MS-LS2-5** Evaluate competing design solutions for maintaining biodiversity and **ecosystem services**. **MS-ESS3-3** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. **MS-ESS3-4** Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
TN (1/2017, 2009)	**GLE 0707.7.6** Evaluate how human activities affect the earth's land, oceans, and atmosphere.
TX (1/2017, 2014)	**112.19a(3).** Grade 7 science is interdisciplinary in nature; however, much of the content focus is on organisms and the environment. National standards in science are organized as a multi-grade blocks such as Grades 5-8 rather than individual grade levels. In order to follow the grade level format used in Texas, the various national standards are found among Grades 6, 7, and 8. Recurring themes are pervasive in sciences, mathematics, and technology. These ideas transcend disciplinary boundaries and include change and constancy, patterns, cycles, systems, models, and scale. **112.19b10(B).** describe how biodiversity contributes to the sustainability of an ecosystem

UT (1/2017, K-2: 2010, 3-6: 2002, 7-8: 2003, 9-12: 2003, Earth Science: 2012)	None.
VT (1/2017, 2013)	NGSS (see CA above).
VA (1/2017, 2016)	See subject-specific documents.
WA (1/2017, 2009)	NGSS (see CA above).
WV (1/2017, 2016)	NGSS (see CA above).
WI (1/2017, 2012)	**A.8.1** Develop their understanding of the science themes by using the themes to frame questions about science-related issues and problems. **C.8.1** Identify questions they can investigate using resources and equipment they have available **C.8.2** Identify data and locate sources of information including their own records to answer the questions being investigated **C.8.5** Use accepted scientific knowledge, models, and theories to explain their results and to raise further questions about their investigations **C.8.6** State what they have learned from investigations, relating their inferences to scientific knowledge and to data they have collected **C.8.7** Explain their data and conclusions in ways that allow an audience to understand the questions they selected for investigation and the answers they have developed **C.8.8** Use computer software and other technologies to organize, process, and present their data **C.8.9** Evaluate, explain, and defend the validity of questions, hypotheses, and conclusions to their investigations **C.8.10** Discuss the importance of their results and implications of their work with peers, teachers, and other adults **C.8.11** Raise further questions which still need to be answered **F.8.8** Show through investigations how organisms both depend on and contribute to the balance or imbalance of populations and/or ecosystems, which in turn contribute to the total system of life on the planet **F.8.10** Project how current trends in human resource use and population growth will influence the natural environment, and show how current policies affect those trends.

	G.8.5 Investigate a specific local problem to which there has been a scientific or technological solution, including proposals for alternative courses of action, the choices that were made, reasons for the choices, any new problems created, and subsequent community satisfaction **G.8.6** Use current texts, encyclopedias, source books, computers, experts, the popular press, or other relevant sources to identify examples of how scientific discoveries have resulted in new technology **G.8.7** Show evidence of how science and technology are interdependent, using some examples drawn from personally conducted investigations **H.8.1** Evaluate the scientific evidence used in various media (for example, television, radio, Internet, popular press, and scientific journals) to address a social issue, using criteria of accuracy, logic, bias, relevance of data, and credibility of sources **H.8.2** Present a scientific solution to a problem involving the earth and space, life and environmental, or physical sciences and participate in a consensus-building discussion to arrive at a group decision **H.8.3** Understand the consequences of decisions affecting personal health and safety
WY (1/2017, 2016)	**MS-LS2-1.** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. **MS-LS2-2.** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. **MS-LS2-4.** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. **MS-LS2-5.** Evaluate competing design solutions for maintaining biodiversity and ecosystem services. **MS-ESS2-4.** Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. **MS-ESS3-3**. Apply scientific principles to design a method for monitoring, evaluating, and managing a human impact on the environment. **MS-ESS3-4.** Construct an argument supported by evidence for how changes in human population and per-capita consumption of natural resources impact Earth's systems. **MS-ETS2-2**. Develop a model defining and prioritizing the impacts of human activity on a particular aspect of the environment, identifying positive and negative consequences of the activity, both short and long-term, and investigate and explain how the ethics and integrity of scientists and engineers and respect for individual property rights might constrain future development.

STATE EDUCATIONAL STANDARDS

8th GRADE, ALL 50 STATES & DC

These Standards have been collected from individual State websites (1/2017). They have been connected to themes that are available in an EPA tool called *EnviroAtlas*.

State (last updated on this chart, Standards adoption year)	**8th grade Science Educational Standards that apply to the "Connecting ecosystems and human health" module**
AL (1/2017, 2015)	None, only physical science
AK (1/2017, 2012)	The student demonstrates an understanding that interactions with the environment provide an opportunity for understanding scientific concepts by [8] SA3.1 conducting research to learn how the local environment is used by a variety of competing interests (e.g., competition for habitat/resources, tourism, oil and mining companies, hunting groups) (L)
AZ (1/2017, 2005)	**Concept 1:** Changes in Environments Describe the interactions between human populations, natural hazards, and the environment. **PO 1.** Analyze the risk factors associated with natural, human induced, and/or biological hazards, including: • waste disposal of industrial chemicals • greenhouse gases **PO 2.** Analyze possible solutions to address the environmental risks associated with chemicals and biological systems.
AR (1/2017, 2005)	None.
CA (1/2017, 2009)	**MS-LS2-4.** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. **MS-LS2-5.** Evaluate competing design solutions for maintaining biodiversity and ecosystem services. **MS-ESS3-3.** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. **MS-ESS3-4.** Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. **NGSS Science and Engineering Practices (NGSS APPENDIX F):**

	1. Asking questions (for science) and defining problems (for engineering). 4. Analyzing and interpreting data. 7. Engaging in argument from evidence. 8. Obtaining, evaluating, and communicating information.
CO (1/2017, 2009)	**2.** Life Science, 1. Human activities can deliberately or inadvertently alter ecosystems and their resiliency.
CT (1/2017, 2015)	NGSS (see CA above).
DC (1/2017, 2013)	NGSS (see CA above).
DE (1/2017, 2013)	NGSS (see CA above).
FL (1/2017, 2014)	**SC.8.N.1.1** Define a problem from the eighth grade curriculum using appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions. **SC.8.N.4.1** Explain that science is one of the processes that can be used to inform decision making at the community, state, national, and international levels.
GA (1/2017, new standards up 2017-2018)	None, very physics-based.
HI (1/2017, 2005)	**SC.8.2.1.** Describe significant relationships among society, science, and technology and how one impacts the other.
ID (1/2017, 2016)	Separated by course subject—Biology and Earth Science
IL (1/2017, 2011)	NGSS (see CA above).
IN (1/2017, 2016)	**8.ESS.3** Research how human consumption of finite natural resources (i.e. coal, oil, natural gas, and clean water) and human activities have had an impact on the environment (i.e. causes of air, water, soil, light, and noise pollution).
IA (1/2017, 2016)	NGSS (see CA above).
KS (1/2017, 2013)	NGSS (see CA above).

KY (1/2017, 2013)	**08-LS2-5.** Evaluate competing design solutions for maintaining biodiversity and ecosystem services. LS2.C: Ecosystem Dynamics, Functioning, and Resilience Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (08-LS2-5) **LS4.D:** Biodiversity and Humans Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. (secondary to 08-LS2-5) **08-ESS3-3**. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
LA (1/2017, 2016)	**Science as Inquiry:** 51. Analyze the consequences of human activities on global Earth systems (SE-M-A4)
ME (1/2017, 2013)	NGSS (see CA above).
MD (1/2017, 2013)	NGSS (see CA above).
MA (1/2017, 2016)	**8.MS-LS1-5.** Construct an argument based on evidence for how environmental and genetic factors influence the growth of organisms.
MI (1/2017, 2015)	NGSS (see CA above).
MN (1/2017, 2009)	**8.3.4.1.2.** In order to maintain and improve their existence, humans interact with and influence Earth systems.
MS (1/2017, 2010)	**4d.** Research the importance of the conservation of renewable and nonrenewable resources, including (but not limited to) Mississippi, and justify methods that might be useful in decreasing the human impact on global warming. (DOK 3) • Greenhouse gases • The effects of the human population • Relationships of the cycles of water, carbon, oxygen, and nitrogen
MO (1/2017, 2015)	**8.MS-LS1-5.** Construct an argument based on evidence for how environmental and genetic factors influence the growth of organisms.
MT (1/2017, 2016)	**1.6** compare how observations of nature form an essential base of knowledge among the Montana American Indians

	3.4 investigate and explain the interdependent nature of populations and communities in the environment and describe how species in these populations adapt by evolving **5.4** use scientific knowledge to investigate problems and their proposed solutions and evaluate those solutions while considering environmental impacts.
NE (1/2017, 2010)	**8.1.1.g** Evaluate predictions, draw logical inferences based on observed patterns/relationships, and account for non-relevant information. 8.3.3.g Identify positive and negative effects of natural and human activity on an ecosystem
NV (1/2017, 2014)	NGSS (see CA above).
NH (1/2017, 2016)	**S:SPS1:8:1.7** Ask questions about relationships between and among observable variables. **S:SPS1:8:4.1** Use appropriate tools (including computer hardware and software) to collect, organize, represent, analyze and explain data. **S:SPS3:8:1.1** Work effectively within a cooperative group setting, accepting and executing assigned roles and responsibilities. **S:SPS3:8:1.2** Work collectively within a group toward a common goal. **S:SPS3:8:1.3** Demonstrate respect of one another's abilities and contributions to the group. **S:SPS3:8:1.4** Demonstrate an understanding of the ethics involved in scientific inquiry. **S:SPS3:8:2.1** Locate and collect reliable information about the environment and environmental topics using a variety of methods and sources. **S:SPS3:8:2.4** Synthesize observations and findings into coherent explanations about natural resources and the environment.
NJ (1/2017, 2013)	NGSS (see CA above).
NM (1/2017, 2009)	Strand II: Content of Science Standard II (Life Science): Understand the properties, structures, and processes of living things and the interdependence of living things and their environments. **5-8 Benchmark I:** **1.** Describe how matter moves through ecosystems (e.g., water cycle, carbon cycle). **2.** Describe how energy flows through ecosystems (e.g., sunlight, green plants, food for animals). **3.** Explain how a change in the flow of energy can impact an ecosystem (e.g., the amount of sunlight available for plant growth, global climate change).
NY (1/2017, 2015)	NGSS (see CA above).

NC (1/2017, 2011)	**8.P.2.2** Explain the implications of the depletion of renewable and nonrenewable energy resources and the importance of conservation. **8.E.1.** Understand the hydrosphere and the impact of humans on local systems and the effects of the hydrosphere on humans. **8.E.1.4. Conclude that the good health of humans requires: monitoring of the hydrosphere, water quality standards, methods of water treatment, maintaining safe water quality, stewardship.** **8.L.3.1.** Explain how factors such as food, water, shelter and space affect populations in an ecosystem.
ND (1/2017, 2014)	**8.2.2.** Use evidence to generate descriptions, explanations, predictions, and models. **8.7.1.** Explain the interaction of science and technology with social issues (e.g., mining, natural disasters)
OH (1/2017, 2014)	Ohio State Science Standards are not numbered or coded in any way: None—genetics and inheritance focus.
OK (1/2017, 2014)	**MS-ESS3-4** Students who demonstrate understanding can: Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
OR (1/2017, 2014)	NGSS (see CA above).
PA (1/2017, 2002)	*3.3.8.A2* Describe renewable and nonrenewable energy resources. **3.4.8.B2** Compare and contrast decisions to develop and use **technologies** as related to environmental and economic concerns.
RI (1/2017, 2013)	NGSS (see CA above).
SC (1/2017, 2014)	**8.S.1A.1** Ask questions to (1) generate hypotheses for scientific investigations, (2) refine models, explanations, or designs, or (3) extend the results of investigations or challenge claims. **8.S.1A.4** Analyze and interpret data from informational texts, observations, measurements, or investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning or (2) support hypotheses, explanations, claims, or designs. **8.S.1A.8** Obtain and evaluate scientific information to (1) answer questions, (2) explain or describe phenomena, (3) develop models, (4) evaluate hypotheses, explanations, claims, or designs or (5) identify and/or fill gaps in knowledge. Communicate using the conventions and expectations of scientific writing or oral presentations by (1) evaluating grade-appropriate primary or secondary scientific literature, or (2) reporting the results of student experimental investigations.
SD (1/2017, 2015)	**MS-LS2-1** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

	MS-LS2-2 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. **MS-LS2-4** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. **MS-LS2-5** Evaluate competing design solutions for maintaining biodiversity and ecosystem services. **MS-ESS3-3** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. **MS-ESS3-4** Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
TN (1/2017, 2009)	**GLE 0807.Inq.5** Communicate scientific understanding using descriptions, explanations, and models. **GLE 0807.5.5** Describe the importance of maintaining the earth's biodiversity.
TX (1/2017, 2014)	**112.20b11. (C)** explore how short- and long-term environmental changes affect organisms and traits in subsequent populations.
UT (1/2017, K-2: 2010, 3-6: 2002, 7-8: 2003, 9-12: 2003, Earth Science: 2012)	**Standard 2, Objective 2:** Generalize the dependent relationships between organisms. d. Research multiple ways that different scientists have investigated the same ecosystem **Standard 2, Objective 3:** Analyze human influence on the capacity of an environment to sustain living things. *a. Describe specific examples of how humans have changed the capacity of an environment to support specific life forms (e.g., people create wetlands and nesting boxes that increase the number and range of wood ducks, acid rain damages amphibian eggs and reduces population of frogs, clear cutting forests affects squirrel populations, suburban sprawl reduces mule deer winter range thus decreasing numbers of deer).* *b. Distinguish between inference and evidence in a newspaper or magazine article relating to the effect of humans on the environment.* *c. Infer the potential effects of humans on a specific food web.* *d. Evaluate and present arguments for and against allowing a specific species of plant or animal to become extinct, and relate the argument to the of flow energy in an ecosystem.*
VT (1/2017, 2013)	NGSS (see CA above).
VA (1/2017, 2016)	See subject-specific documents.
WA (1/2017, 2009)	NGSS (see CA above).
WV	NGSS (see CA above).

(1/2017, 2016)	
WI (1/2017, 2012)	**A.8.1** Develop their understanding of the science themes by using the themes to frame questions about science-related issues and problems. **A.8.3** Defend explanations and models by collecting and organizing evidence that supports them and critique explanations and models by collecting and organizing evidence that conflicts with them. **C.8.1** Identify questions they can investigate using resources and equipment they have available **C.8.2** Identify data and locate sources of information including their own records to answer the questions being investigated **C.8.5** Use accepted scientific knowledge, models, and theories to explain their results and to raise further questions about their investigations **C.8.6** State what they have learned from investigations, relating their inferences to scientific knowledge and to data they have collected **C.8.7** Explain their data and conclusions in ways that allow an audience to understand the questions they selected for investigation and the answers they have developed **C.8.8** Use computer software and other technologies to organize, process, and present their data **C.8.9** Evaluate, explain, and defend the validity of questions, hypotheses, and conclusions to their investigations **C.8.10** Discuss the importance of their results and implications of their work with peers, teachers, and other adults **C.8.11** Raise further questions which still need to be answered **F.8.8** Show through investigations how organisms both depend on and contribute to the balance or imbalance of populations and/or ecosystems, which in turn contribute to the total system of life on the planet **F.8.9** Explain how some of the changes on the earth are contributing to changes in the balance of life and affecting the survival or population growth of certain species **F.8.10** Project how current trends in human resource use and population growth will influence the natural environment, and show how current policies affect those trends. **G.8.2** Explain how current scientific and technological discoveries have an influence on the work people do and how some of these discoveries also lead to new careers **G.8.3** Illustrate the impact that science and technology have had, both good and bad, on careers, systems, society, environment, and quality of life **G.8.5** Investigate a specific local problem to which there has been a scientific or technological solution, including proposals for alternative courses of action, the choices that were made, reasons for the choices, any new problems created, and subsequent community satisfaction

	G.8.6 Use current texts, encyclopedias, source books, computers, experts, the popular press, or other relevant sources to identify examples of how scientific discoveries have resulted in new technology **G.8.7** Show evidence of how science and technology are interdependent, using some examples drawn from personally conducted investigations **H.8.1** Evaluate the scientific evidence used in various media (for example, television, radio, Internet, popular press, and scientific journals) to address a social issue, using criteria of accuracy, logic, bias, relevance of data, and credibility of sources **H.8.2** Present a scientific solution to a problem involving the earth and space, life and environmental, or physical sciences and participate in a consensus-building discussion to arrive at a group decision **H.8.3** Understand the consequences of decisions affecting personal health and safety
WY (1/2017, 2016)	**MS-PS1-3.** Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. **MS-LS2-1.** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. **MS-LS2-2.** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. **MS-LS2-4.** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. **MS-LS2-5.** Evaluate competing design solutions for maintaining biodiversity and ecosystem services. **MS-ESS3-3**. Apply scientific principles to design a method for monitoring, evaluating, and managing a human impact on the environment. **MS-ESS3-4.** Construct an argument supported by evidence for how changes in human population and per-capita consumption of natural resources impact Earth's systems. **MS-ETS2-2**. Develop a model defining and prioritizing the impacts of human activity on a particular aspect of the environment, identifying positive and negative consequences of the activity, both short and long-term, and investigate and explain how the ethics and integrity of scientists and engineers and respect for individual property rights might constrain future development.

STATE EDUCATIONAL STANDARDS

HIGH SCHOOL GRADES 9-12, SPLIT BY GRADE (AK & PA)

These Standards have been collected from individual State websites (1/2017). They have been connected to themes that are available in an EPA tool called *EnviroAtlas*.

State (last updated on this chart, Standards adoption year)	**State Science Educational Standards that apply to the Greenway Lesson, separated by individual grades 9-12**
AK—9th grade (1/2017, 2012)	The student demonstrates an understanding that solving problems involves different ways of thinking by [9] SE2.1 questioning, researching, modeling, simulating, and testing a solution to a problem (L) The student demonstrates an understanding of the bases of the advancement of scientific knowledge by [9] SG2.1 explaining the importance of innovations (i.e., microscope, immunization, computer)
AK—10th grade (1/2017, 2012)	The student demonstrates an understanding that solving problems involves different ways of thinking by [10] SE2.1 questioning, researching, modeling, simulating, and testing multiple solutions to a problem (L)
PA—10th grade (1/2017, 2002)	3.4.10.B1 Compare and contrast how the use of **technology** involves weighing the trade-offs between the positive and negative effects. 3.4.10.B2 Demonstrate how humans devise **technologies** to reduce the negative consequences of other **technologies.**
AK—11th grade (1/2017, 2012)	The student demonstrates an understanding that solving problems involves different ways of thinking by [11] SE2.1 questioning, researching, modeling, simulating, and testing multiple solutions to a problem* (L)
PA—12th grade (1/2017, 2002)	3.3.12.A2 Analyze the availability, location, and extraction of Earth's resources. Evaluate the impact of using renewable and nonrenewable energy resources on the Earth's **system.** 3.4.12.B2 Illustrate how, with the aid of **technology**, various aspects of the environment can be monitored to provide information for decision making.

STATE EDUCATIONAL STANDARDS

ALL HIGH SCHOOL GRADES 9-12, NOT SPLIT BY GRADE

These Standards have been collected from individual State websites (1/2017). They have been connected to themes that are available in an EPA tool called *EnviroAtlas*.

State (last updated on this chart, Standards adoption year)	**State Science Educational Standards that apply to the Greenway Lesson, separated by all grades (9-12)**
AL (1/2017, 2015)	Separated by subject areas.
AK (1/2017, 2012)	Separated by grade, see 9-12 above.
AZ (1/2017, 2005)	**Concept 1:** Changes in Environments. Describe the interactions between human populations, natural hazards, and the environment. PO 1. Evaluate how the processes of natural ecosystems affect, and are affected by, humans. **PO 4**. Evaluate the following factors that affect the quality of the environment: • urban development • smoke • volcanic dust
AR (1/2017, 2005)	Separated by subject areas.
CA (1/2017, 2009)	**HS-ETS1-1.** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. **HS-ETS1-2.** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. **HS-ETS1-3.** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. **NGSS Science and Engineering Practices (NGSS APPENDIX F):** 1. Asking questions (for science) and defining problems (for engineering). 4. Analyzing and interpreting data. 7. Engaging in argument from evidence. 8. Obtaining, evaluating, and communicating information.
CO (1/2017, 2009)	Separated by subject areas.
CT (1/2017, 2015)	Separated by subject areas.
DC	NGSS (see CA above).

DE (1/2017, 2013)	NGSS (see CA above).
FL (1/2017, 2014)	Separated by subject areas.
GA (1/2017, new standards up 2017-2018)	Separated by subject areas.
HI (1/2017, 2005)	Separated by subject areas.
ID (1/2017, 2016)	Separated by subject areas.
IL (1/2017, 2011)	NGSS (see CA above).
IN (1/2017, 2016)	Separated by subject areas.
IA (1/2017, 2016)	NGSS (see CA above).
KS (1/2017, 2013)	NGSS (see CA above).
KY (1/2017, 2013)	**HS-LS2-2.** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. **HS-LS2-6.** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. **HS-LS2-7.** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. **HS-LS4-6.** Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. **HS-ESS3-1.** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. **HS-ESS3-4.** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
LA (1/2017, 2016)	Separated by subject areas.

ME (1/2017, 2013)	NGSS (see CA above).
MD (1/2017, 2013)	NGSS (see CA above).
MA (1/2017, 2016)	**HS-ESS3-1.** Construct an explanation based on evidence for how the availability of key natural resources and changes due to variations in climate have influenced human activity. **HS-ESS3-2.** Evaluate competing design solutions for minimizing impacts of developing and using energy and mineral resources, and conserving and recycling those resources, based on economic, social, and environmental cost-benefit ratios. **HS-ESS3-3.** Illustrate relationships among management of natural resources, the sustainability of human populations, and biodiversity.
MI (1/2017, 2015)	NGSS (see CA above).
MN (1/2017, 2009)	**9.1.3.1.1.** Natural and designed systems are made up of components that act within a system and interact with other systems. **9.4.4.2.4.** Personal and community health can be affected by the environment, body functions and human behavior. Explain how environmental factors and personal decisions, such as water quality, air quality and smoking affect personal and community health.
MS (1/2017, 2010)	Separated by subject areas.
MO (1/2017, 2015)	**HS-ESS3-1.** Construct an explanation based on evidence for how the availability of key natural resources and changes due to variations in climate have influenced human activity. **HS-ESS3-2.** Evaluate competing design solutions for minimizing impacts of developing and using energy and mineral resources, and conserving and recycling those resources, based on economic, social, and environmental cost-benefit ratios. **HS-ESS3-3.** Illustrate relationships among management of natural resources, the sustainability of human populations, and biodiversity.
MT (1/2017, 2016)	**1.3** review evidence, communicate and defend results, and recognize that the results of a scientific investigation are always open to revision by further investigations. (e.g., through graphical representation or charts) **1.6** explain how observations of nature form an essential base of knowledge among the Montana American Indians

	5.5 explain how the knowledge of science and technology applies to contemporary Montana American Indian communities (e.g., natural resources development, management and conservation)
NE (1/2017, 2010)	**12.1.1.j** Share information, procedures, results, conclusions, and defend findings to a scientific community (peers, science fair audience, policy makers). **12.1.1.k** Evaluate scientific investigations and offer revisions and new ideas as appropriate. **12.4.2.c** Evaluate the impact of human activity and natural causes on Earth's resources (groundwater, rivers, land, fossil fuels). **12.3.3.d** Analyze factors which may influence environmental quality.
NV (1/2017, 2014)	NGSS (see CA above).
NH (1/2017, 2016)	**S:LS2:11:1.1** Explain how the amount of life an environment can sustain is restricted by the availability of matter and energy, and the ability of the ecosystem to recycle materials. **S:LS2:11:1.2** Describe how the interrelationships and interdependencies among organisms generate stable ecosystems that fluctuate around a state of rough equilibrium for hundreds or thousands of years. **S:LS2:11:1.3** Identify the factors in an ecosystem that can affect its carrying capacity. **S:LS2:11:1.4** Analyze and describe how environmental disturbances, such as climate changes, natural events, human activity and the introduction of invasive species, can affect the flow of energy or matter in an ecosystem. **S:LS2:11:1.5** Using data from a specific ecosystem, explain relationships or make predictions about how environmental disturbance (human impact or natural events) affects the flow of energy or cycling of matter in an ecosystem. **S:LS2:11:1.6** Explain or evaluate potential bias in how evidence is interpreted in reports concerning a particular environmental factor that impacts the biology of humans. **S:LS3:11:1.1** Identify ways humans can impact and alter the stability of ecosystems, such as habitat destruction, pollution, and consumption of resources; and describe the potentially irreversible effects these changes can cause. **S:LS3:11:1.2** Identify ways of detecting, and limiting or reversing environmental damage. **S:LS3:11:1.3** Analyze the aspects of environmental protection, such as ecosystem protection, habitat management, species conservation and environmental agencies and regulations; and evaluate and justify the need for public policy in guiding the use and management of the environment. **S:LS4:11:3.1** Describe how the length and quality of human life are influenced by many factors, including sanitation, diet, medical care, gender, genes, and environmental conditions and personal health behaviors. **S:LS5:11:1.1** Describe ways in which technology has increased our understanding of the life sciences.

	S:LS5:11:1.2 Understand that technology is designed with a particular function in mind, and principles of life science are useful in creating technology for the life sciences. **S:LS5:11:3.1** Describe ways technology can support and improve our understanding of environmental issues. **S:LS5:11:4.1** Explain the kinds of applications of knowledge and skills necessary for jobs/careers specific to the life sciences. **S:SPS1:12:1.4** Ask questions about relationships between and among observable variables as well as theoretical entities.
NJ (1/2017, 2013)	NGSS (see CA above).
NM (1/2017, 2009)	**Strand II:** The Content of Science Standard II (Life Science): Understand the properties, structures, and processes of living things and the interdependence of living things and their environments. 9-12 Benchmark I: **Ecosystems** 1. Know that an ecosystem is complex and may exhibit fluctuations around a steady state or may evolve over time. 2. Describe how organisms cooperate and compete in ecosystems (e.g., producers, decomposers, herbivores, carnivores, omnivores, predator-prey, symbiosis, mutualism). 3. Understand and describe how available resources limit the amount of life an ecosystem can support (e.g., energy, water, oxygen, nutrients). 4. Critically analyze how humans modify and change ecosystems (e.g., harvesting, pollution, population growth, technology).
NY (1/2017, 2015)	NGSS (see CA above).
NC (1/2017, 2011)	Separated by subject areas.
ND (1/2017, 2014)	**9-10.2.3.** Identify questions and concepts that guide scientific investigations. **9-10.5.6.** Explain the effects of human activities (e.g., dams, levees, farming practices, deforestation, land-use practices, land management strategies) on the environment. **9-10.6.1.** Use appropriate technologies and techniques to solve a problem (e.g., computer-assisted tools, Internet, research skills). **11-12.2.4.** Formulate and revise explanations based upon scientific knowledge and experimental data. **11-12.2.8.** Communicate and defend a scientific argument.

	11-12.6.1. Select and use appropriate technologies, tools, and techniques to solve a problem (e.g., computer-assisted tools, Internet, research skills, CBL, graphing calculators). **11-12.6.3.** Explain how designing and implementing technology requires weighing trade-offs between positive and negative impacts on humans and the environment. **11-12.7.1.** Explain the impact of environmental laws and policies on the environment and society (e.g., waste/pollutants from industry, carbon dioxide emissions, location and number of animals in a feedlot versus water supply). **11-12.7.2.** Explain ways renewable and nonrenewable resources are managed (e.g., land reclamation, forest management, CRP, hunting licenses, energy –conserving technologies). **11-12.7.3.** Explain the economic and social impact of using alternative energy resources. **11-12.7.4.** Explain how science and technology can influence personal, industrial, and cultural decision-making (e.g., organ transplants, cloning, stem cell research, genetic manipulation, use of genetic profile, archeological discoveries, land management, resource management).
OH (1/2017, 2014)	Ohio State Science Standards are not numbered or coded in any way: See "Biology" and "Earth Science" courses
OK (1/2017, 2014)	Separated by subject areas.
OR (1/2017, 2014)	NGSS (see CA above).
PA (1/2017, 2002)	NGSS (see CA above).
RI (1/2017, 2013)	NGSS (see CA above).
SC (1/2017, 2014)	Separated by subject areas.
SD (1/2017, 2015)	Separated by subject areas.
TN (1/2017, 2009)	Separated by subject areas.
TX (1/2017, 2014)	Separated by subject areas.
UT (1/2017, K-2: 2010, 3-6: 2002, 7-8:	Separated by subject areas.

2003, 9-12: 2003, Earth Science: 2012)	
VT (1/2017, 2013)	NGSS (see CA above).
VA (1/2017, 2016)	Separated by subject areas.
WA (1/2017, 2009)	NGSS (see CA above).
WV (1/2017, 2016)	NGSS (see CA above).
WI (1/2017, 2012)	**A.12.1** Apply the underlying themes of science to develop defensible visions of the future. **A.12.2** Show how conflicting assumptions about science themes lead to different opinions and decisions about evolution, health, population, longevity, education, and use of resources, and show how these opinions and decisions have diverse effects on an individual, a community, and a country, both now and in the future. **A.12.3** Give examples that show how partial systems, models, and explanations are used to give quick and reasonable solutions that are accurate enough for basic needs. **A.12.5** Show how the ideas and themes of science can be used to make real-life decisions about careers, work places, life-styles, and use of resources. **A.12.6** Identify and, using evidence learned or discovered, replace inaccurate personal models and explanations of science-related events. **A.12.7** Re-examine the evidence and reasoning that led to conclusions drawn from investigations, using the science themes. **B.12.5** Explain how science is based on assumptions about the natural world and themes that describe the natural world. **C.12.5** Use the explanations and models found in the earth and space, life and environmental, and physical sciences to develop likely explanations for the results of their investigations. **C.12.6** Present the results of investigations to groups concerned with the issues, explaining the meaning and implications of the results, and answering questions in terms the audience can understand. **C.12.7** Evaluate articles and reports in the popular press, in scientific journals, on television, and on the Internet, using criteria related to accuracy, degree of error, sampling, treatment of data, and other standards of experimental design. **E.12.4** Analyze the benefits, costs, and limitations of past, present, and projected use of resources and technology and explain the consequences to the environment.

	F.12.8 Using the science themes, infer changes in ecosystems prompted by the introduction of new species, environmental conditions, chemicals, and air, water, or earth pollution. **H.12.1** Using the science themes and knowledge of the earth and space, life and environmental, and physical sciences, analyze the costs, risks, benefits, and consequences of a proposal concerning resource management in the community and determine the potential impact of the proposal on life in the community and the region. **H.12.2** Evaluate proposed policy recommendations (local, state, and/or national) in science and technology for validity, evidence, reasoning, and implications, both short and long-term. **H.12.3** Show how policy decisions in science depend on social values, ethics, beliefs, and time-frames as well as considerations of science and technology. **H.12.4** Advocate a solution or combination of solutions to a problem in science or technology. **H.12.5** Investigate how current plans or proposals concerning resource management, scientific knowledge, or technological development will have an impact on the environment, ecology, and quality of life in a community or region. **H.12.6** Evaluate data and sources of information when using scientific information to make decisions. **H.12.7** When making decisions, construct a plan that includes the use of current scientific knowledge and scientific reasoning.
WY (1/2017, 2016)	**HS-ETS1-1.** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. **HS-ETS1-2.** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. **HS-ETS1-3.** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

STATE EDUCATIONAL STANDARDS

HIGH SCHOOL BIOLOGY/LIFE SCIENCE, ALL 50 STATES & DC

These Standards have been collected from individual State websites (1/2017). They have been connected to themes that are available in an EPA tool called *EnviroAtlas*.

State (last updated on this chart, Standards adoption year)	**High School Biology/Life Science Educational Standards that apply to the "Connecting ecosystems and human health" module**
AL (1/2017, 2015)	**7.** Develop and use models to illustrate examples of ecological hierarchy levels, including biosphere, biome, ecosystem, community, population, and organism
AK (1/2017, 2012)	Separated by grade-level.
AZ (1/2017, 2005)	Separated by "All High school."
AR (1/2017, 2005)	**EBR.8.B.8** Identify the properties of each of the five levels of ecology: ♣ organism ♣ population ♣ community ♣ ecosystem ♣ biosphere **EBR.9.B.1** Analyze the effects of human population growth and technology on the environment/biosphere **EBR.9.B.2** Evaluate long range plans concerning resource use and by-product disposal in terms of their environmental, economic, and political impact
CA (1/2017, 2009)	**HS-LS2-2.** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. **HS-LS2-4.** Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. **HS-LS2-7.** Evaluate and assess impacts on the environment and biodiversity in order to refine or design a solution for detrimental impacts or enhancement for positive impacts. **HS-LS4-6.** Create and/or use a simulation to evaluate the impacts of human activity on biodiversity.

	NGSS Science and Engineering Practices (NGSS APPENDIX F): 1. Asking questions (for science) and defining problems (for engineering). 4. Analyzing and interpreting data. 7. Engaging in argument from evidence. 8. Obtaining, evaluating, and communicating information.
CO (1/2017, 2009)	None.
CT (1/2017, 2015)	NGSS (see CA above).
DC (1/2017, 2013)	NGSS (see CA above).
DE (1/2017, 2013)	NGSS (see CA above).
FL (1/2017, 2014)	**SC.912.L.17.12** Discuss the political, social, and environmental consequences of sustainable use of land. **SC.912.L.17.13** Discuss the need for adequate monitoring of environmental parameters when making policy decisions.
GA (1/2017, new standards up 2017-2018)	**SB5.** Obtain, evaluate, and communicate information to assess the interdependence of all organisms on one another and their environment. a. Plan and carry out investigations and analyze data to support explanations about factors affecting biodiversity and populations in ecosystems. c. Construct an argument to predict the impact of environmental change on the stability of an ecosystem. d. Design a solution to reduce the impact of a human activity on the environment.
HI (1/2017, 2005)	Common Core.
ID (1/2017, 2016)	Goal 1.3: Understand Constancy, Change, and Measurement **9-10.B.1.3.1** Measure changes that can occur in and among systems. (648.03b) **9-10.B.1.3.2** Analyze changes that can occur in and among systems. (648.03b) Goal 5.1: Understand Common Environmental Quality Issues, Both Natural and Human Induced **9-10.B.5.1.1** Analyze environmental issues such as water and air quality, hazardous waste, forest health, and agricultural production. (656.01a)

IL (1/2017, 2011)	NGSS (see CA above).
IN (1/2017, 2016)	**B.3.2** Design, evaluate, and refine a model which shows how human activities and natural phenomena can change the flow of matter and energy in an ecosystem and how those changes impact the environment and biodiversity of populations in ecosystems of different scales, as well as, how these human impacts can be reduced. **B.3.3** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, and identify the impact of changing conditions or introducing non-native species into that ecosystem.
IA (1/2017, 2016)	NGSS (see CA above).
KS (1/2017, 2013)	NGSS (see CA above).
KY (1/2017, 2013)	Separated by "Middle School/High School," not by grade or subject.
LA (1/2017, 2016)	**Interdependence of Organisms:** **27.** Analyze positive and negative effects of human actions on ecosystems (LS-H-D4) (SE-H-A7)
ME (1/2017, 2013)	NGSS (see CA above).
MD (1/2017, 2013)	NGSS (see CA above).
MA (1/2017, 2016)	**HS-LS2-6.** Analyze data to show ecosystems tend to maintain relatively consistent numbers and types of organisms even when small changes in conditions occur but that extreme fluctuations in conditions may result in a new ecosystem. Construct an argument supported by evidence that ecosystems with greater biodiversity tend to have greater resistance to change and resilience. **HS-LS2-7.** Analyze direct and indirect effects of human activities on biodiversity and ecosystem health, specifically habitat fragmentation, introduction of non-native or invasive species, overharvesting, pollution, and climate change. Evaluate and refine a solution for reducing the impacts of human activities on biodiversity and ecosystem health.
MI (1/2017, 2015)	NGSS (see CA above).

MN (1/2017, 2009)	Separated by "All High school."
MS (1/2017, 2010)	**Intro Bio: 3d.** Predict the impact of human activities (e.g., recycling, pollution, overpopulation) on the environment. (DOK 3) **Biology 1:** b. Provide examples to justify the interdependence among environmental elements. (DOK 2).
MO (1/2017, 2015)	**HS-LS2-6.** Analyze data to show ecosystems tend to maintain relatively consistent numbers and types of organisms even when small changes in conditions occur but that extreme fluctuations in conditions may result in a new ecosystem. Construct an argument supported by evidence that ecosystems with greater biodiversity tend to have greater resistance to change and resilience. **HS-LS2-7.** Analyze direct and indirect effects of human activities on biodiversity and ecosystem health, specifically habitat fragmentation, introduction of non-native or invasive species, overharvesting, pollution, and climate change. Evaluate and refine a solution for reducing the impacts of human activities on biodiversity and ecosystem health.
MT (1/2017, 2016)	Benchmarks at end of 4th grade, 8th grade, and upon graduation from high school
NE (1/2017, 2010)	Separated by "All High school."
NV (1/2017, 2014)	NGSS (see CA above).
NH (1/2017, 2016)	Separated into GSEs (Grade Span Expectations), 9-11 (so, "By the end of Grade 11, all students will…")
NJ (1/2017, 2013)	NGSS (see CA above).
NM (1/2017, 2009)	Separated by "All High school."
NY (1/2017, 2015)	NGSS (see CA above).
NC (1/2017, 2011)	Bio.2.2.1 Infer how human activities (including population growth, pollution, global warming, burning of fossil fuels, habitat destruction and introduction of nonnative species) may impact the environment.

	Bio.2.2.2 Explain how the use, protection and conservation of natural resources by humans impact the environment from one generation to the next.
ND (1/2017, 2014)	Separated by "All High school."
OH (1/2017, 2014)	Ohio State Science Standards are not numbered or coded in any way: **Note 3:** Constructing food webs/food chains to show interactions between organisms within ecosystems was covered in upper elementary school and middle school; constructing them as a way to demonstrate content knowledge is not appropriate for this grade. Students may use these diagrams to help explain real-world relationships or events within an ecosystem, but not to identify simple trophic levels, consumers, producers, predator-prey and symbiotic relations.
OK (1/2017, 2014)	**HS-LS2-6**: Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
OR (1/2017, 2014)	NGSS (see CA above).
PA (1/2017, 2002)	NGSS (see CA above).
RI (1/2017, 2013)	NGSS (see CA above).
SC (1/2017, 2014)	**H.B.1A.1** Ask questions to (1) generate hypotheses for scientific investigations, (2) refine models, explanations, or designs, or (3) extend the results of investigations or challenge scientific arguments or claims. **H.B.1A.2** Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others. **H.B.1A.4** Analyze and interpret data from informational texts and data collected from investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning, (2) support or refute hypotheses, explanations, claims, or designs, or (3) evaluate the strength of conclusions. **H.B.1A.8** Obtain and evaluate scientific information to (1) answer questions, (2) explain or describe phenomena, (3) develop models, (4) evaluate hypotheses, explanations, claims, or designs or (5) identify and/or fill gaps in knowledge. Communicate using the conventions and expectations of scientific writing or oral presentations by (1)

	evaluating grade-appropriate primary or secondary scientific literature, or (2) reporting the results of student experimental investigations. **H.B.6D.1** Design solutions to reduce the impact of human activity on the biodiversity of an ecosystem.
SD (1/2017, 2015)	**HS-LS2-6** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms under stable conditions; however, moderate to extreme fluctuations in conditions may result in new ecosystems. **HS-LS2-7** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
TN (1/2017, 2009)	**CLE 3210.Inq.6** Communicate and defend scientific findings. **CLE 3210.T/E.1** Explore the impact of technology on social, political, and economic systems. **CLE 3210.T/E.4** Describe the dynamic interplay among science, technology, and engineering within living, earth-space, and physical systems. **CLE 3210.2.1** Investigate how the dynamic equilibrium of an ecological community is associated with interactions among its organisms. **CLE 3210.2.3** Predict how global climate change, human activity, geologic events, and the introduction of non-native species impact an ecosystem. **CLE 3216.Inq.1** Recognize that science is a progressive endeavor that reevaluates and extends what is already accepted. **CLE 3216.T/E.4** Describe the dynamic interplay among science, technology, and engineering within living, earth-space, and physical systems. **CLE 3216.2.1** Describe how the stability of an ecosystem is maintained.
TX (1/2017, 2014)	None.
UT (1/2017, K-2: 2010, 3-6: 2002, 7-8: 2003, 9-12: 2003, Earth Science: 2012)	**Standard 1, Objective 1:** Summarize how energy flows through an ecosystem. **Standard 1, Objective 2:** Explain relationships between matter cycles and organisms. **Standard 1, Objective 3:** Describe how interactions among organisms and their environment help shape ecosystems. e. Research and evaluate local and global practices that affect ecosystems.
VT	NGSS (see CA above).

(1/2017, 2013)	
VA (1/2017, 2016)	Life Science. **LS.1d,i,-j.** The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which *d) models and simulations are constructed and used to illustrate and explain phenomena;* *i) patterns are identified in data and are interpreted and evaluated; and* *j) current applications are used to reinforce life science concepts.* **LS.6a-c.** The student will investigate and understand that organisms within an ecosystem are dependent on one another and on nonliving components of the environment. Key concepts include *a) the carbon, water, and nitrogen cycles;* *b) interactions resulting in a flow of energy and matter throughout the system;* *c) complex relationships within terrestrial, freshwater, and marine ecosystems* **LS.9a-c.** The student will investigate and understand how organisms adapt to biotic and abiotic factors in an ecosystem. Key concepts include *a) differences between ecosystems and biomes;* *b) characteristics of land, marine, and freshwater ecosystems; and* *c) adaptations that enable organisms to survive within a specific ecosystem.* **LS.10b-c.** The student will investigate and understand that ecosystems, communities, populations, and organisms are dynamic, change over time, and respond to daily, seasonal, and long-term changes in their environment. Key concepts include *b) factors that increase or decrease population size; and* *c) eutrophication, climate changes, and catastrophic disturbances.* **LS.11a-d.** The student will investigate and understand the relationships between ecosystem dynamics and human activity. Key concepts include *a) food production and harvest;* *b) change in habitat size, quality, or structure;* *c) change in species competition;* *d) population disturbances and factors that threaten or enhance species survival; and e) environmental issues.* **BIO.8a-e.** The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include *a) interactions within and among populations including carrying capacities, limiting factors, and growth curves;* *b) nutrient cycling with energy flow through ecosystems;*

	c) succession patterns in ecosystems; *d) the effects of natural events and human activities on ecosystems; and* *e) analysis of the flora, fauna, and microorganisms of Virginia ecosystems.*
WA (1/2017, 2009)	NGSS (see CA above).
WV (1/2017, 2016)	NGSS (see CA above).
WI (1/2017, 2012)	Separated by "All High school."
WY (1/2017, 2016)	**HS-LS2-2.** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. **HS-LS2-4.** Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. **HS-LS2-7.** Evaluate and assess impacts on the environment and biodiversity in order to refine or design a solution for detrimental impacts or enhancement for positive impacts. **HS-LS4-6.** Create and/or use a simulation to evaluate the impacts of human activity on biodiversity.

STATE EDUCATIONAL STANDARDS

HIGH SCHOOL EARTH/ENVIRONMENTAL SCIENCE, ALL 50 STATES & DC

These Standards have been collected from individual State websites (1/2017). They have been connected to themes that are available in an EPA tool called *EnviroAtlas*.

State (last updated on this chart, Standards adoption year)	**High School Earth/Environmental Science (*excluding AP Environmental Science*) Educational Standards that apply to the "Connecting ecosystems and human health" module**
AL (1/2017, 2015)	**Environmental Science:** **4.** Engage in argument from evidence to evaluate how biological or physical changes within ecosystems (e.g., ecological succession, seasonal flooding, volcanic eruptions) affect the number and types of organisms, and that changing conditions may result in a new or altered ecosystem. **10**. Design solutions for protection of natural water resources (e.g., bioassessment, methods of water treatment and conservation) considering properties, uses, and pollutants (e.g., eutrophication, industrial effluents, agricultural runoffs, point and nonpoint pollution resources).***** **11.** Engage in argument from evidence to defend how coastal, marine, and freshwater sources (e.g., estuaries, marshes, tidal pools, wetlands, beaches, inlets, rivers, lakes, oceans, coral reefs) support biodiversity, economic stability, and human recreation. **13.** Obtain, evaluate, and communicate information based on evidence to explain how key natural resources (e.g., water sources, fertile soils, concentrations of minerals and fossil fuels), natural hazards, and climate changes influence human activity (e.g., mass migrations). **14**. Analyze cost-benefit ratios of competing solutions for developing, conserving, managing, recycling, and reusing energy and mineral resources to minimize impacts in natural systems (e.g., determining best practices for agricultural soil use, mining for coal, and exploring for petroleum and natural gas sources). **15.** Construct an explanation based on evidence to determine the relationships among management of natural resources, human sustainability, and biodiversity (e.g., resources, waste management, per capita consumption, agricultural efficiency, urban planning).

	16. Obtain and evaluate information from published results of scientific computational models to illustrate the relationships among Earth's systems and how these relationships may be impacted by human activity (e.g., effects of an increase in atmospheric carbon dioxide on photosynthetic biomass, effect of ocean acidification on marine populations).
AK (1/2017, 2012)	Separated by grade-level.
AZ (1/2017, 2005)	Separated by "All High school."
AR (1/2017, 2005)	**Environmental Science:** **PD.1.ES.9** Construct and interpret information on topographic maps. **BD.2.ES.8** Describe biodiversity. **BD.2.ES.9** Explain how limiting factors affect populations and ecosystems. **SP.3.ES.1** Explain the reciprocal relationships between Earth's processes (natural disasters) and human activities. **SP.3.ES.5** Evaluate the impact of different points of view on health, population, resource, and environmental issues: • governmental • economic • societal **SP.3.ES.9** Evaluate personal and societal benefits when examining health, population, resource, and environmental issues. **SP.3.ES.10** Predict the long-term societal impact of specific health, population, resource, and environmental issues. **SP.3.ES.11** Investigate the effect of public policy decisions on health, population, resource, and environmental issues
CA (1/2017, 2009)	**HS-ESS2-2.** Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. **HS-ESS3-1.** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. **HS-ESS3-3.** Use computational tools to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. **HS-ESS3-4**. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. **HS-ESS3-6**. Use the results of a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. **NGSS Science and Engineering Practices (NGSS APPENDIX F):** 1. Asking questions (for science) and defining problems (for engineering). 4. Analyzing and interpreting data.

	7. Engaging in argument from evidence. 8. Obtaining, evaluating, and communicating information.
CO (1/2017, 2009)	None.
CT (1/2017, 2015)	NGSS (see CA above).
DC (1/2017, 2013)	NGSS (see CA above).
DE (1/2017, 2013)	NGSS (see CA above)
FL (1/2017, 2014)	None.
GA (1/2017, new standards up 2017-2018)	**Earth Science:** **SES6.** Obtain, evaluate, and communicate information about how life on Earth responds to and shapes Earth's systems. c. Ask questions to investigate and communicate how humans depend on Earth's land and water resources, which are distributed unevenly around the planet as a result of past geological and environmental processes. **Environmental Science:** **SEV1.** Obtain, evaluate, and communicate information to investigate the flow of energy and cycling of matter within an ecosystem. a. Develop and use a model to compare and analyze the levels of biological organization including organisms, populations, communities, ecosystems, and biosphere. c. Construct an argument to predict changes in biomass, biodiversity, and complexity within ecosystems, in terms of ecological succession. **SEV4.** Obtain, evaluate, and communicate information to analyze human impact on natural resources. a. Construct and revise a claim based on evidence on the effects of human activities on natural resources: Human Activities, Natural Resources, Agriculture, Forestry, Ranching, Mining, Urbanization, Fishing, Water use, Pollution, Desalination, Waste water treatment, Land, Water, Air, Organisms. **SEV5**. Obtain, evaluate, and communicate information about the effects of human population growth on global ecosystems. a. Construct explanations about the relationship between the quality of life and human impact on the environment in terms of population growth, education, and gross national product. c. Construct an argument from

	evidence regarding the ecological effects of human innovations (Agricultural, Industrial, Medical, and Technological Revolutions) on global ecosystems. d. Design and defend a sustainability plan to reduce your individual contribution to environmental impacts, taking into account how market forces and societal demands (including political, legal, social, and economic) influence personal choices.
HI (1/2017, 2005)	Common Core.
ID (1/2017, 2016)	**Earth Science:** **Goal 5.1:** Understand Common Environmental Quality Issues, Both Natural and Human Induced 8-**9.ES.5.1.1**: Analyze environmental issues such as water and air quality, hazardous waste, and depletion of natural resources. (656.01a)
IL (1/2017, 2011)	NGSS (see CA above).
IN (1/2017, 2016)	**Env.1.2** Understand and explain that human beings are part of Earth's ecosystems and give examples of how human activities can, deliberately or inadvertently, alter ecosystems. **Env.1.7** Identify tools and technologies used to adapt and alter environments and natural resources in order to meet human physical and cultural needs. **Env.2.11** Recognize and describe the role of natural resources in providing the raw materials for an industrial society. **Env.5.2** Explain how the great diversity of species increases the chance that at least some living organisms will survive in the event of major global changes. **Env.5.6** Identify and explain the three levels of biodiversity: genetic, species, and ecosystem. **Env.6.3** Describe and give examples about how the decisions of one generation both provide and limit the range of possibilities open to the next generation. **Env.8.1** Demonstrate a knowledge of the distribution of natural resources in the U.S. and the world, and explain how natural resources influence relationships among nations. **Env.8.2** Understand and describe the concept of integrated natural resource management and the values of managing natural resources as an ecological unit. **Env.8.6** Understand and describe the concept and the importance of natural and human recycling in conserving our natural resources.
IA (1/2017, 2016)	NGSS (see CA above).
KS	NGSS (see CA above).

(1/2017, 2013)	
KY (1/2017, 2013)	Separated by "All High school."
LA (1/2017, 2016)	**Science and the Environment, Ecological Systems and Interactions** **8.** Explain how species in an ecosystem interact and link in a complex web (SE-HA7) (SE-H-A10) **11.** Explain why biodiversity is essential to the survival of organisms (SE-H-A9) **16.** Evaluate the effectiveness of natural resource management in Louisiana (SE-HB4) (SE-H-B5) **18.** Identify the factors that affect sustainable development (SE-H-B6) **Environmental Awareness and Protection** **19.** Determine the interrelationships of clean water, land, and air to the success of organisms in a given population (SE-H-C1) **20.** Relate environmental quality to quality of life (SE-H-C2) **21.** Analyze the effect of common social, economic, technological, and political considerations on environmental policy (SE-H-C3) **22.** Analyze the risk-benefit ratio for selected environmental situations (SE-H-C4) **23.** Describe the relationship between public support and the enforcement of environmental policies (SE-H-C5) **Personal Choices and Responsible Actions** **26.** Determine local actions that can affect the global environment (SE-H-D4) **27.** Describe how accountability toward the environment affects sustainability (SE-HD5)
ME (1/2017, 2013)	NGSS (see CA above).
MD (1/2017, 2013)	NGSS (see CA above).
MA (1/2017, 2016)	None.
MI (1/2017, 2015)	NGSS (see CA above).
MN (1/2017, 2009)	Separated by "All High school."

MS (1/2017, 2010)	**Earth Science:** **5a.** Draw conclusions about how life on Earth shapes Earth systems and responds to the interaction of Earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3) **Environmental Science:** **3a.** Summarize the effects of human activities on resources in the local environments. (DOK 2) Sources, uses, quality, and conservation of water Renewable and nonrenewable resources Effects of pollution (e.g., water, noise, air, etc.) on the ecosystem **3b.** Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere and atmosphere and develop a logical argument to support how communities restore ecosystems. (DOK 3) **Spatial Information Science:** **2.** Develop an understanding of geographic information systems. a. Demonstrate the basic concepts of global positioning systems (GPS) by determining locations, (e.g., latitude, longitude, and elevation of the school flag pole or a site where a GPS receiver is unable to make an accurate measurement). (DOK 1) **2f.** Explain the basic concepts of data and image processing. (DOK 1) Types of data (e.g., raster, vector, and attribute) Variety of sources for geological data and imaging. **2h.** Explain how data sets are geo-referenced and geo-rectified. (DOK 1) **2i.** Assess the quality and accuracy of GPS and/or remote sensing data. (DOK 2) **2j.** Analyze and apply the basic concepts of geographic information systems. (DOK 2) Compatible geographic data layers of information utilizing computer software Relationships between geographic data Geographic information image showing results of analysis **2k.** Draw conclusions based on analysis and summary of geographic image information results. (DOK 3) **2l.** Research and defend a variety of applications for geographic information systems. (DOK 3) m. Describe the proper use and care of GPS receivers, computers, and other scientific equipment. (DOK 1)
MO (1/2017, 2015)	None.
MT (1/2017, 2016)	Benchmarks at end of 4th grade, 8th grade, and upon graduation from high school
NE (1/2017, 2010)	Separated by "All High school."
NV	NGSS (see CA above).

(1/2017, 2014)	
NH (1/2017, 2016)	Separated into GSEs (Grade Span Expectations), 9-11 (so, "By the end of Grade 11, all students will…"
NJ (1/2017, 2013)	NGSS (see CA above).
NM (1/2017, 2009)	Separated by "All High school."
NY (1/2017, 2015)	NGSS (see CA above).
NC (1/2017, 2011)	**EEn.2.4.1** Evaluate human influences on freshwater availability. **EEn.2.4.2** Evaluate human influences on water quality in North Carolina's river basins, wetlands and tidal environments. **EEn.2.5.5** Explain how human activities affect air quality. **EEn.2.6.3** Analyze the impacts that human activities have on global climate change (such as burning hydrocarbons, greenhouse effect, and deforestation). **EEn.2.6.4** Attribute changes to Earth's systems to global climate change (temperature change, changes in pH of ocean, sea level changes, etc.). **EEn.2.7.1** Explain how abiotic and biotic factors interact to create the various biomes in North Carolina. **EEn.2.7.3** Explain how human activities impact the biosphere. **EEn.2.8.1** Evaluate alternative energy technologies for use in North Carolina. **EEn.2.8.2** Critique conventional and sustainable agriculture and aquaculture practices in terms of their environmental impacts.
ND (1/2017, 2014)	Separated by "All High school."
OH (1/2017, 2014)	Ohio State Science Standards are not numbered or coded in any way: **EARTH SYSTEMS: INTERCONNECTED SPHERES OF EARTH** • Biosphere • Evolution and adaptation in populations • Biodiversity • Ecosystems (equilibrium, species interactions, stability) • Population dynamics • Atmosphere • Atmospheric properties and currents • Lithosphere • Geologic events and processes • Hydrosphere • Oceanic currents and patterns (as they relate to climate) • Surface and ground water flow patterns and movement • Cryosphere • Movement of matter and energy through the hydrosphere, lithosphere, atmosphere and biosphere •

	Energy transformations on global, regional and local scales • Biogeochemical cycles • Ecosystems • Climate and weather **EARTH'S RESOURCES** • Energy resources • Renewable and nonrenewable energy sources and efficiency • Alternate energy sources and efficiency • Resource availability • Mining and resource extraction • Air and air pollution • Primary and secondary contaminants • Greenhouse gases • Clean Air Act • Water and water pollution • Potable water and water quality • Hypoxia, eutrophication • Clean Water Act • Point source and non-point source contamination • Soil and land • Desertification • Mass wasting and erosion • Sediment contamination • Land use and land management (including food production, agriculture and zoning) • Solid and hazardous waste • Wildlife and wilderness • Wildlife and wilderness management • Endangered species GLOBAL **ENVIRONMENTAL PROBLEMS AND ISSUES** • Human population • Potable water quality, use and availability • Climate change • Sustainability • Species depletion and extinction • Air quality • Food production and availability • Deforestation and loss of biodiversity • Waste management (solid and hazardous)
OK (1/2017, 2014)	**HS-ESS2-2** Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks and interactions that cause changes to other Earth's systems. **HS-ESS2-5** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. **HS-ESS3-2** Evaluate competing design solutions for developing, managing, and utilizing natural resources based on cost-benefit ratios. **HS-LS2-1** Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. **HS-LS2-2** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. **HS-LS2-4** Use a mathematical representation to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. **HS-LS2-6** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. **HS-LS2-7** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment biodiversity. **HS-ESS3-2** Evaluate competing design solutions for developing, managing, and utilizing natural resources based on cost-benefit ratios.

	HS-ESS3-3 Create a computational simulation to illustrate the relationship among management of natural resources, the sustainability of human populations, and biodiversity. **HS-ESS3-4** Evaluate or refine a technological solution that reduces the impacts of human activities on natural systems.
OR (1/2017, 2014)	NGSS (see CA above).
PA (1/2017, 2002)	NGSS (see CA above).
RI (1/2017, 2013)	NGSS (see CA above).
SC (1/2017, 2014)	**H.E.1A.1** Ask questions to (1) generate hypotheses for scientific investigations, (2) refine models, explanations, or designs, or (3) extend the results of investigations or challenge scientific arguments or claims. **H.E.1A.2** Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others. **H.E.1A.4** Analyze and interpret data from informational texts and data collected from investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning, (2) support or refute hypotheses, explanations, claims, or designs, or (3) evaluate the strength of conclusions. **H.E.1A.6** Construct explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams. **H.E.1A.8** Obtain and evaluate scientific information to (1) answer questions, (2) explain or describe phenomena, (3) develop models, (4) evaluate hypotheses, explanations, claims, or designs or (5) identify and/or fill gaps in knowledge. Communicate using the conventions and expectations of scientific writing or oral presentations by (1) evaluating grade-appropriate primary or secondary scientific literature, or (2) reporting the results of student experimental investigations. **H.E.3B.2** Construct scientific arguments to support claims that responsible management of natural resources is necessary for the sustainability of human societies and the biodiversity that supports them. **H.E.3B.4** Obtain and evaluate available data on a current controversy regarding human activities which may affect the frequency, intensity, or consequences of natural hazards.

	H.E.3B.5 Define problems caused by the impacts of locally significant natural hazards and design possible devices or solutions to reduce the impacts of such natural hazards on human activities. **H.E.6A.2** Obtain and communicate information to explain how location, movement, and energy transfers are involved in making water available for use on Earth's surface (including lakes, surface-water drainage basins, freshwater wetlands, and groundwater zones). **H.E.6A.3** Plan and conduct controlled scientific investigations to determine how a change in stream flow might affect areas of erosion and deposition of a meandering alluvial stream. **H.E.6A.4** Analyze and interpret data of a local drainage basin to predict how changes caused by human activity and other factors influence the hydrology of the basin and amount of water available for use in the ecosystem. **H.E.6A.5** Analyze and interpret data to describe how the quality of the water in drainage basins is influenced by natural and human factors (such as land use, domestic and industrial waste, weather/climate conditions, topography of the river channel, pollution, or flooding).
SD (1/2017, 2015)	**HS-ESS3-1** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. **HS-ESS3-3** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. **HS-ESS3-4** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. **HS-ESS3-6** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
TN (1/2017, 2009)	**CLE 3204.Inq.1** Recognize that science is a progressive endeavor that 93204.Inq.1 Trace the historical development of a scientific principle reevaluates and extends what is already accepted. **CLE 3204.T/E.4** Describe the dynamic interplay among science, technology, and engineering within living, earth-space, and physical systems. **CLE 3260.T/E.1** Explore the impact of technology on social, political, and economic systems. **CLE 3260.2.2** Discuss the roles of biodiversity and coevolution in ecosystems. **CLE 3260.4.1** Examine common resource use practices in agriculture, forestry, urban/suburban development, mining, and fishing. **CLE 3260.4.2** Explore best management practices related to water and soil resources. **CLE 3260.4.3** Compare and contrast preservation and conservation. **CLE 3260.4.4** Evaluate the impact of human activities on natural resources.

	CLE 3260.6.1 Investigate the causes, environmental effects, and methods for controlling/preventing land, air and water pollution. **CLE 3260.6.2** Apply case studies to relate land, air, and water pollution to human health issues. **CLE 3260.6.3** Explore methods used for remediation of land, air and water pollution. **CLE 3260.6.4** Research local and national environmental legislation related to protecting land, air and water resources. **CLE 3260.6.5** Research local and state methods used for solid waste reduction, recycling and disposal; compare them to methods used in other developed countries. **CLE 3255.1.4** Investigate various approaches to maintain biodiversity. **CLE 3255.4.4** Summarize the human impact on ecosystems. **CLE 3255.4.5** Describe how biodiversity relates to stability of an ecosystem. **CLE 3255.5.5** Identify how humans impact biomes. **CLE 3255.6.1** Investigate the role of public lands in sustaining biodiversity. **CLE 3255.6.2** Examine state, national, and international efforts to sustain native species and ecosystems. **CLE 3255.6.3** Evaluate the impact of personal actions on the environment. **CLE 3255.6.4** Identify and explain choices you can make to lessen your impact on the environment.
TX (1/2017, 2014)	**112.37.c3E.** describe the connection between environmental science and future careers **112.37.c4F.** predict how the introduction or removal of an invasive species may alter the food chain and affect existing populations in an ecosystem. **112.37.c4H.** research and explain the causes of species diversity and predict changes that may occur in an ecosystem if species and genetic diversity is increased or reduced **112.37.c5A-F.** (A) summarize methods of land use and management and describe its effects on land fertility; (B) identify source, use, quality, management, and conservation of water; (C) document the use and conservation of both renewable and non-renewable resources as they pertain to sustainability; (D) identify renewable and non-renewable resources that must come from outside an ecosystem such as food, water, lumber, and energy; (E) analyze and evaluate the economic significance and interdependence of resources within the environmental system; and

	(F) evaluate the impact of waste management methods such as reduction, reuse, recycling, and composting on resource availability. **112.37.c6C.** Explain the flow of energy in an ecosystem, including conduction, convection, and radiation. **112.37.c9A-B.** (A) identify causes of air, soil, and water pollution, including point and nonpoint sources; (B) investigate the types of air, soil, and water pollution such as chlorofluorocarbons, carbon dioxide, pH, pesticide runoff, thermal variations, metallic ions, heavy metals, and nuclear waste. **112.37.c9D-G.** (D) describe the effect of pollution on global warming, glacial and ice cap melting, greenhouse effect, ozone layer, and aquatic viability; (E) evaluate the effect of human activities, including habitat restoration projects, species preservation efforts, nature conservancy groups, hunting, fishing, ecotourism, all terrain vehicles, and small personal watercraft, on the environment; (F) evaluate cost-benefit trade-offs of commercial activities such as municipal development, farming, deforestation, over-harvesting, and mining; (G) analyze how ethical beliefs can be used to influence scientific practices such as methods for increasing food production **112.37.c9I-J.** (I) discuss the impact of research and technology on social ethics and legal practices in situations such as the design of new buildings, recycling, or emission standards; (J) research the advantages and disadvantages of "going green" such as organic gardening and farming, natural methods of pest control, hydroponics, xeriscaping, energy-efficient homes and appliances, and hybrid cars.
UT (1/2017, K-2: 2010, 3-6: 2002, 7-8: 2003, 9-12: 2003, Earth Science: 2012)	**Standard 3, Objective 3:** Examine the natural and human-caused processes that cause Earth's climate to change over intervals of time ranging from decades to millennia. *e. Investigate the current and potential consequences of climate change (e.g., ocean acidification, sea level rise, desertification, habitat loss) on ecosystems, including human communities.* **Standard 4, Objective 2:** Analyze the characteristics and importance of freshwater found on Earth's surface and its effect on living systems. *b. Plan and conduct an experiment to investigate biotic and abiotic factors that affect freshwater ecosystems.* *c. Using data collected from local water systems, evaluate water quality and conclude how pollution can make water unavailable or unsuitable for life.*

	d. Research and report how communities manage water resources (e.g., distribution, shortages, quality, flood control) to address social, economic, and environmental concerns. **Standard 4, Objective 3:** Analyze the physical, chemical, and biological dynamics of the oceans and the flow of energy through the oceans. *e. Evaluate the impact of human activities (e.g., sediment, pollution, overfishing) on ocean systems.* **Standard 5, Objective 2:** Describe how humans depend on Earth's resources. **Standard 5, Objective 3:** Indicate how natural hazards pose risks to humans. *b. Evaluate and give examples of human activities that can contribute to the frequency and intensity of some natural hazards (e.g., construction that may increase erosion, human causes of wildfires, climate change).* *c. Document how scientists use technology to continually improve estimates of when and where natural hazards occur.* *d. Investigate and report how social, economic, and environmental issues affect decisions about human-engineered structures (e.g., dams, homes, bridges, roads).*
VT (1/2017, 2013)	NGSS (see CA above).
VA (1/2017, 2016)	**ES.2a-d.** The student will demonstrate an understanding of the nature of science and scientific reasoning and logic. Key concepts include *a) science explains and predicts the interactions and dynamics of complex Earth systems;* *b) evidence is required to evaluate hypotheses and explanations;* *c) observation and logic are essential for reaching a conclusion; and* *d) evidence is evaluated for scientific theories.* **ES.6a-d.** The student will investigate and understand the differences between renewable and nonrenewable resources. Key concepts include *a) fossil fuels, minerals, rocks, water, and vegetation;* *b) advantages and disadvantages of various energy sources;* *c) resources found in Virginia; and* *d) environmental costs and benefits.* **ES.8d-f.** The student will investigate and understand how freshwater resources are influenced by geologic processes and the activities of humans. Key concepts include *d) identification of sources of fresh water including rivers, springs, and aquifers, with reference to the hydrologic cycle; e) dependence on freshwater resources and the effects of human usage on water quality; and f) identification of the major watershed systems in Virginia, including the Chesapeake Bay and its tributaries.*

WA (1/2017, 2009)	NGSS (see CA above).
WV (1/2017, 2016)	NGSS (see CA above).
WI (1/2017, 2012)	Separated by "All High school."
WY (1/2017, 2016)	**HS-ESS2-2.** Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. **HS-ESS2-5.** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. **HS-ESS3-1.** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. **HS-ESS3-3.** Use computational tools to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. **HS-ESS3-4**. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. **HS-ESS3-6**. Use the results of a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

The following Eco-Health Notecards can be found online for your use with this lesson:

- Elementary Notecards, Double-Sided
- Middle/High School+ Notecards, Double-Sided
- Middle/High School+ Notecards, Single-Sided