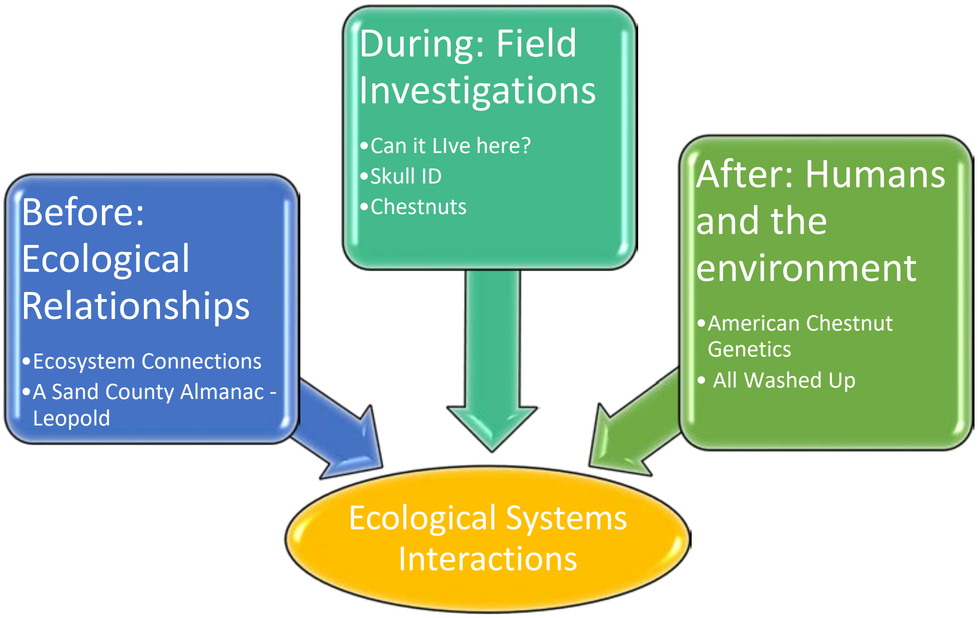
YOUNG ECOLOGISTS



Your students will be visiting Blandy to engage in a field investigation focused on ecological systems and interactions.

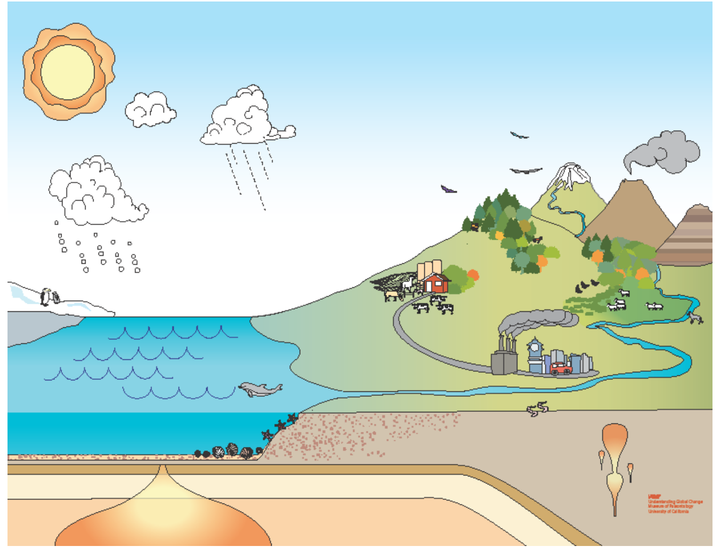
To enhance classroom connections, we have developed this lesson cluster. **Field investigations** are more meaningful to students when they are integrated into their curriculum. This lesson cluster can be used to: introduce ecological concepts, increase depth of knowledge by synthesizing a variety of components in a systems approach, and review and reflect on concepts. **Before-visit activities** increase student awareness of the process of science, understanding of ecological systems, and create literacy connections with historical conservation figures. With the **after-visit activities**, students synthesize data and concepts learned /gathered in the field to explain phenomena in ecological systems concepts.

BEFORE 1: Ecosystem Connections

Before your visit to increase student awareness of the science process and understanding of ecological systems, use this activity developed by Berkeley and HHMI. https://ugc.berkeley.edu/teaching-resources/

VA Standards Addressed: Science (2018) LS.6, LS.8, LS.11

Lesson Preparation:



1. Download the video. https://www.hhmi.org/biointeractive/trophic-cascades-salt-marsh-ecosystems
2. Print (the larger the better) and laminate the "Earth Scene" one for each group.
3. Print, cut, and laminate (optional) the "IconsSets" (best if done in color). NOTE: there are two versions of the cards so the lesson can scaffold to a variety of grades, cognitive levels, English language learners, etc.
4. For an example of how students may lay out the system using the storyboard, refer to slide 9 of Young Ecologist HHMI StoryboardSlides pdf.

Instructional Strategy:

1. Open Young Ecologist HHMI StoryboardSlides pdf and project on your smartboard or other presentation device.
2. On slide 1, watch video with students. https://www.hhmi.org/biointeractive/trophic-cascades-salt-marsh-ecosystems Ask, "What science concepts and research processes are discussed in the video?"
3. Group students in teams of not more than three (ideally pairs).
4. Provide the following directions to your students:
   a. Slides 3, 4, 5- Next, working in pairs, identify 3 or 4 measurable changes (the blue cards) that are most relevant to Brian Silliman's research from your stack (Limit the number of cards presented to 8-10 of the total blue cards). Place the icon cards on the storyboard (slide 4) in an appropriate place, draw arrows to represent relationships, cause & effect, input or outputs. Then label the arrows to explain why you connected them (slide 5).
   b. Slides 7- Identify 3 or 4 Earth systems (yellow cards) most relevant to the research from your stack. Place them on storyboard and draw and label arrows as before
   c. Slide 8- Identify 3 or 4 causes of change (red icon cards) from your stack and then place, draw and label as before.
   d. Slide 9 shows an example of a completed storyboard.
5. Instruct students to share their storyboards with the other groups and explain their reasoning for the connections they made. How is this a system? What are some differences between?
6. Conclusion- Ask students: How are your storyboards systems? While on our field investigation, make note of system connections you observe and consider how you are engaging in the process of science.

BEFORE 2: *A Sand County Almanac* by Aldo Leopold

Background: Aldo Leopold is considered the father of wildlife ecology and the United States' wilderness system. He was a conservationist, forester, philosopher, educator, writer, and outdoor enthusiast. Among his best known ideas is the “land ethic,” which calls for an ethical, caring relationship between people and nature.

VA Standards addressed: English (2017) 7.1, 7.4, 7.6. Science (2018) LS.6

Instructional Strategy:

1. Students will read one of the excerpts from *A Sand County Almanac*. “Back from the Argentine” or “November”. Instruct them to note any unfamiliar words, figurative language. They should also read to be prepared to discuss the author’s word choice and language, identify the main ideas, and summarize the supporting details.
2. Next, ask students to have a small group discussion: What is the author trying to convey in this passage? How did this passage make you feel? Do you think this was the intention of the author? Why or why not?
3. Science and language arts connections: Students re-read the passage, this time noting any science concepts, skills, and vocabulary found in the passage. In their small groups, they will discuss. To increase engagement with the task, consider making it a competition to identify the most unique science concepts, skills, or vocabulary. Then, transfer their notes to a whiteboard/smartboard or use Post-its to write the:
    a. Main ideas
    b. Supporting details
    c. Scientific concepts, skills, and vocabulary
4. Ask: What did you learn from this passage about ecology and natural systems? Make a food web or diagram explaining what you learned.
5. Extension: Students research another published ecologist, conservationist, etc. and choose a passage to share with the class and explain why they chose that excerpt.

A SAND COUNTY ALMANAC EXCERPTS ALDO LEOPOLD

Back from the Argentine

When dandelions have set the mark of May on Wisconsin pastures, it is time to listen for the final proof of spring. Sit down on a tussock, cock your ears at the sky, dial out the bedlam of meadowlarks and redwings, and soon you may hear it: the flight-song of the upland plover, just now back from the Argentine.

If your eyes are strong, you may search the sky and see him, wings aquiver, circling among the woolly clouds. If your eyes are weak, don't try it; just watch the fence posts. Soon a flash of silver will tell you on which post the plover has alighted and folded his long wings. Whoever invented the word 'grace' must have seen the wing-folding of the plover. There he sits; his whole being says it's your next move to absent yourself from his domain. The county records may allege that you own this pasture, but the plover airily rules out such trivial legalities. He has just flown 4000 miles to reassert the title he got from the Indians, and until the young plovers are a-wing, this pasture is his, and none may trespass without his protest.

Somewhere nearby, the hen plover is brooding the four large pointed eggs which will shortly hatch four precocial chicks. From the moment their down is dry, they scamper through the grass like mice on stilts, quite able to elude your clumsy efforts to catch them. At thirty days, the chicks are full-grown; no other fowl develops with equal speed. By August they have graduated from *Flying* school, and on cool August nights you can hear their whistled signals as they set wing for the pampas, to prove again the age-old unity of the Americas. Hemisphere solidarity is new among states- men, but not among the feathered navies of the sky.

The upland plover fits easily into the agricultural countryside. He follows the black-and-white buffalo, which now pasture his prairies, and finds them an acceptable substitute for brown ones. He nests in hayfields as well as pastures, but unlike the clumsy pheasant, does not get caught in hay mowers. Well before the hay is ready to cut, the young plovers are a-wing and away. In farm country, the plover has only two real enemies: the gully and the drain- age ditch. Perhaps we shall one day find that these are our enemies, too.

There was a time in the early 1900's when Wisconsin farms nearly lost their immemorial timepiece, when May pastures greened in silence, and August nights brought no whistled reminder of impending fall. Universal gunpowder, plus the lure of plover-on-toast for post-Victorian banquets, had taken too great a toll. The belated protection of the federal migratory bird laws came just in time.

NOVEMBER

November is, for many reasons, the month for the axe. It is warm enough to grind an axe without freezing, but cold enough to fell a tree in comfort. The leaves are off the hardwoods, so that one can see just how the branches intertwine, and what growth occurred last summer. Without this clear view of treetops, one cannot be sure which tree, if any, needs felling for the good of the land. I have read many definitions of what is a conservationist, and written not a few myself, but I suspect that the best one is written not with a pen, but with an axe. It is a matter of what a man thinks about while chopping, or while deciding what to chop. A conservationist is one who is humbly aware that with each stroke he is writing his signature on the face of his land. Signatures of course differ, whether written with axe or pen, and this is as it should be. I find it disconcerting to analyze, *ex post facto,* the reasons behind my own axe-in-hand decisions. I find, first of all, that not all trees are created free and equal. Where a white pine and a red birch are crowding each other, I have an *a priori* bias; I always cut the birch to favor the pine. Why?

Well, first of all, I planted the pine with my shovel, whereas the birch crawled in under the fence and planted itself. My bias is thus to some extent paternal, but this cannot be the whole story, for if the pine were a natural seed- ling like the birch, I would value it even more. *So* I must dig deeper for the logic, if any, behind my bias.

The birch is an abundant tree in my township and becoming more *so,* whereas pine is scarce and becoming scarcer; perhaps my bias is for the underdog. But what would I do if my farm were further north, where pine is abundant and red birch is scarce? I confess I don't know.

My farm is here. The pine will live for a century, the birch for half that; do I fear that my signature will fade? My neighbors have planted *no* pines but all have many birches; am I snobbish about having a woodlot of distinction? The pine stays green all winter, the birch punches the clock in October; do I favor the tree that, like myself, braves the winter wind? The pine will shelter a grouse but the birch will feed him; do I con- sider bed more important than board? The pine will ultimately bring ten dollars a thousand, the birch two dollars; have I an eye on the bank? All of these possible reasons for my bias seem to carry some weight, but none of them carries very much.

So I try again, and here perhaps is something; under this pine will ultimately grow a trailing arbutus, an Indian pipe, a pyrola, or a twin flower, whereas under the birch a bottle gentian is about the best to be hoped for. In this pine a Pileated woodpecker will ultimately chisel out a nest; in the birch a hairy will have to suffice. In this pine the wind will sing for me in April, at which time the birch is only rattling naked twigs. These possible reasons for my bias carry weight, but why? Does the pine stimulate my imagination and my hopes more deeply than the birch does? If so, is the difference in the trees, or in me? The only conclusion I have ever reached is that I love all trees, but I am in love with pines. As I said, November is the month for the axe, and, as in other love affairs, there is skill in the exercise of bias. If the birch stands south of the pine, and is taller, it will shade the pine's leader in the spring, and thus discourage the pine weevil from laying her eggs there. Birch competition is a minor affliction compared with this weevil, whose progeny kill the pine's leader and thus deform the tree. It is interesting *to* meditate that this insect's preference for squatting in the sun determines not only her own continuity as a species, but also the future figure of my pine, and my own success as a wielder of axe and shovel.

Again, if a droughty summer follows my removal of the birch's shade, the hotter soil may offset the lesser competition for water, and my pine be none the better for my bias.

Lastly, if the birch's limbs rub the pine's terminal buds during a wind, the pine will surely be deformed, and the birch must either be removed regardless of other considerations, or else it must be pruned of limbs each winter to a height greater than the pine's prospective summer growth. Such are the pros and cons the wielder of an axe must foresee, compare, and decide upon with the calm assurance that his bias will, on the average, prove to be something more than good intentions. The wielder of an axe has as many biases as there are species of trees on his farm. In the course of the years he imputes to each species, from his responses to their beauty or utility, and their responses to his labors for or against them, a series of attributes that constitute a character. I am amazed to learn what diverse characters different men impute to one and the same tree.

DURING: Field Investigation

VA Standards addressed: Science (2018) LS.1, LS.6, L.S7, LS.8, LS.9, LS.10, LS.11 Math (2016) 7.1, 7.4

During your field investigation at Blandy, your students will engage in several indoor and outdoor lessons where they explore ecology concepts as ecologists, watershed scientists, and ecological historians do.

Below is an overview of the "standard" program activities to assist you with integrating this field experience into the classroom experiences. Field investigations may change due to weather, volume of students, or through communication with Blandy educators.

* "**Can it Live Here?"** at Lake Georgette: In small ecologists research groups, students conduct a series of observations and tests to determine if the abiotic and biotic needs of a "mystery" organism are met at the vernal (temporary) wetland pond. They communicate their findings and use evidence and reasoning to support their conclusions.
* **American Chestnut Legacy:** A truly content integrated subject, students explore the history and ecology of the American chestnut tree. Students discriminate fine details between American Chestnuts, Chinese chestnuts, and hybrid restoration trees and leaves. They explore the ecology, history, and current status of American chestnuts in the Eastern U.S.
* **Skull Identification**: Using measuring tools and drawing inferences, as forensic biologists students examine replica skulls to determine an organism's role in our local food web (predator, prey, or both), diet (carnivore, herbivore, omnivore) and explore other adaptations of warm-blooded native VA organisms.

AFTER 1: American Chestnut Genetics

After the American chestnut legacy field experience at Blandy, students delve into the genetics of backcrossing the American and Chinese chestnut trees.

VA Standards Addressed: Science (2018) LS.1, LS.10

Instructional Strategy:

1. View the Powerpoint "BackcrossingmethodBlandy.ppt" (feel free to modify this presentation to suit your students' learning needs).
2. Pause on slide 3 to practice the Punnet Square as an introduction to genetics.
3. Assess student understanding of Punnet square concept.
4. Continue with presentation.
5. Ask: In slide 19, in this BC3F3 intercross, what percentage or portion (decimal) of the whole is the tree's genotype American and what portion is Chinese? What is the proportion when you intercross two of these?
6. Carry out the "BeanThereDoneThat" Activity after the end of the ppt.
7. Conclusion: Inquiry discussion on the pros and cons of this backcross method.
8. **Extension**: What are other chestnut restoration methods scientists are researching? In independent studies or in groups, students conduct internet research to explore other methods. If time allows, you can conduct a class discussion of the various methods.

Bean There Done That

Genetic Backcrossing of the American Chestnut

Note: this lesson Developed by Carroll County Public Schools, MD. Modified & revised by Blandy Experimental Farm, 2018 & 2019.

Background: Genotype is the set of genes, genetic information that an organism has. An organism's **phenotype** consists of the physical characteristics that result from the genes. For example, dimples would be the phenotype, but the genotype would be DD or Dd, the two possible gene forms that can result in a dimple phenotype. The American Chestnut has many different genotypes than the Chinese Chestnut and thus, many different phenotypes. The Chinese Chestnut has blight resistance due to its genes, but the American Chestnut does not have these blight resistant genes (blight resistance is a phenotype). Research into the genes that infer blight resistant has revealed that at least seven different genes are involved in providing the Chinese Chestnut with resistance to the blight fungus. The goal of The American Chestnut Foundation (TACF) is to reestablish the once flourishing American Chestnut tree in forests. In order to do this, scientists are inter-breeding American and Chinese Chestnuts. They are using a process called **genetic backcrossing** to try to insert blight resistant genes into our American Chestnut. This activity simulates the backcross process.

Standards addressed: Science (2018) LS.1, LS.10

Materials

- Two different types of beans (pinto, black, or kidney); several beakers full of each type
- Paper plates (for pouring the beans out of the beakers)
- 50 mL beakers (or small measuring cups or small drinking cups)

Lesson Preparation

- The entire "Bean there done that" activity and data sheet are located here.
- Print student data sheets; make containers of beans for each table/group.

Instructional Strategy:

Part 1. Independent Reading. Students read the background information paragraph to review genetic concepts pertinent to this investigation.

Part 2. Hybrid & backcrossing simulation

1. Identify and label one set of beans as American Chestnut (kidney beans) and the other as Chinese Chestnut (black beans).
2. Pour a full beaker of the "American" beans and a full beaker of "Chinese" beans and mix them on the paper plate—this represents the F_1 generation. Record the proportion of beans (genetic information) that is American Chestnut and that is Chinese Chestnut.
3. Remove a beaker full of the mixed F_1 generation and put them into a separate container.
4. Add another beaker of American Chestnut beans (kidney beans) to the F_1 generation on the paper plate and mix. This represents the BC_1 generation (BC stands for Back Cross). Record the proportion of beans (genetic information) that is American Chestnut and that is Chinese Chestnut.
5. Remove a beaker of the mixed BC_1 generation and put them into a separate container.

6. Add another beaker of American Chestnut beans (kidney beans) to the BC_1 generation on the paper plate. This represents the BC_2 generation. Record the proportion of beans (genetic information) that is American Chestnut and that is Chinese Chestnut.
7. Remove a beaker of the mixed BC_2 generation and put them into a separate container.
8. Add another beaker of American Chestnut beans (kidney beans) to the BC_2 generation on the paper plate. This represents the BC_3 generation. Record the proportion of beans (genetic information) that is American Chestnut and that is Chinese Chestnut.
9. Now… Remove a beaker of the mixed BC_3 generation and mix them with another group's beaker of BC_3 generation. This is the first intercross generation; it is labeled BC_3F_1. Record the proportion of beans (genetic information) that is American Chestnut and that is Chinese Chestnut in the data table.
10. Look at the TACF backcross diagram: What percentage of American Chestnut and what percentage of Chinese Chestnut is the intercross generation?

Part 3. Review & Synthesize.

1. Look at The American Chestnut Foundation hybrid cross and backcross chart for another visual representation of the genetic engineering that TACF has been doing since the 1980's. What percentage of American Chestnut and what percentage of Chinese Chestnut is the intercross generation?
2. Answer the Analysis and Conclusion questions.

Lesson Plan
Bean there…Done that
Genetic Backcrossing of the American Chestnut

1. Identify Desired Results **What should students know and/or be able to do as a result of this lesson?**	
Big Idea: **American chestnut research by TACF involves genetic backcrossing.**	Investigation Essential Questions • What is a backcross? How is a backcross done? • What are the desired genes associated with the American Chestnut & Chinese Chestnut backcross and why are scientists attempting to add them to the American chestnut?

Learning Objectives

- Students demonstrate understanding of the concepts genotype, phenotype, and genetic backcross.
- Students illustrate backcrossing and use vocabulary: (Genotype, Phenotype, Backcross, Hybrid, Resistance) to explain the reasons for the process.

2. Assessing Student Learning

What evidence or artifact will you accept as proof that the Learning Objectives have been met?

Formative: Access students' prior knowledge of (a) what genetic information is, where it is stored, and how it is shared with successive generations; (b) the relationship between genotype and phenotype; (c) examples of genetic engineering/genetic biotechnology and types of genetic engineering processes

Summative: The students complete the BLIGHT conclusion questions.

3. Lesson Elements

Process:
Warm-up: Ask for students take-aways from the chestnut investigation at Blandy. Record these on a whiteboard or post it notes.
Independent Practice (You do): Read background information on backcrossing.
Guided Instruction (We do): (a) Small groups perform the backcross activity using manipulatives. Encourage healthy dialogue regarding genetics and use of the appropriate terms.
(b) Use the manipulative (paper strip) to demonstrate the proportion of American Chestnut to Chinese Chestnut genes after genetic cross.

Assessment: The students will complete the BLIGHT conclusion questions.

Closure: Give each student AN EXIT PASS which asks them to relate the following 5 words and explain them: genotype, phenotype, hybrid, backcross, resistance

Reflections

Student Learning Expectations:
Did students achieve the stated objective?
How do you know?
If not, why not?

Implementation
How effective was the lesson?
What went really well?
What would you differently?

Name:___________________________________ Date:________________

Bean There Done That

Genetic Backcrossing of the American Chestnut

Background Information:

Genotype is the set of genes, genetic information that an organism has. An organism's **phenotype** consists of the physical characteristics that result from the genes. For example, dimples would be the phenotype, but the genotype would be DD or Dd, the two possible gene forms that can result in a dimple phenotype. The American Chestnut has many different genotypes than the Chinese Chestnut and thus, many different phenotypes. The Chinese Chestnut has blight resistance due to its genes, but the American Chestnut does not have these blight resistant genes (blight resistance is a phenotype). Research into the genes that infer blight resistant has revealed that at least seven different genes are involved in providing the Chinese Chestnut with resistance to the blight fungus. The goal of The American Chestnut Foundation (TACF) is to reestablish the once flourishing American Chestnut tree in forests. To do this, scientists are inter-breeding American and Chinese Chestnuts. They are using a process called **genetic backcrossing** to try to insert blight resistant genes into our American Chestnut. This activity simulates the backcross process.

Hybrid and Backcross Data Table

Step	Generation	Proportion of American to Chinese chestnut genes	Genetic engineering process (choose from hybridization, backcross, or intercross)
1			
2			
3			
4			
5			

Analysis and Conclusions Questions

1. Based on this investigation and what you already know, define the term *hybrid.*

2. What characteristics is the American Chestnut Foundation trying to obtain in the American Chestnut with each cross?

3. Why was each successive generation backcrossed with the American Chestnut?

4. Based on what you have observed (with this simulation and your visit to the Blandy chestnut plot), do you think there ever will be a pure American Chestnut (100% American Chestnut genes) that is resistant to the fungal blight? Explain your answer (why or why not?)

5. Brainstorm some other genetic engineering or genetic biotechnology techniques that could be used to add blight resistance to the American chestnut genetic information.

AFTER 2: All Washed Up: The effects of floods on cutthroat trout

Background: Research programs at Long Term Ecological Research Stations support ecological discovery on the influence of long term and large-scale phenomena. Each Data Nugget includes a brief background to a scientist and their study system along with a small, manageable dataset. Students are then given the scientist's hypothesis and must use the data to construct an argument as to whether the data does or does not support it. One of LTERs' priorities has been to provide resources for students of all ages and skill levels because they recognize that students are often overwhelmed with data interpretation.

VA Standards Addressed: Science (2018) LS.1, LS.7, LS.9

Instructional Strategy:

1. **Hook**: Recall the field investigation at Blandy where you conducted tests to determine if an organism's life needs were met. What were some of the biotic and abiotic things to consider? Generate a list of student responses. You may wish to refer to their field data sheets.
2. This research is based on a trout native to the Western U.S. but there are many correlations between the cutthroat trout and our native rainbow trout of Virginia. The issues of flooding, sediment loading and impacts on habitat and organism life needs to name a few.
3. Navigate on smart board or student devices to: https://datanuggets.org/2019/01/all-washed-up/

   Ask: What are some possible threats to your organism? Generate a list of possible threats from student responses. If possible, sort to abiotic or biotic factors (or ask student to do so after the list is made.)
4. Wildlife biologists, climate change scientists, and other researchers are concerned about population declines and humans impacts on numerous populations of species and to habitats in general. Researchers, such as those at a long-term ecological station collect population data and study changes over time.
5. Use mathematical language.
6. Extension: Brainstorm ideas for long-term research projects at school (plant flower times over the years, tree growth patterns at school, or insect populations in the school yard.) Each year's class can contribute data to the project thus simulating the LTER work.