Science Assessment System Through Course Task

Armadillo Migration

Grade Levels:
9, 10, 11, 12

Phenomena:
Armadillo habitat is moving northward

Science & Engineering Practices:
Obtaining, Evaluating and Communicating Information
Engaging in Argument from Evidence

Crosscutting Concepts:
Cause and Effect

Designed and revised by Kentucky Department of Education staff
in collaboration with teachers from Kentucky schools and districts.

Preparing to implement Through Course Tasks in the Classroom

What is a TCT?

- TCTs are 3-dimensional tasks specifically designed to get evidence of student competency in two dimensions, Science and Engineering Processes (SEPs) and Crosscutting Concepts (CCC), untethered from Performance Expectations (PEs)/standards. Tasks are sense-making experiences.
- Tasks are to be used formatively. The goal isc for both students and teachers to understand areas of strength and improvement for the SEP(s) and CCC assessed within the task.

How do I facilitate a Through Course Task (TCT)?

- TCT facilitation is a collaborative process in which teacher teams calibrate understanding of the expectations of the task and refine strategies to be used during task facilitation.

Before the task:

1. Complete the TCT as a learner – compare understanding of task through the lens of success criteria (identified in the task) in order to understand expectations. Success criteria include:
    - What is this task designed to get evidence of?
    - What is the task asking the students to do?
    - What might a student response look like?
2. Identify the phenomenon within the task. Consult resources to assure teacher teams have a deep understanding of associated science concepts.
3. Collaborate to generate, review and refine feedback questions during facilitation.
4. Identify potential "trouble spots" and plan for possible misconceptions.

During the task:

5. Collect defensible evidence of each student's competencies in 3-dimensional sense-making for the task.
6. Ask appropriate feedback questions to support student access and engagement with the task in order to elicit accurate evidence of student capacities.

After the task:

7. Reflect on the task as a collaborative team.
8. Review student work samples to identify areas of strength and areas of need.
9. Determine/plan next steps to move 3-D sense making forward through the strengthening of the use of SEPs and CCCs.

Using the materials included in this packet:

- **Task Annotation:** The task annotation is a teacher guide for using the task in the classroom. Additionally, the annotation gives insight into the thinking of developers and the task overall.

    - Each task has science and engineering practices, disciplinary core ideas, and crosscutting concepts designated with both color and text style:
        - **Science and Engineering Practices**
        - *Disciplinary Core Ideas*
        - Crosscutting Concepts
- **Student Task:** The materials to be used by students to complete the TCT.

Armadillo Migration Task Annotation

Task Template: **After analyzing information from several sources** *about armadillos and climate patterns*, **develop an argument to support or refute a claim** *that global climate changes* are causing *the migration patterns of the armadillo, using evidence from the sources as evidence for your argument.*

Phenomenon within the task. The nine-banded armadillo has been migrating north from South America since the year 1850. Biologists never expected these mammals to reach areas in the Midwest US, or far northern climates, but this is occurring at a steady pace. A number of factors have assisted the progress of the armadillos' northward movement. These factors include, but are not limited to, habitat, food, climate and change in hunting pressures.

Questions students may ponder include:

- What factors cause an animals to migrate into new areas?
- What changes in climate patterns have happened over the last 50 years?
- What adaptations assist in better survival of these animals?

How the phenomenon relates to DCI, if applicable.

LS4.C: Adaptation

- Changes in the physical environment, whether naturally occurring or human induced, have contributed to the expansion of some species.

This task builds upon what students learned in Middle School (LS2.A: Interdependent Relationships in Ecosystems). Students will rely on the understanding of the role of resources in population change. In this instance, expansion of the armadillo population into new areas may be attributed to the changes in resource availability.

What information/data will students use within this task?

Students are provided with two articles that describe armadillos and possible reasons for the expansion. In addition, maps showing current and projected population change are included. Students are also provided climate data in the form of a graphic as well as a "hardiness zone" map, showing the change in growing seasons.

Ideas for setting up the task with students.

Students are asked to support or refute Cindy's claim based upon the research provided. Students should strategically identify any evidence that may support or produce a counterclaim. Depending on the level of the class, teachers may choose to provide a graphic organizer, or encourage students to develop one, that will assist in their analysis. In addition, students may need assistance in understanding the Hardiness Zone maps. It's not important to know what each zone represents as it is to identify how the zones have shifted.

Overall intent: The overall intent of this task is to elicit evidence that students can make a claim, and support the claim with evidence from the data and readings that have been analyzed.

Intent of the Task for Assessment.

The intent of this task is to determine if students can evaluate information about armadillo migration, and other data, in order to determine a causative or correlative reason for changes in migration patterns. Students are provided information about armadillos and climate data to analyze. The intent is to synthesize this information in order to support or refute Cindy's claim about why armadillos have able to migrate north. Although climate change is a factor in movement there are many other variables that allow for the opportunity of such massive movement north

List components of the task / resources used with the task.

All components are provided in the Armadillo Migration task.

Success Criteria

Evidence of Learning Desired based on Progression from Appendices

Obtaining, Evaluating and Communicating Information:

- Read and evaluate scientific information from multiple authoritative sources, assessing the evidence and usefulness of each source.

Engaging in Argument from Evidence

- Construct, use and/or present an oral and written argument or counter-arguments based on data and evidence.

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Success Criteria

Student constructs an argument to support or refute Cindy's claim using the information provided as evidence.

The argument presented by the student will connect the information to either a causative (support) or correlative (refute) reason for armadillo migration.

Possible Student Responses

"Cindy claims that the main variable for armadillo migration is climate. According to Article 1, armadillos have little body fat and cannot establish stable colonies in areas below an average of 28 degrees F. According to the climate information, average temperatures are increasing and growing seasons are changing. This suggests that the lower average temperatures are found further north, allowing the armadillos to move north. Therefore, Cindy's claim is valid and is supported by the information."

"Cindy claims that the main variable for armadillo migration is climate. Armadillos have many ways of surviving its environment, including delayed pregnancy and the ability to hold its breath for long periods of time. These characteristics provide the armadillo with a method of ensuring species survival, especially if resource availability changes. According to Article 1, a reason for migration and new colonization is because of the deliberate or accidental release of these into the wild. Once they find a suitable habitat, including appropriate food and water, stable populations can quickly be established. Therefore, Cindy's claim is not valid as other factors play a role in migration."

Other information teacher teams might find useful when preparing to use this task in the TCT process.

Teachers may wish to include some background information from Land Between the Lakes (https://www.landbetweenthelakes.us/armadillos-arrived/) to share with students prior to completing the task. Teacher teams may wish to assist students in organizing the information provided. This could be through providing a graphic organizer or asking students to collectively suggest a way(s) to organize the information for analysis.

Students had a tendency to focus on information that was not meaningful to the claim that Cindy made. It may be helpful to remind students that all of the information should be taken into consideration and related to the climate change/migration cause/effect relationship. This is where an organizer of some sort may have helped.

Extensions and/or other uses after the task is implemented.

Other animals have had similar patterns of migration. Students may wish to research these and compare with the armadillo.

Through Course Task – Armadillo Migration

Armadillo Migration

A high school student named Cindy observed a nine-banded armadillo that crossed in front of her family's car at Hillman Ferry Campground at Kentucky Lake. She thought armadillos were only located in places like Texas and New Mexico, not in Kentucky. She did research to try and determine why armadillos have migrated this far north in the United States. Her research proposed several ideas for this movement including opportunity for new habitat, change in climate, food availability, reproduction numbers, hunting pressures and the ability to swim well. Based upon what she read, Cindy claims that climate change is the primary cause for the armadillo migration.

Task

You are provided with the research Cindy used to make her claim. Read and evaluate this research that Cindy found about armadillo migratory patterns and the planting zones. Develop an argument that either supports or refutes Cindy's claim that climate change is the primary cause for armadillo migration. You must support your argument with evidence from Cindy's research and explain your reasoning.

Article 1

Armadillos — coming soon to a place near you?

The nine-banded armadillo (*D. novemcinctus*) has the widest distribution of any armadillo species. The nine-banded armadillo has expanded its range northward into the United States over the last 150 years. Prior to about 1850, the nine-banded armadillo was not found north of the Rio Grande River. The sudden and extremely rapid armadillo colonization of the southern United States has puzzled quite a few biologists. The degree of range expansion per year is nearly ten times faster than the average rate expected for a mammal. Sightings of the animals farther north are reported every year, prompting many people to wonder just how far north the armadillo will go.

Where did the armadillos come from?

Members of Superorder Xenarthra (sloths, anteaters and armadillos) originated in South America. Many mammals migrated into North America across the newly formed Panamanian land bridge about 3 million years ago. About half of the animals moving north were Xenarthrans. Giant ground sloths and glyptodonts, among others, migrated into the open plains of North America. All of these first Xenarthran migrants into the modern United States were extinct by about 10,000 years ago. The beautiful armadillo (*Dasypus bellus*) was the last member of the genus *Dasypus* to live in North America. *D. bellus* ranged as far north as Missouri, Iowa and Nebraska, prior to its extinction around 11,000 years ago. For several thousand years, there were no armadillos in the present-day United States. The majority of the Xenarthran species continue to be limited to South and Central America to this day.

Why is the armadillo moving north again?

The nine-banded armadillo's remarkable invasion of the United States appears to be due to a combination of factors. Large rivers, hunting by humans, and unsuitable habitat probably contributed to the scarcity of armadillos in the US prior to 1850.

Major obstacles to armadillo expansion in the United States prior to 1850

- Rivers: Although armadillos are good swimmers, the Rio Grande is a formidable barrier. Large rivers such as the Mississippi continue to deter or delay expansion in some areas of the US. It is likely that very few animals will attempt to cross such large rivers.
- Hunting and Predation: In many parts of South and Central America, armadillos are a valuable food source. Overhunting has threatened many species. The hunting practices of native peoples of northern Mexico and southern Texas probably limited the number of armadillos in the area. Large predators such as wolves and panthers also likely contributed to limit distribution.

- Lack of Suitable Habitat: Nine-banded armadillos live in a variety of habitats but prefer brushy or forested areas which provide lots of cover. Due to yearly burn offs (both natural fires and those started by humans), Texas was largely covered by prairie grasses.

With the mass colonization of Texas by American settlers in the late 1800's, these physical, societal and ecological barriers to armadillo expansion were reduced or removed. Increased travel across the Rio Grande resulted in more armadillos moving across the river. Suppression of Native American culture reduced hunting pressure on the armadillo, and the halting of yearly prairie fires allowed more mesquite brush land to invade the open grasslands. The majority of the animals were probably brought across the Rio Grande by humans as a food source. Animals that attempted to swim across were not more successful than previous armadillos in swimming but were lucky enough to find a more suitable habitat. Decreased hunting pressure, coupled with a decrease in large predators due to human activity, allowed the armadillo population to increase on both sides of the river, resulting in a larger population base. Armadillos do not tend to move from the area they are born in unless the population is high. A larger population resulted in an increased density of animals, prompting emigration and subsequent expansion of range.

The advancement of American settlers and farming practices also allowed the armadillos to invade the United States. Colonization of other states was helped by the deliberate or accidental release of captive animals. The Florida armadillo population, for example, was the result of a few animals released from a small zoo in 1924, combined with several more that escaped from a traveling circus in 1936. Movement of cattle from Texas to other states by railway also helped the armadillo. There are several reports stating that stowaway armadillos were fairly common in cattle cars. The armadillos would often escape when the cars were unloaded. The regular production of identical quadruplets, as well as the ability to delay implantation of fertilized eggs for 14 months or more give the nine-banded armadillo a high reproductive rate. Life spans of up to twenty years, coupled with the reproductive success of the animals, means that it only takes a small number of armadillos to successfully establish stable populations in new areas.

How far north will the armadillo go?

Armadillo expansion into the United States appears to be limited primarily by temperature and rainfall. Armadillos have very little body fat and are not good at conserving heat. Long periods of extremely cold weather are dangerous, especially to younger animals. Armadillos cannot establish stable colonies if the average January temperature is below -2°C (28°F). They also require a constant source of water. Estimates indicate that armadillos can survive in areas that receive at least 38 cm (15 inches) of precipitation annually. Comparing this information with annual weather and rainfall data for the United States, Taulman and Robbins generated a potential range map for the nine-banded armadillo. They estimate that the nine-banded armadillo could establish stable populations from Nebraska to New York, and northeast to Cape Cod. Although physiological barriers prevent the armadillo from moving farther west on its own, human introductions (accidental or otherwise) could establish populations in parts of Arizona,

Colorado and New Mexico. Animals released on the west coast could range from California to Washington and into parts of Canada. Regions of eastern Washington and Oregon, and part of northwest Idaho could also support armadillo populations.

Does this mean we will see armadillos in New York's Central Park? Armadillos digging up the potato fields in Idaho? Armadillos sipping coffee in Seattle? Armadillos riding the streetcars in San Francisco? Enjoying the seashore in Massachusetts? Perhaps some Canadian armadillos in Vancouver, eh? Only time will tell! If you live in one of the areas targeted for armadillo invasion, keep your eyes open for invading armadillos. Report sightings to your local wildlife officials to help keep range data current. If you don't think that armadillos will ever make it in your neck of the woods, keep in mind that another South American mammal, the Virginia opossum, successfully invaded the United States despite the cold winters and physical barriers to range expansion. For the nine-banded armadillo, it looks like it's Canada or bust!

Sources

Nowak, R.M. 1999. *Walker's Mammals of the World*, 6th edition. Johns Hopkins University Press, Baltimore, MD. 158 — 168.

Taulman, J F, and Robbins, L W 1996. Recent range expansion and distributional limits of the nine-banded armadillo (*Dasypus novemcinctus*) in the United States. *Journal of Biogeography* 23: 635-648.

Article 2

Contrary to popular belief, the nine-banded armadillo cannot roll itself into a ball to escape predators!! Only one of the twenty-odd varieties of armadillos — the three-banded armadillo (*Tolypeutes tricinctus*) — is able to roll up. The other types are covered with too many bony plates to allow them to curl up. Other armadillos have to rely on their armored shells for defense while they scuttle away through thick, thorny brush or dig themselves a hole to hide in.

Armadillos are not blind, but they do have poor eyesight. They rely on their ears and noses more than their eyes to detect food or predators. (When your food is never farther away than the end of your tongue, you don't really need spectacular vision to find it, do you?) If you are close to an armadillo, and you stay quiet and stand still, the chances of it not noticing you are there are fairly good.

Nine-banded armadillos always give birth to four identical young — the only mammal known to do so. All four young develop from the same egg — and they even share the same placenta.

Armadillos are used in leprosy research because their body temperatures are low enough for them to contract the most virulent form of the disease. They also do not have a very strong immune system, making them an ideal model for many types of medical research.

Some female armadillos being used for research have given birth to young long after they were captured. These "virgin births" are a result of the female's ability to delay implantation of the fertilized egg during times of stress. While some anecdotal cases have suggested delays of up to two years, this has never been proven. Currently, published studies have confirmed that armadillos can delay implantation for at least four months. This reproductive tactic is one reason why the armadillos are so good at colonizing new areas (such as the United States).

Armadillos like to swim, and they are very good at it. They have a strong dog paddle, and can even go quite a distance underwater, walking along the bottom of streams and ponds. They can hold their breath for four to six minutes at a time. When they need to cross larger bodies of water, they swim across. Because their heavy shell makes it hard for them to float, they gulp air into their intestines to make them more buoyant. The ability to cross streams and rivers has helped armadillos expand their home range.

Armadillo teeth have no enamel (the hard, outer covering of the tooth). They also have very few teeth — just several peg-like molars. Since they primarily eat insects, they don't have to do a lot of heavy chewing, making big, strong teeth a waste of energy to grow.

Like most insect-eating mammals, armadillos have a very long, sticky tongue to slurp up bugs as quickly as possible. They also are equipped with strong claws to tear open ant nests.

Armadillos have a very low metabolic rate, which means they don't produce much body heat. This also means that they are not good at living in cold areas, because they can't keep warm very well! Armadillos don't have a lot of body fat, so they must forage for food on a daily basis. Just a few cold days in a row can be deadly to an armadillo. Despite this fact, armadillos are steadily moving north.

One way that armadillos conserve energy is through *reta mirabila* (Latin for "miraculous net") — a system of veins and arteries in their legs. Hot blood going out through arteries is cooled by cold blood coming in through veins, and vice versa. This means that not much heat actually goes out into the legs, keeping it in the body. This also means they will get frostbitten very easily, since they have no way to warm their extremities through blood flow. Marine mammals, like whales, use a similar net of veins and arteries to stop the loss of body heat through the fins.

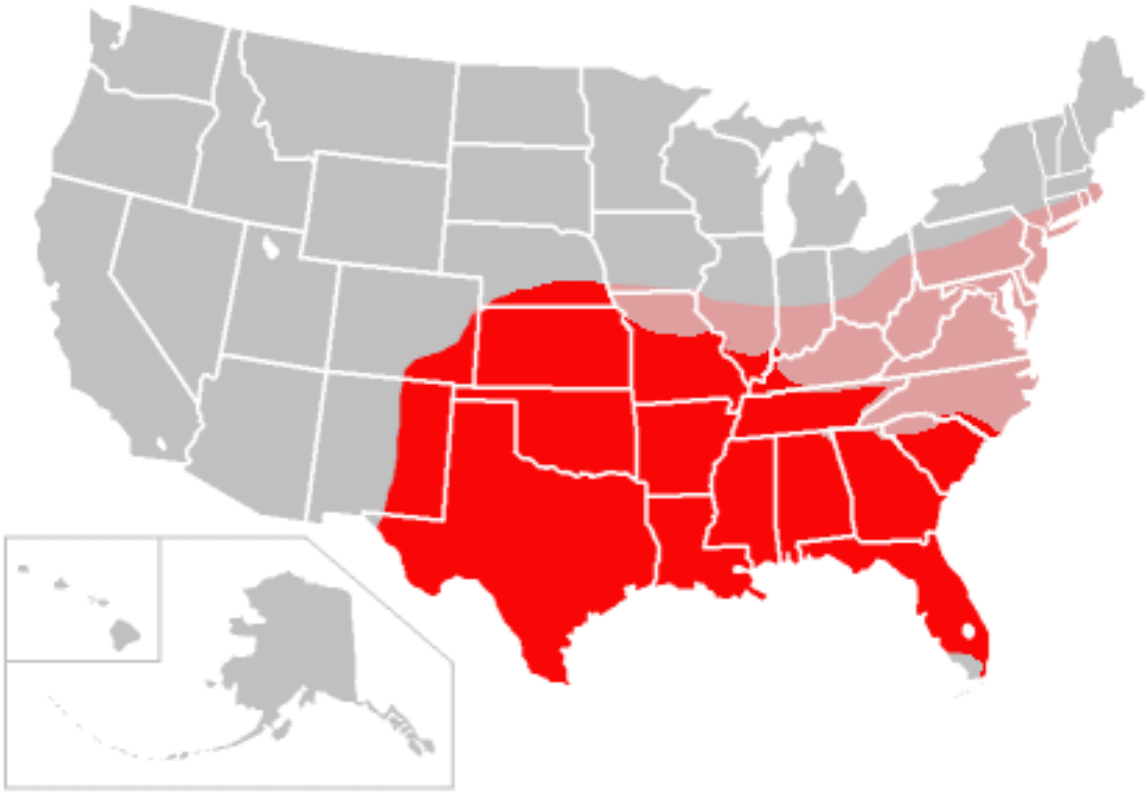
Baby armadillos have soft shells, like human fingernails. They get harder as the animal grows, depositing bone under the skin to make a solid shell. The process of laying down bone is known as "ossification".

If you are thinking about a pet armadillo, you had better check with your local authorities first. According to the Department of Inland Fisheries and Wildlife, it is illegal to own an armadillo in the state of Maine. Hawaii has strict regulations against the import of any foreign animal,

including armadillos. The state of Montana classifies them as livestock and regulates their import accordingly. Many states do not allow the private ownership of any wild animals without a license. Note that this applies to “rescued” armadillos as well. If you find an abandoned or injured animal, you should take it to a licensed wildlife rehabilitation center.

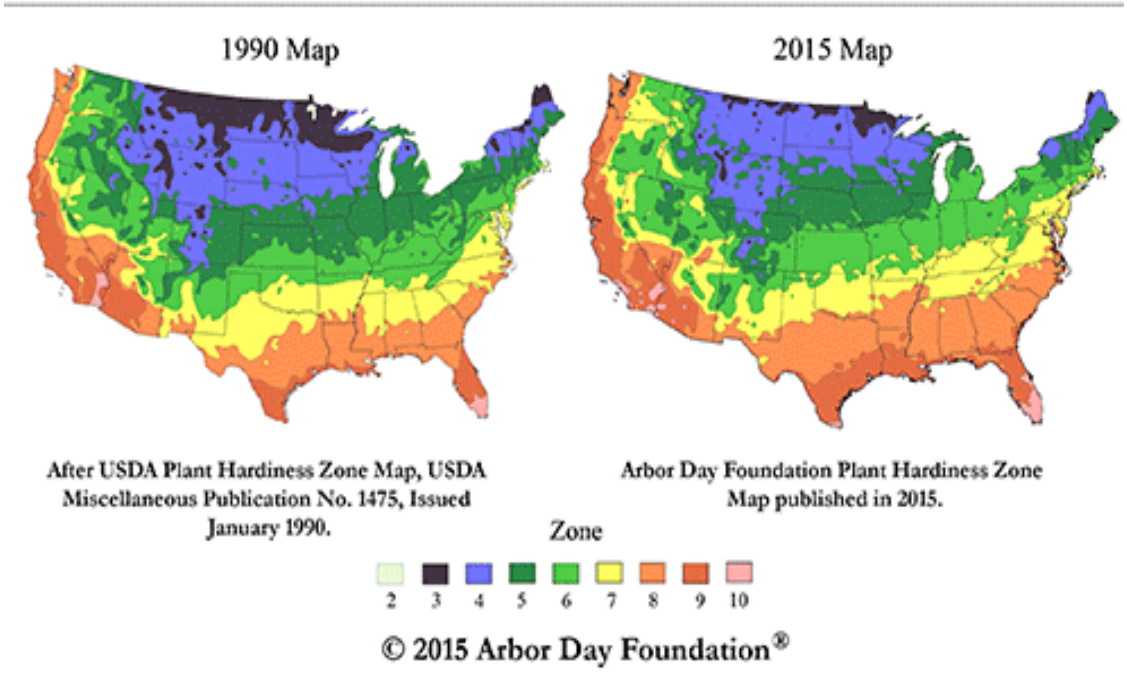
In many parts of the world, including the United States, you might find armadillo meat on the menu. During the Great Depression of the 1920’s, armadillos were nicknamed “Hoover Hogs” by the people who ate them. The name was a bitter jab at President Herbert Hoover, who had promised “a chicken in every pot” but had instead presided over a collapse of the US economy following World War I.

Armadillo Migratory patterns from 2009-current



The current (*circa* 2009–2010) range (shaded red) and predicted future range (shaded pink) of the nine-banded armadillo in the USA.

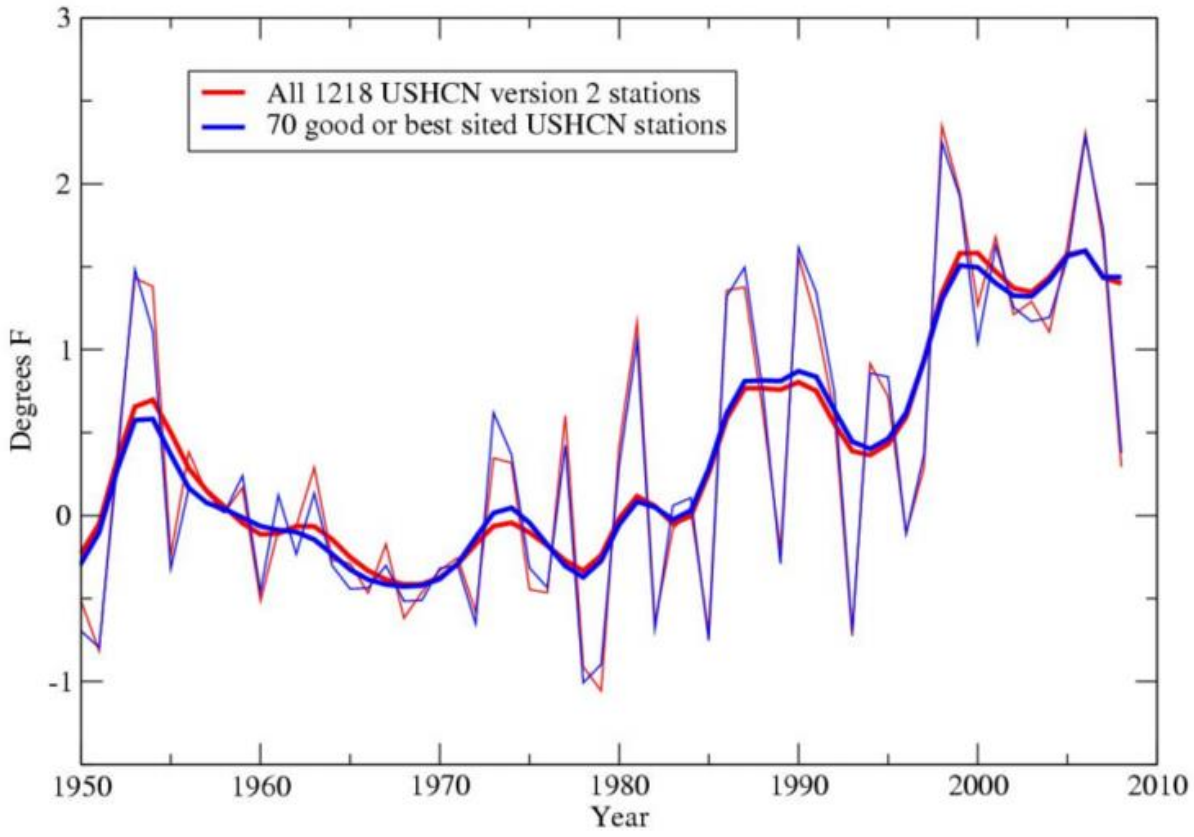
These Hardiness zone maps indicate an increase in temperature over the last 25 years across the US. As the temperatures increase, plants and animals adapt to these climatic changes. Animals increase migration north, plants from the southern zones now can survive in areas farther north.



Zone Planting Maps showing climate changes from 1990-2015.

https://www.arborday.org/media/map_change.cfm

U.S. Historical Climatology Network (USHCN) Temperature Record



The bold lines represent the trend of the individual data points. Students should focus on the same color line (light red/bold red or light blue/bold blue).