Public Engagement Case Study
Engaging K-12 Students in Authentic Place-Based Research

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Category/type of activity: Knowledge Co-Production

Web links related to activity: We don’t have an official website for this project, but the following links contain media coverage of the activity, which provides more information on goals, outcomes, and activities.

- http://exploreutahscience.org/science-topics/environment/item/134-the-west-s-pika-plight-captivates-middle-schoolers-scientific-minds#sthash.zpcDzNYr.dpuf

A longer summary of our activity is attached, with both scientific background on the project as well as a framework for supporting classroom lesson plans.

1. Goals for activity:
In this activity, I worked closely with two seventh-grade math and science teachers at a local public middle school to design a citizen science project in which the students would help collect data about a small mammal that may be sensitive to climate change. This activity had four primary goals:
   1. Engage students in thinking about the local effects of climate change.
   2. Collect actual field data that advance scientific understanding of the status of American pikas (*Ochotona princeps*) in the Uinta Mountains of northern Utah (this mountain range harbors a distinct subspecies of pikas).
   3. Connect local data and the fieldwork experience to the broader issues of global climate change and biodiversity.
   4. Expose urban students to an exciting part of local alpine ecosystems which many students had never had an opportunity to visit.

2. Audience for the activity:
The primary audience for the activity was seventh grade students at a Salt Lake City public school (Salt Lake Center for Science Education, SLCSE); however, the students also presented their research at a special science fair we called “Pika Palooza” held at the University of Utah. Some students also developed questions and tested hypotheses for science fair projects which they presented to peers, parents and other community members at various science fair levels. As a result, students also reached members of their school community and the university community with their results.
3. **Key messages for the activity:**
This activity was more about knowledge co-production and less about messaging; however, you might say that there were a few take-home messages I hoped the kids would come away with, after participating in the pika activity:

   1. Anyone can collect reliable observations and important field data.
   2. Pikas are an interesting and important part of our local alpine ecosystems.
   3. Global climate change is affecting our local alpine ecosystems. We should care.

4. **How did you become involved in this activity?**
I first became connected with my collaborators at SLCSE through a NSF-GK12 program called Think Globally, Learn Locally (TGLL). Together, we designed the field trips, selected data collection protocols and created lessons that would tie the experience to a broader understanding of climate change and diversity.

5. **Who were key collaborators?**
I want to be explicitly clear that two **champion** teachers (Dr. Niki Hack and Ms. Diane Crim) and the administrators at SLCSE were essential to the success of this project. The activity never would have been a success without their commitment and hard work. The teachers conducted in-class lessons that supported and reinforced the experience of collecting field data. They also supported students in follow-up assignments to analyze and present their results. We also depended heavily on buy-in from the school’s administrators to support this project (with time and resources such as bus transport to the field sites, and by assuming liability for the field trips).

6. **How did the activity invite and engage in dialogue with the audience?**
One of the foundational pillars of this project was encouraging students to participate in the entire scientific process: not simply memorizing information, but contributing to knowledge production. Prior to our field trip, students were provided some background information about pikas, climate change and alpine ecosystems. However, they were then encouraged to develop and test their own hypotheses with the data we collected. Some of these hypotheses developed into projects for independent research (e.g., as science fair projects). In addition, a few students contributed ideas and conducted experiments that advanced my own research outside of our Uintas monitoring effort. Specifically, one student suggested an experiment looking at stress hormones for my study on how pikas recolonize habitat after a wildfire. She performed the assay, and the results were published in the International Journal of Wildland fire along with the rest of that study. You can read more about this project (and others in which citizen scientists have advanced pika research) in a recent Trellis discussion: [https://www.trelliscience.com/#/discussions-about/22303/](https://www.trelliscience.com/#/discussions-about/22303/).

7. **How was the activity evaluated? How was feedback incorporated and any changes to the activity as a result?**
We administered short, anonymous surveys to students before and after the activity. These surveys contained questions from validated survey instruments to assess the students’ content knowledge.
about pikas and climate change, self-efficacy as a scientist and views towards nature and the environment. Excitingly, we found a significant shift in student opinions in which more students agreed with the scientific consensus that climate change is happening and humans are causing it. They also felt a stronger sense of environmental stewardship after participating in the project than they had beforehand.

8. How long did it take to plan and implement this activity?
Planning and “test driving” the activity took a full year; however, this was largely because there is only a short window each year in early fall in which the pikas are accessible (i.e., not under snow!) and students are in school. I expect that a similar field experience could be designed and implemented much more quickly if one were to collect data on a species that is more reliably available for observation year-round!

9. What resources did you need to implement this activity?
I cannot stress enough how important the buy-in from champion teachers like Dr. Hack and Ms. Crims is for such projects. K-12 teachers are busy humans, and contrary to popular beliefs held by many scientists, they are actually less flexible in their schedules and objectives than we academics are.

To connect with K-12 teachers effectively, scientists MUST carefully research the needs of the teachers in their district and explicitly consider how a proposed activity will help teachers meet their content requirements (as mandated by state standards). Without carefully considering and communicating how we will be helping (as opposed to creating extra work for teachers or simply doing something “cool” or “fun”) the relationship is unlikely to be successful.

Beyond teacher buy-in, this particular activity required financial buy-in from the administration. In this example, buy-in was manifested in transportation to field sites (a one-hour trip from school) and support for liability coverage for taking students out of the classroom and into the field. Again, approaching the administration from the perspective of having carefully researched their needs and articulating how the activity will help them achieve their goals is essential.

10. What lessons did you learn about public engagement as a result of this activity?
I would argue that the lessons that I learned from participating in this activity were just as meaningful as what my students learned!

I learned a great deal about how to approach K-12 teachers and institutions for citizen science or knowledge co-production endeavors. On a personal level, I also discovered that involving kids in scientific research can help us as scientists to achieve our own goals. In a program like this, the kids were collecting real data that were used (with attribution!) in ecological analyses and publications. My conversations with the students also really enriched my own research with creative perspectives and fresh observations.
PIKA OUTREACH PROJECT OUTLINE

Scientific Background:

Climate change is affecting communities of plants and animals worldwide, but mountain ecosystems are projected to be among the most sensitive to small changes in temperature and precipitation patterns. Many alpine plants and animals are already moving upslope in elevation in response to climate change, presumably to track their niche as lower elevations become warmer and dryer.

One species that may be particularly vulnerable to climate change is the American pika, a small mammal closely related to rabbits. Pikas inhabit rockslides and boulder fields in western North America, usually in high elevation mountains. Unlike most alpine mammals, pikas do not hibernate over the winter. Instead, they must spend the short summer collecting and storing plants in caches called "haypiles" that sustain them during the winter. Pikas are well adapted to survive cold winters: they are well insulated by thick fur and have a high metabolism. However, their incredibly high resting body temperature (104°F) is just a few degrees below their lethal body temperature, so they are extremely sensitive to high temperatures. As a result, pikas must rest in the colder region below the rocks to lose body heat after foraging, and they are usually inactive at the warmest parts of the day during the summer. In fact, a pika will die of heat stress if kept above the surface of the rockslide at 75°F and prevented from behaviorally thermoregulating for two hours.

Because they cannot tolerate long periods of activity at high temperatures, pikas are also relatively poor dispersers. An individual pika can move about a mile if there are patches of boulders where it can rest along the way, but it is nearly impossible for animals to move across the low elevation valleys that separate mountain ranges from each other. As a result, if pikas are lost from one mountain range, they are unlikely to recolonize it from another mountain range.

In the past decade, researchers have conducted extensive surveys to determine how the pattern of pika occurrence has changed in the last century. In the Great Basin, pikas have disappeared from about 40% of historically occupied sites, mostly at low elevations where the summer temperatures are high and winter snowpack is reduced. These losses may be related to the animals’ inability to lower their body temperature after foraging at high temperatures. Similarly, warm summer temperatures may prevent the animals from collecting large enough haypiles, leading to a food shortage over winter. In addition, the winter snowpack may act as a layer of insulation, sheltering pikas from extreme winter weather at the surface. When winter snowpack disappears, the animals may be exposed to colder temperatures and more intense wind and precipitation, which may exceed their capacity to stay warm over winter.

The situation is less extreme in the southern Rocky Mountains, where pikas have only disappeared from about 6% of historically occupied sites. The sites where pikas have been lost were among the driest sites surveyed, with low average annual precipitation, low water availability at the site, and low winter snowpack, suggesting that water availability is important for pika survival. In addition to the insulation provided by winter snowpack, water availability may also affect pikas through the nutritional quality of the plants that support them.

Despite the dramatic population declines seen in the Great Basin, the American pika was denied listing under the federal Endangered Species Act in 2010 because it remains unclear how climate change is affecting the species across its entire range. The Uinta Mountains are home to one of the five subspecies of American pika, *Ochotona princeps uinta*, but no long-term monitoring or historical resurveys have been conducted for pikas in the region. By monitoring these populations for several years, students could contribute to a better understanding of the status of the species as a whole.

Project Goals:

1. Engage students in thinking about the local effects of climate change
2. Conduct field observations that advance scientific understanding of the status of pikas in the Uintas (a distinct subspecies)
3. Connect field results back to the “big picture” of global climate change and biodiversity
4. Expose students to an exciting part of our local alpine ecosystems

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Annual Activities:

Monitor two populations of pika in the Uintas along the Mirror Lake Highway: a high elevation population (Bald Mountain Pass, ~10,500’) and a low elevation population (Cobblerest Campground, ~8,500’). These sites are only separated by about 15 miles, but differ in elevation by about 2,000 vertical feet. The two sites may therefore have very different microclimates, which could impact the animals’ continued survival through temperature extremes, duration and amount of snowpack, or the plant community.

1. **Describe / characterize the habitat** using temperature dataloggers and vegetation surveys (winter vs summer temperatures, dates of snow-cover, dominant vegetation types) [note: we have been continuously recording temperatures at these two sites, as well as at two additional sites since 2011]

2. **Conduct population censuses** by counting haypiles and/or animals (e.g. how many animals are in a 100 m radius circle) [note: we have monitored occupancy at several haypiles each year since 2011 at each of these sites]

3. **Estimate minimum elevation** of pika occurrence

4. **Collect scat samples** to be included in a regional analysis of stress hormone levels

5. **Analyze and synthesize results** in classroom discussions and activities
   a. **Compare high and low elevation pika habitats** (between-sites, within-year)
      - Statistics projects to compare winter and summer max/min/average temperatures and dates of snowmelt, Differences in population size related to vegetation
   
   b. **Identify annual variation and/or trends** (within-site, between-years)
      - Changes in minimum elevation, Temperature and snowmelt trends, Population size

   c. **Assess the biological significance of habitat differences or trends** for pika persistence in the Uinta mountains:
      - Are these populations stable or declining?

Example: Using temperature data from the Great Basin pika resurveys (right) to address objectives a, b, c:
   1. Compare habitats (extant vs extirpated)
   2. Identify annual variation/trends
   3. Assess the significance for pika persistence

Beever et al. 2011, Global Change Biology
Sites where pikas have been extirpated do not have consistent winter snowpack. Snowpack acts as an insulation layer and buffers the animals from harsh weather in the winter. Without winter snowpack, pikas will be subjected to more extreme winter weather (lower temperature, high winds, freezing rain, etc) perhaps exceeding their capacity for winter thermoregulation.

(Minimum elevation and population sizes could also be used instead of temperatures)

d. **Connect the pika to the broader alpine ecosystem** in the context of climate change

![Diagram of climate effects on pikas and other organisms]

- How could climate affect pikas (or other organisms in the ecosystem)?
  - Too hot
  - Freeze
  - Starve
  - Parasites
  - Disease
  - Amount/timing of food
  - Eaten
  - Predators
  - Reduced snowpack
  - Competition for Resources
  - DIRECT vs. INDIRECT Effects on Biodiversity

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1. Pikas are an important food source for predators like hawks and weasels
2. Pikas can affect alpine vegetation community composition, which can also change the way that soil absorbs and releases water, like a sponge
3. All of Salt Lake City’s drinking water comes from our mountain watersheds and snowmelt
4. If pikas are being lost from our watershed ecosystems, it could reflect a bigger problem (like reduced snowpack and water availability) that may make water less available for drinking or agriculture

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e. **Propose solutions** to protect the pika and reduce environmental impacts in the mountains

- **Habitat preservation and management**
  - Pika migration corridors

  Artificial “talus” slopes from highway construction along the I-90 corridor in the cascades support pikas
• Facilitate dispersal
  - Introduce genetic diversity
  - Assisted reintroductions from heat-tolerant populations

Pikas living at Lava Beds National Monument tolerate surface temperatures near 60°C

• Reduce our impact on the environment