I have long been a proponent of Problem-Based Learning (PBL), first as a classroom teacher and now as a curriculum specialist. The intent of the Next Generation Science Standards is to provide students with “an in-depth understanding of content and develop key skills—communication, collaboration, inquiry, problem solving, and flexibility that will serve them throughout their educational and professional lives” (NGSS Lead States 2013). The Buck Institute for Education describes PBL as “Students work[ing] on a project over an extended period of time—from a week up to a semester—that engages them in solving a real-world problem or answering a complex question. They demonstrate their knowledge and skills by developing a public product or presentation for a real audience.”

By utilizing a PBL approach in your classroom, students will engage in authentic science investigations based on their questions that promote a deeper understanding of a concept. In this article, fifth graders were involved in a PBL scenario that would impact an entire natural habitat. This interdisciplinary experience involved the Essential Design Elements from the Buck Institute of Education, including using key knowledge, understanding, and skills; a challenging problem or question; sustained inquiry; authenticity; student voice and choice; reflection, critique, and revision; and a public product in trying to save a swamp from being drained.

THE PROJECT: HABITAT ANALYSIS

This project started off with a Challenge of the Week (COW) that centered around a data analysis of Blanding’s turtle habitats. In fourth grade, students have the opportunity to assist the Blanding’s turtle, a threatened species in our state. Students received the turtle as a hatchling at the beginning of the school year, took care of it over the school year, and then released the turtle in the wild at the end of that school year. Since I worked with the biologist heading the project before, I reached out to see if he had any data for the fifth-grade students to work on in this type of format. He asked the students to analyze which particular area was the best to release the turtles in terms of them being the most successful in gaining weight, which would indicate that particular environment had favorable shelter and food for these young turtles to be successful. In fact, he had a reason for the students to be looking into this issue—the town wanted to drain one of the areas where the turtles were released and he wanted the students to provide him with some data on whether or not this area was the best area to release the turtles. And so the best habitat for Blanding’s turtle challenge was begun.

DATA ANALYSIS

When the students had the turtles in fourth grade, they collected data on how many pellets the turtles ate as well as their monthly weight and length. However, there was no real data analysis involved. In this challenge, students were provided data about the turtles’ weight over an 850-day time period. There were two areas to compare: a national wildlife refuge and a swamp about a half mile away from the wildlife refuge. Our faculty was receiving training in data-driven dialogues, and I decided to train the students in using this protocol as well. Students created statements such as, “One hundred days after being released, 75% of the turtles at the wildlife refuge lost weight versus 0% of the turtles at the swamp.” Students then reasoned that perhaps the food sources at the swamp were better for the turtles than the food sources at the wildlife refuge. Students used fractions and decimals to describe their data, such as 6 out of 8 turtles lost weight, and after 850 days, the turtles at the wildlife refuge were 21.8% larger while the turtles at the swamp were 76.6% larger. Additionally, with the help of our technology specialist, the students learned how to use Microsoft Excel with their data. They needed to decide what types of graph would be best to display their findings. In some cases, the students used line graphs to show the weight over time change, and in other cases, they used pie charts to compare weight loss/weight gain at particular time intervals at the two locations. At the end of this exercise and based on evidence that they had analyzed, stu-
tents wrote their claim of what was the best habitat for the young Blanding’s turtles and sent it to the biologist. Based on their research, it was found that at the swamp, the majority of the turtles did not lose weight after a year, whereas at the wildlife refuge, the turtles did lose weight.

**NATURAL RESOURCES COMMISSION MEETING**

Armed with their data collected about the best habitat, the students went to a Natural Resources Commission meeting where the topic was the town’s Department of Public Works (DPW) wanting to drain the swamp where the young Blanding’s turtles prospered. The students listened attentively to presentations about how the turtles wouldn’t be affected by the swamp being drained and why it was important to drain the swamp. When it was time for public comment, I was beyond proud to have many of my students address the committee to discuss the importance of this habitat being saved. The commission did not vote to allow the DPW to start draining the swamp until the DPW supplied more information, so it bought time for the students to find evidence to counter the DPW’s points on why the swamp should be drained.

**BACK TO WORK: USE YOUR RESOURCES!**

The DPW identified several reasons why they thought the swamp should be drained, including that graves in a nearby cemetery were “wet,” fear of an epic flood hitting a historic town center; and that the swamp was created recently by beavers. From these statements, as an entire class, the students developed questions, such as “What is the history of the cemetery?” “When were the biggest floods in Concord’s history?” “How can we find out if the swamp was created by beavers?” and “What other animals would be impacted if they drained the swamp?” After generating these questions, the class decided on different topics to further pursue.

I am a proponent of using your local and digital resources to help students answer questions. In this case, students utilized the special collections librarian at the town library, local biologists, amateur birders, a local hydrologist, Google Earth, and the United States Geological Survey (USGS) to help them answer some of the questions that the class had generated. In this project-based learning experience, as the teacher, I did not know the answers to these questions and became a learner along with the students. In my experience, I have found the best PBL experiences to be the ones that are not “planned” but rather are “home grown” from a real problem. For the students to see their teacher as a fellow learner is empowering to the entire classroom community.

To me, another important aspect of PBL is the ability to investigate “place.” In this case, the students were not familiar with the swamp, which was located on the other side of town. We were not able to do a field trip during the school day, so I sent an email inviting the students and their families to take a Sunday hike at the swamp. On a snowy Sunday, we had seven students and their families out surveying the area. A swamp in the Northeast in January is frozen over, so we did not witness much wildlife during our trip, but we were able to see evidence of swamp inhabitants, such as empty
great blue heron nests, signs of beavers as evidenced by freshly gnawed trees, and small animal footprints in the snow. This swamp is the home to Blanding’s turtles, green frogs, pumpkinseed fish, beavers, great blue heron, and 35 other different species of animals. (While there are no alligators or poisonous snakes, it is important to follow your school or district guidelines for outdoor field experiences.)

The teams were self-selected with the understanding that they all needed to work well together since this was an important project. Students can be provided rubrics such as those that the Buck Institute for Education has developed (see Online Resources) that evaluate the students on collaboration skills. Each team decided how they would find out the answers to their questions. My class consisted of two additional groups of students with learning differences, so all the work was scaffolded to meet the needs of these students so that they could fully participate in this experience. This scaffolding included rewriting information at a more appropriate reading level for some students and having students have a “buddy” to help with technology, such as creating graphs and using Google Earth. We started a Google Document where each team would write about their findings. Using a Google “Doc” also enabled everyone to work on the same document at the same time. One student served as the editor, making sure every section transitioned to the next one. This approach of having students reflecting on their work is a central element of PBL.

The group that traveled to the local library to study the history of the cemetery discovered some very interesting information by reading past cemetery commission reports. They found that “in 1953, the town bought 37.5 acres of land and although the land was low, but the town thought they could somehow use the land.” By continuing to research the reports, the students found out that in 1959, more land was purchased around the swamp and by using fill from a construction project, they were able to fill in swampy land. The students concluded, “So this means that the Town filled in swampy lands. They covered the swampy areas up so they could use it for other graves. While the DPW is saying it is the fault of the swamp for having graves with water in them, it is really their fault for filling in a swamp.”

Another group researched the statement that the swamp had only recently become so due to beavers blocking up a culvert. This group researched Henry David Thoreau, a famous naturalist from the 1850s and found in his journals many mentions of the swamp, along with the plants that were found there. The students concluded, “Moore’s Swamp has been a swamp since the time of Thoreau, who wrote about his trips to the swamp in his journal. This would suggest to us that this area has been a swamp for far longer than the 20 years that some neighbors have mentioned.”

A different group researched the concern that if there was a catastrophic flood, the historic downtown would flood because of this swamp. This group pulled up flood records from the USGS and found that the most historic flooding occurred in 2010. They then researched old copies of local newspapers to find mentions of where flooding was prevalent during this time and found that there was no flooding on this side of town. Additionally, they used Google Earth to measure the elevation from the local river to the swamp, found a hydrologist to discuss flood storage with them, and found that the height differential would make it very difficult to ever have flooding from the river impact the swamp area: “The elevation of the swamp is 122 feet. The elevation of the river at its closest proximity to the swamp is 113 feet. This is a difference of nine feet. According to a professor of hydrology at a local university, it would have to rise 9 feet to reach the 122 feet at the swamp—so yes, that’s an enormous quantity of water, a very big flood.”

Another group researched what else lived in this habitat other than the Blanding’s turtles. They sought out local birders and biologists who reported to them that 40 types of different organisms either lived in the swamp or around the swamp. They researched what would happen to many of those organisms if the swamp was drained, as proposed by the DPW. The students hypothesized that one possible negative result might be more mosquitoes. “One of the problems with draining the swamp is that it would highly increase the population of mosquitoes. Even if the swamp was only partway drained, most of the fish would die. There is a certain fish called the pumpkinseed fish that eats mosquito larvae. Because these blood-sucking bugs thrive in small, warm, manmade bodies of water, there wouldn’t be the type of fish that would eat the larvae before it hatched into the actual mosquito.”

This group of students investigated the benefits of beavers for an ecosystem. After investigating, they found that “So, who was responsible for making the swamp a wildlife sanctuary? The answer is: beavers. While some people think of beavers as being destructive, they have had a hand in creating the diversity of wildlife that now live in the swamp. Beavers help turtles, mammals, fish, frogs, birds, and ducks. The beavers help these animals by creating watery habitats for them to breed, eat, rest, and just live there.”

THE END RESULT

The result of this PBL investigation was the creation of a 29-page document that was sent to both the lo-
cal conservation committee and the state’s Natural Heritage group, whose task is to protect threatened species. The DPW was initially not granted permission to drain the swamp. Two years after this project, the blocked culvert that the beavers had created became mysteriously unblocked, lowering the swamp’s water level. Despite the wonderful work of this group of students, the DPW then finally received permission to continue to lower the water level. This ecosystem is no longer the one where 40 different species flourished, but I think the work of this group of students saved it for several years.

CONCLUSION
Students were engaged in an authentic science investigation centered around an actual situation that required them to analyze many different aspects that may have contributed to this problem. In this interdisciplinary scenario, all students were actively engaged in rebutting many of the arguments that a local DPW had used to justify draining a swamp. I have long contended that if students are engaged in learning, there are no classroom management issues. This was the case with this project, as the students were provided choice as a means of differentiation. While some students wrote long sections, other students worked on graphs, and other students used Google Earth to investigate the area around the swamp. In PBL, formative assessment is interwoven throughout the project. Project-based learning experiences do not end with an end-of-unit test, rather teachers and students should be continually assessing learning. In this project, students were assessed on their social skills (collaboration), oral communication, and written composition skills that were part of our standards-based report card. I was constantly meeting with each group, reviewing their progress and assessing their knowledge about their particular topic. Students also provided feedback to one another on their specific topic area, both through the use of the Google Doc and with the student editor. The Buck Institute for Education’s Gold Standard for PBL discusses that the assessment of student learning is the creation of a public product. The summative assessment in this project was the creation of this report, which was submitted to both the town’s natural resources commission and to the state’s Wildlife and Endangered Species Department. This document provided a clear understanding of student learning in response to the town’s reasons on why to drain the swamp. This created a powerful and authentic learning experience for this group of fifth-grade students, as evidenced by one of the students—who I just bumped into five years later—stating that this type of learning sticks.

REFERENCES
Buck Institute for Education. What is PBL? http://www.bie.org/about/what_pbl/

ONLINE RESOURCES
Buck Institute for Education rubrics http://www.bie.org/objects/cat/rubrics

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Great blue heron nests dot the trees in the swamp.