Table of Contents

Tributary 4: Intro to Inquiry

We will begin our discussion of inquiry with two stories that illustrate the process.

Pottstown Students and The Spotted Lantern Fly

In the spring of 2017, fourth grade Pottstown PA students visited Memorial Park in downtown Pottstown to conduct a stream health assessment. While they were there, a colorful insect captured their attention. The insect turned out to be an invasive species called the Spotted Lantern Fly. Fast forward to their fifth grade year, when the students were invited by the NorthBay team and their teacher to conduct a research project. They remembered the Spotted Lantern Fly, and when given a list of potential research topics, selected them as the topic they wished to investigate further. The students conducted online research and also read an article provided by their teacher. They realized that Spotted Lantern Flies were destructive, and the students became concerned about the impacts the flies might have on their own school courtyard gardens. For their action project, the students conducted more research to determine how to get rid of the flies. They developed a design for Spotted Lantern Fly traps they could install in the school courtyard. They wrote persuasive letters to stakeholders—the maintenance staff, the principal and assistant principal, explaining the problem of Spotted Lantern Flies and how they hoped to address the problem. And then, the school year ended.

As these students move into sixth grade, NorthBay will encourage the teachers to keep the project going by inviting students to build, install, and monitor the traps. The students can continue their research by looking at trap effectiveness, and share their results with the wider community to help them combat this particular invasive species problem. Who knows, perhaps the work begun by these students will lead to a commercially viable trap that helps many more people in the future. Even if their project

doesn't go that far, surely they will have increased the community's awareness of and knowledge about a particular invasive species. And that, combined with the academic rigor they brought to the project, is very important work.

Stevensville Middle School Students and Teacher Transportation

Seventh grade students from Stevensville Middle School in MD learned how to conduct inquiry during their visit to NorthBay as sixth graders. So when their environmental science teacher asked them to conduct a habitat assessment in their schoolyard, they were ready. When the students looked at the transportation category of the assessment, they noticed something significant about their teachers' driving habits. The students observed that just about every teacher drove his or her own car to school. The students decided this was a problem that they could do something about. First, however, they needed to know more. The students surveyed the teachers to find out if they were interested in carpooling, and if they were, where they lived. Using this geographical information, the students developed regional car pools, so teachers could ride to school with teachers who lived nearby. Each time the teachers participated in a carpool, they earned points: The more teachers in a car, the higher the point value. Their progress was tracked on a bulletin board in the hallway. Each time teachers carpooled, their paper bulletin board "car" moved closer to the finish line on the bulletin board racetrack. Teachers who crossed the finish line received a gift card as a reward to recognize their positive contributions to the environment. This tracking project will be continued into the new school year, thereby increasing its visibility and effectiveness.

These two examples represent our highest hopes, whereby students go outside and discover an environmental issue that sparks their curiosity. In the first story, students were conducting a stream assessment but noticed a colorful insect flying near the stream. Although they finished their stream assessment, the appearance of the Lantern Fly took their research in a new, unexpected (and delightful) direction. In the second story, the students conducted a habitat assessment and then used a finding about

school transportation to launch additional research. In both cases, the students discovered something, investigated it further, and then, they took action.

When students inquire about the world around them in a formalized way, they utilize many high-level thinking skills throughout the process, and their curiosity keeps them moving through the challenges. The work is multi-disciplinary, and students acquire considerable content knowledge as they conduct research. The final project component, taking action, empowers the students, setting them up to tackle with confidence more complex challenges in the future. Children are our future decision-makers, and this process helps them learn to see and to think with rigor. These last two qualities are at the heart of a teacher's work, regardless of discipline taught. Teachers teach students how to "see," and how to think. Let's now look more deeply into the methodology of inquiry.

About Inquiry

What is inquiry? Inquiry is a process people follow all the time to figure out the answer to something that is puzzling us. In this course the inquiry process is more formalized and more in-depth than the process we use everyday, so it is scientifically rigorous and replicable. In evaluating the health of a local waterway in "Tributary 3," you have begun an inquiry, using this question, "What is the health of this waterway?" We will come back to your results later in this course.

The inquiry model used in this course is derived from the pioneering issue analysis model, *Investigating and Evaluating Environmental Issues and Actions*, (IEEIA) developed by Harold R. Hungerford, Trudi L. Volk, John M. Ramsey, Ralph A. Litherland, and R. Ben Peyton, (1990, 2003). If you have the time and opportunity to teach the full IEEIA curriculum to your students, we recommend that you do so. This inquiry curriculum underpins Standard 1 in Maryland's Environmental Literacy Standards.The IEEIA model also informs Meaningful Watershed Education

Experiences, hereafter known by the delightful name of MWEE, a program developed by NOAA, the National Oceanic Atmospheric Administration, and numerous partners. MWEEs connect students to their local watersheds through field trips and research and classroom work, and culminate in action. If you are interested in learning more about MWEEs, please visit this link: The Bay Backpack MWEE.

The word “inquiry,” suggests that answers to questions may not be known and students will need to investigate, collaborate and communicate in order to find them. Sometimes, students can use a pre-existing assessment tool to collect data, like a carbon footprint calculator or stream assessment. After they have analyzed data, they can determine appropriate actions to address any problems they find.Their findings may lead them to become curious about something else, and now another inquiry can be launched. This is what the seventh grade Stevensville students featured in the story at the beginning of the chapter did after they looked at the results of their schoolyard habitat assessment, and realized they could do something about transportation. The Pottstown students were led into their research by the appearance of Spotted Lantern Flies during a stream assessment. There are questions all around us waiting to be explored! As one teacher with whom we have worked says, “the problem becomes the curriculum.” In this case, the problem (or observation) sparks the inquiry.

Inquiry engages students by inviting them to follow their interests. Moreover, it is inherently rigorous. As students work through an inquiry, they address multiple unknowns by applying high level thinking skills. They also use skills and content from all major subject disciplines: Math, English Language Arts, Social Studies, and Science. Action is inherent in the inquiry process. Students always move towards solutions for problems and issues, thereby building and reinforcing their personal efficacy.

Sometimes, the questions that emerge may require that students develop their own survey instruments. At other times, students may use an existing instrument. The difference in inquiry structure is somewhat like the difference between making bread from a boxed mix versus making it from scratch. How you ultimately approach and

guide inquiry depends upon available time, learning needs and goals, the questions that are asked, and the skill sets of your students.

In keeping with NorthBay's mission, which is to "challenge people through transformative educational and retreat experiences to realize their attitudes and actions have a lasting impact on their lives, communities, and the environment," the goal of the inquiry model is not to preach a biased environmental agenda to students. It is to teach them critical thinking and citizenship skills and empower them to take action, *if they see fit to do so.*

A significant body of educational research, including evaluations of NorthBay's programs, supports the multi-faceted value of the inquiry approach for social, environmental, and academic outcomes. (Please connect with us if you are interested in delving deeper into the research or consult the articles listed in the **Resources** section).

When teachers take students outside to learn about the watershed they inhabit and contribute to, they will notice and wonder about what they see and hear and touch and experience. Teachers can use these student-driven observations and wonderings to launch inquiry projects.

"What do you notice?" "What do you wonder?" These two simple yet powerful questions can launch a thousand exciting inquiries.

Click on these links to see students practicing inquiry at NorthBay.

https://vimeo.com/308602352

https://vimeo.com/308597826

https://vimeo.com/308589221

Now, we want to delve further into the details of inquiry by looking at two environmental issues that resulted from human activity on a major river, in this case, a dam has been built. Often, when NorthBay educators are working with students, time is limited, so the inquiries are structured and guided by the educator. In this section, we will guide you to explore two issues that result from the construction of a dam, as a way of illustrating the guided process followed when students visit NorthBay for the residential program, although, this will be an expanded version. Soon after we will invite you to develop your own inquiry.

At NorthBay, an educator might take her students to the waterfront, invite them to "notice" and then point out (if no one else does) the breakwaters that were built to slow and calm the water movement on the east side of the upper bay. The educator will invite the students to consider what impact the breakwaters have on animal habitat, after explaining why they were installed. Educators working with older students might pull out LIDAR photos of the area to show students how the beach shape changed after the breakwaters were installed.Once the students have acquired some background information, the educator will help the students fashion a research question about the types and abundance of clams or fish that live within and outside of the breakwater. From there, the students are off and running (or, as often happens, swimming!) with data collection, so they can evaluate the impact the breakwaters have on fish or clam populations. Afterwards, they'll hold a discussion and record their findings and conclusions in their journals. They will also, time permitting, think about a potential action to take or recommend. Let's now do something similar using a dam to focus our thinking.

Essential Questions of Inquiry:

What happened here or what did we discover? Who is impacted, and in what ways? How do we fix this? What are some potential consequences (positive and negative) of

our fix? To whom do we need to talk—stakeholders? What are their perspectives? What additional information do we need? How will we obtain it? Lastly, given all that we have learned, what will we do?

Dams are found worldwide, and many more are in the planning and construction stages. It can be difficult to foresee all the consequences of a dam being installed, especially initially. In a more general sense, it can be difficult to foresee the consequences of any of our actions. This idea of consequences is something we discuss with our students, and we hope you will as well. The example we will use is the Conowingo Dam on the Susquehanna River, Maryland, USA, built nearly 90 years ago.

Assignment 4a. Learn About a Local Dam

Before we go any further, identify the closest dam to you. Where is it? What do you know about it? As you learn more about the issues from the Conowingo dam, consider the issues that have resulted from the construction of the dam nearest you. A dam in your area could become the next inquiry for you and your students.

Look at this photo.

K. Williams, *Freshwater Journeys*

What do you notice?

Maybe you notice a river. Maybe you notice a big wall of concrete. Maybe you see the metal structure on the left and toward the middle of the structure. (A gantry).

What do you wonder?
What questions spring to mind after viewing this photo? Maybe you wonder what this structure is, or maybe where it is. Maybe you wonder what fish live here. Maybe you wonder what those metal structures are used for. Maybe you wonder when it was built. Maybe you wonder something else.

Take the next few moments to consider the issues associated with the construction and maintenance of this structure. We will use your initial observations and wonderings to launch a practice inquiry about this dam.

Assignment 4b. Questions

Using your journal, record all your questions about the dam.

Background Information for the Conowingo Dam

Conowingo Dam provides hydroelectric power and it backs up the Susquehanna River to provide cooling water to Peach Bottom nuclear power plant. It also serves as an important bridge across the Susquehanna river. Construction of Conowingo Dam was completed in 1928. The massive wall of concrete is nearly a mile long and 100 feet tall. Migratory fish that used to travel between the Chesapeake Bay and their historical breeding grounds upriver are now blocked a mere 10 miles into their formerly 464 mile journey.

When Conowingo Dam was built it was celebrated as a massive success. It provided affordable electricity to people who needed it. It linked the cities of Baltimore and Philadelphia by Highway 1. It provided jobs in a rural area. It also caused a few problems, however. Migratory fish couldn’t swim upstream to spawn any more. This

consequence of Conowingo Dam was entirely unintended. The intention behind Conowingo was to help people, not to harm migratory fish. Each of our actions has an effect, some of which we can foresee, some of which become apparent after the act.

Issue 1 Conowingo Dam: Migratory Fish

Some fish spend the majority of their lives at sea and migrate from the sea into our rivers and streams to spawn. They lay eggs on clean gravel bars in rivers and streams. The eggs hatch and the young head down river and out to sea where they spend their lives until it is their turn to migrate and spawn. These fish are called **anadromous**, and include herrings and salmons. Some fish do the opposite and spend their lives in rivers and streams and migrate to the sea to spawn. The young swim back up into our rivers and streams where they grow to maturity and repeat the downstream migration as adults. These fish are **catadromous** and include the American Eel. Some fish, such as catfish and bass, don't migrate at all to spawn, while others, such as Brook Trout and Brook Lamprey, migrate as far upstream as possible. When they release their eggs, the eggs have ample habitat in which to float downstream. When dams are constructed they block the migration route of short and long-distance migratory fish. In the case of Conowingo, that was primarily American Eels and fish in the herring family, which includes shad.

Migrating Herring Video. 23 sec.

Shad were incredibly important to the local economy. In times past, a net was strung across the mouth of the Susquehanna during the springtime migration and hundreds of thousands of fish were harvested. Shad floats and shacks dotted the shoreline of the river, and economies of entire towns were dependent on the seasonal harvest of shad. The Cecil County Historical Society has a few photos of this event in its collection: Shad haul on the Susquehanna

Shad numbers fell due to overfishing, the loss of clean gravel bars, and severed migration routes from the construction of dams. American Shad are currently listed as

endangered, and other herring species are threatened. The mid-Atlantic population of Blueback Herring has dropped by 90% over the last 20 years for the same reasons. People tried to remedy the loss by installing fish lifts and ladders designed to get anadromous fish up and over dams as they migrate upstream to spawn. These are the gantries you see in the far left side of the dam and the grey structure more to the center. Exelon power, the current owner of Conowingo Dam, has spent $12 million on fish lifts. In 2015, only 8,341 American Shad utilized the lifts.

Assignment 4c. The Cost of Restoring Shad Migration Passages

Please take some time to think through the following questions. How much money should Exelon spend on migratory fish? Do you think Exelon should spend this much money trying to preserve and restore American Shad? Establish an argument to support your position using CER (Claim Evidence Reasoning).

Assignment 4d. Migratory Fish and Local Culture

Investigate migratory fish that live/have lived near you and report in your journal their current status, efforts to restore them and their cultural significance.

Further Reading: Migratory Fish

Read the two articles for more information.
Article 1: *Conowingo Dam Fish-Lift Overhaul Urged to Restore Susquehanna's Shad, Eels.*
http://www.baltimoresun.com/features/green/blog/bs-md-conowingo-fish-lift-20150811-story.html
Article 2: *Dismal Shad Run puts Conowingo Dam in Crosshairs*
http://www.baltimoresun.com/features/green/blog/bs-gr-conowingo-shad-20130604-story.html

Assignment 4e. Calculate Cost of Transporting American Shad

Calculate a dollar per American Shad cost based on the information provided in these articles.

In the above case, the construction of Conowingo Dam while providing many benefits, severed migration routes for migratory fish. The environmental issue was (and is) how to fix the problem.

Issue 2 Conowingo Dam: Sedimentation

Water erodes land, and when it does it puts dirt in water, which we call sediment. Erosion and sedimentation are natural processes. However, when we disturb land such as at a construction site or ploughed farm field, we increase the amount of sediment that washes into the nearby river. Sediments cloud water which makes it hard for some fish species to find food. Sediments can carry other pollutants with them, like phosphorus, which makes excess algae grow. Sediments eventually settle out of the water to the bottom where they fill in all the nooks and crannies of a rocky, diverse stream bottom habitat, creating a monotonous habitat with little habitat diversity. Sediments also collect behind blockages in rivers and streams, like logs that fall across

them, or human-made dams, like Conowingo. The lake backed up by Conowingo Dam can no longer capture any more sediment. Some of the sediment already captured by the dam might flush into the Chesapeake Bay with heavy river flows. The sediment behind Conowingo Dam doesn't affect the dam's ability to generate electricity. There is a lot of disagreement on this issue. Some people don't think this is a problem. Others think it is the biggest problem facing the Chesapeake Bay. Even if there was agreement on whether this is a problem or not, there is no agreement on how to fix the problem. Do we dredge? Do we do nothing? Do we slowly pump the sediments around the dam?

Further Reading: The Sedimentation Issue

Assignment 4f. Sedimentation.

Read the following articles to learn more about sedimentation. Write a quick summary of your understanding of the articles in your journal. Include any questions that may have arisen.

Article 1: *Will Dredging Alleviate the Conowingo Dam Sediment Issue?*

https://www.washingtonpost.com/national/health-science/will-dredging-alleviate-the-conowingo-dam-sediment-issue/2015/04/05/fec9cb0e-c025-11e4-9271-610273846239_story.html

Article 2: *Dredging Conowingo Little Help to Bay, Study Finds*

http://www.baltimoresun.com/features/green/blog/bs-md-conowingo-bay-study-20141112-story.html

Article 3: *Conowingo Dam above 90 Percent Capacity for Sediment Storage*

ttp://www.usgs.gov/newsroom/article.asp?ID=4129&from=rss#.VhkU58-FPmI

Article 4: *Conowingo Dam Not a Major Threat to Bay, Study Says; Others Disagree*

http://marylandreporter.com/2014/11/13/conowingo-dam-not-a-major-threat-to-bay-study-says-others-disagree/

Assignment 4g. The Effects of Land Use on Sedimentation

Return to the model you made for Assignment 2d. Use it to demonstrate the effects of different land use on sedimentation. Please submit a photo to share your work with us.

UPDATE: Conowingo Dam, August, 2018

Stream Visit

Estimated time for this stream visit: 1 hour

What you'll need: Journal, regular and color pencils, something to sit on.

Contemplate: Sit Spot Visit 4

On your way to your sit spot, pay attention to how you approach it. Are you walking quickly or slowly? Are you quiet and focused on the walk, or are you distracted? Notice your thoughts without judging them. Simply notice, and then, let them fly free like dandelion seed parachutes floating on a puff of air.

Once you arrive at your special spot become quiet and still, activate your senses, and begin to observe. What do you notice today? Do you notice any patterns beginning to emerge over the course of four visits? What additional questions do you have about this waterway? Is your waterway impacted by dams?

When finished with the journaling assignments, pay attention to how you leave your site.

Investigate & Reflect: Evidence of the Past

Storms, floods, earthquakes, human and animal activities. Events and phenomena leave their marks on a landscape. Learning to see them is an important skill, as is considering their impacts. Perhaps a passing racoon has left footprints along the bank, perhaps an abandoned car speaks to a time you could drive down a road long forgotten. Perhaps a beaver has built a dam and created a pool. Perhaps people built a railroad bridge over a waterway, constricting the free flow of the water.

Please reflect upon these questions in your journal:

- What phenomena or human history can you see etched in your landscape?
- Have these events caused problems and/or created opportunities?
- Are there different perspectives from which to view these as problems or as opportunities?
- Can you list some unintended environmental consequences of your actions on this waterway? We inhabit watersheds and influence watershed health.
- How about unintended consequences of your actions on other people?

NorthBay asks questions such as these last two of our students, to get them thinking about who they are in the world, and how their actions impact others. We hope you will also ask these questions of your students.

Add any additional thoughts you may have in your journal before leaving the site. On your walk out, notice the stories of phenomena, and human activities embedded in the landscape you are walking through. Some of these stories are ancient, and held in the rocks. Others are more recent. Consider how all these happenings have influenced this particular waterway. Consider what impacts your mere presence might have on the species who live in and along the waterway.

Interlude 4

A sheet of bubbles

A rippling layer of silver flecked light

Fifteen sun-splashed fish

Create a living tessellation.

Light flickers, ricochets off an unfurling fin

Illuminating for a moment

An underwater

Fire.

– K. Chambliss