NATIONAL PARK FIELD SCIENCE

PROGRAM GUIDE

Updated May 5, 2021

National Park Foundation
WONDER CALLS

TABLE OF CONTENTS

WHAT IS THE PURPOSE AND FORMAT OF THE PROGRAM GUIDE?

The benefits of environmental and experiential education have been widely acknowledged. There is much anecdotal evidence from individual classrooms, and more recently, wider-ranging studies (like that of Nicole M. Ardoin and colleagues in 2018) that clearly document the value of this approach. This guide will serve as a manual for nonprofit environmental and experiential education leaders and partners from National Park Service (NPS) units who want to implement place-based science education as part of an immersive curriculum experience developed by the National Park Foundation (NPF) and partners. Place-based education encourages teachers and students to use the schoolyard, community, public lands, and other special places as resources, turning communities into classrooms. This program guide is informed by a three-year NPF pilot program, Citizen Science 2.0 (CS2.0), funded by the Veverka Family Foundation, which emphasized place-based learning, teacher professional development, and institutionalizing parks as places of learning within local school districts. Parts of this project took place during the months when the pandemic most severely impacted life at school and at home. The participants developed virtual tools and home-based projects, which added resilience and provided resources, such as videos and online research assignments, that can be used in both classroom and remote scenarios. This guide is meant to help set the foundation for a successful place-based science education effort and provide access to tools for adapting efforts to unique situations and supporting the program in periods of unexpected change. You will notice we shift from discussing the model of the CS2.0 program to a new initiative tilted National Park Field Science, as we look to expand on the CS2.0 pilot.

Our National Park Field Science program guide, based on the findings of the CS2.0 program, is meant to lead you to question your role in your own ecosystem. For our initial cohort, we chose community science-based projects that centered around watershed ecology because we believe the powerful experience of nature can be found not only in the grandeur of snowmelt cascading into the Yosemite Valley, but there is something equally sublime about the fungi-root interactions below a sycamore tree clutching to the banks of the Anacostia River in Washington, D.C. Waterways, like roots of a tree or the veins, arteries, and capillaries in our bodies, can be divided up smaller and smaller. We can follow the tributaries of the mighty Mississippi River until we are looking at the hydrology of our local creeks, of the water that falls off the roofs of our houses, and even the droplets swept away by our windshield wipers while straddling the divide of the Blue Ridge Parkway. Where do these creeks, falls, and droplets end up? What role do we play in their journey? And what can tracing these paths using the scientific method tell us about our past, our present, and where we're headed? Examination of watersheds and other natural systems also tie into big ideas that are on students' minds and increasingly frequently addressed at school, among them drought, severe storms, and climate change.

In the CS2.0 pilot program, students used data, or perhaps more importantly, the process of data collection, management and analysis to understand their local watersheds and to begin their journey to answer some of these questions. The data collection processes, some of which took place in schoolyards and, during 2020, at home, were integral to the CS2.0 model because when students are actively engaged in the collection, analysis, and understanding of data and information concerning natural resources, they are more likely to care about the implications of the data, as well as their personal role in protecting, maintaining, and ultimately, preserving these resources and ecosystems for future generations. Place-based education is a powerful tool in fostering connections between individuals and their community. Going forward, we plan to update this toolkit to include greater analysis of the innovations used during the pandemic and provide insights from new teams who launch their projects in 2021-22 and beyond.

Our guide consists of ten sections and four appendices designed to lead you to a community-based creation of a similar program. The sections are as follows:

1. ***What exactly was CS2.0? Immediately following this section is a description of the CS2.0 program model along with specifics about our pilot sites.***
2. ***Definitions of Place-Based Education,*** Citizen Science and Community Science. As defined by the National Park Service and with a short discussion on this guide's focus.
3. ***Forming your National Park Field Science partnership team.*** Here, the roles of the School/School District, Community Education Organization, and the NPS unit are defined along with recommendations on how to best lean into each of the institution's strengths.
4. ***Focus on the school partner: districts, schools, and teachers.*** How to help school and district partners get the most out of the program.
5. ***Professional development.*** What do teachers want, what do they need, and how to work together to achieve that.
6. ***Designing and testing your Field Science curriculum.*** Working with teachers and other school officials in order to implement place-based lesson plans.
7. ***The field experience.*** Leaning into synergy between your three organizations and making sure that the needs of all students are met.
8. ***Data collection, data management, and data analysis.*** What does good data collection processes look like, and how does this create a genuine, passionate interest in the resource?
9. ***Program sustainability.*** How to institutionalize what's working, and how to change what isn't.
10. ***Conclusion.*** What we wish we knew when we started.

    Appendices:
    - A – Considering a full-time program coordinator
    - B – Example teacher professional development materials
    - C – Sample curriculum materials
    - D – Resourcing your program.

We recommend following the ten sections in order as this will allow you to best build your program and cultivate a strong partnership with school administrators, teachers, community partners, and National Park Service educators and resource managers.

...and with that, *welcome.*

WHAT EXACTLY WAS CS2.0?

Citizen Science 2.0 was a watershed-based science curriculum for middle or high school students that incorporates field studies, data analysis, and student-designed action initiatives. The 2.0 designation is intended to distinguish this program from many citizen science initiatives that focus on recruiting volunteers, typically adults, to collect data for research or monitoring programs (see definitions in Section 2, What's in a Name?). Instead, this program engages students in the full course of the scientific method, including issue identification, research, field design, data collection, analysis, conclusions and action steps. Among the program's priorities was creating a sustainable framework so that it persists for many years as part of school district curriculum and/or as a project of a nonprofit or an NPS unit.

CS2.0 was piloted at eight National Park Service sites. Each pilot grantee was led by a team of NPS leaders, school administrators and/or teachers, and nonprofit education staff and volunteers. A list of the eight pilot sites with their team of partners follows and more information on the learnings from the pilot can be found in the CS2.0 Final Report. Below is the framework of the CS2.0 program from which this Field Science program guide is derived. This guide will be most useful for programs that already do, or intend to, follow a similar model of place-based education.

Anacostia Park (Washington, DC, Maryland) Anacostia Watershed Society	**Jean Lafitte National Park and Preserve (Louisiana)** Barataria-Terrebonne Estuary Foundation
Cabrillo National Monument (California) Ocean Discovery Institute	**Mississippi National River and Recreation Area (Minnesota)** Science Museum of Minnesota Mississippi Park Connection
Cuyahoga Valley National Park (Ohio) Conservancy for Cuyahoga Valley NP	**Rock Creek Park (Washington, DC)** Audubon Naturalist Society
Great Smoky Mountains National Park (Tennessee, North Carolina) Great Smoky Mountains Institute at Tremont	**Saguaro National Park (Arizona)** Ironwood Tree Experience, Sonoran Desert Inventory and Monitoring Network

- The effort is undertaken by three or more partners, including, at minimum, an NPS site, an education nonprofit, and a school district or schools. Each partner has a vital role to play, described in more detail below.

- Longevity is a central goal. To this end, the program is designed to be incorporated within school or school district practices. Therefore, it is most successful when the curriculum module fits within broader district curriculum objectives (typically science programs) and meets relevant district and state education objectives. Another route toward sustainability can be aligning with long-term priorities for city, state, or nonprofit groups capable of providing ongoing support.

- Desired program outcomes for students typically include environmental literacy and actions like stewardship or conservation. Students should come away with a deeper understanding of humans' relationship with and responsibility toward the natural world. Cultural understanding, civic engagement, and other social-emotional-ethical learning outcomes can also be prioritized depending on the questions students are addressing.

- Learning is largely experiential and hands-on, utilizing inquiry-based approaches where students are encouraged to ask questions, make observations, and conduct investigations of natural phenomena.

- The primary purpose of this program is student education, not contribution to scientific research or resource monitoring; however, participation and guidance from scientists, historians, and/or natural resource managers is highly valued.

WHAT'S IN A NAME?

Recognizing the terms citizen science and community science have specific meaning to the National Park Service, in particular, NPF will shift away from the program name Citizen Science 2.0. In its place, we will move forward with place-based education under the banner "National Park Field Science" in order to clarify the type of activities encouraged and/or permitted.

National Park Field Science: NPF's future activities supporting science, place-based, experiential learning will be under the program name, National Park Field Science.

Place-based Education: Place-based education encourages teachers and students to use the schoolyard, community, public lands, and other special places as resources, turning communities into classrooms. This National Park Field Science Program Guide encourages this approach for maximum flexibility and creativity incorporating teacher and student voice.

Citizen Science: Citizen science is a general term that refers to the involvement of the non-specialist public in scientific research or monitoring. It is a genuine and legitimate approach to science that yields new information and understanding while also engaging people meaningfully with science. For the National Park Service, this typically means inviting volunteers to collect scientific data that it needs in order to understand and manage natural resources.

Community Science: Community science is an egalitarian collaboration between a community and one or more scientists to meet the priorities of the community. It is a specific type of citizen science in which the community, not the scientist or scientific institution, sets the research or monitoring agenda. The result is co-created knowledge that the community needs in order to understand and improve its livelihood.

We recognize that these terms are not used uniformly and, in some cases, are used interchangeably or intentionally substituted for one another (i.e. the use of "community science" as a preferred synonym for "citizen science" because of concern that the latter term is exclusive or dismissive of undocumented residents and other non-citizens of a country). For the purpose of this Program Guide, we will focus on Place-Based Education and the role of recorded observations, or data, and the analysis of that data in this work.

FORMING YOUR FIELD SCIENCE PARTNERSHIP TEAM

The most essential program element is cultivating a robust partnership between a nonprofit education organization, the NPS site, and a local school district and/or schools. Within this larger structure, it is important to also cultivate inter-group partnerships – like the joint participation of a park's natural resource management team and its interpretation and education team, or equal engagement of teachers and their school administrators. It is critical to achieve full buy-in from all partners, because a more robust partnership is better able to handle challenges, like employee turnover and limited time/resources and produce a lasting program.

The Core Team – Partner Roles and Responsibilities

Nonprofit Education Organization: Education partner organizations bring significant expertise in teacher training, student-centered program design, financial investment, trained volunteers, and logistics management. Typically, these nonprofits specialize in environmental education, but not always. The pilot experience demonstrated that these groups often play leadership roles and help cement the partnership. On a day-to-day basis, the partner organization may coordinate schedules and communications, deliver teacher professional development, and/or host the tools for data collection and analysis. It is helpful when the science education project reinforces the nonprofit's priorities, such as contributing to an ongoing project, like tree or animal monitoring. This strengthens the partnership and makes it more natural for the organization to contribute resources like staff and volunteer support, outside funding, short or long-term planning, and more on an ongoing basis.

National Park Service (NPS): Both the park's education and natural resource management staff should be involved in the co-creation of the proposed program. NPS staff is responsible for completing all legal compliance ahead of the project and ensuring that scientific permits (if needed) are approved. While education staff typically lead the program, resource management staff must be consulted about ongoing data collection or inventory and monitoring efforts in the park (and/or surrounding areas). The relevance of students' work to actual park management decisions helps them to understand that their efforts have genuine impact. In the original CS2.0 program, NPS resource managers played a key role in identifying relevant community science projects.

School District and Schools: An integral component to the Field Science approach is recognizing teachers as key partners. Teachers understand the curriculum, along with grade-level standards, and what works for students' learning needs. Thus, they provide necessary insight into key desired outcomes for student projects from a learning objectives standpoint. Through this program, teachers are supported with professional development from NPS and/or the community education partner, which provides specialized training in taking students outdoors, community science and aid in project development. The combination of the teachers' existing expertise and program-specific professional development contributes to experiences that fully engage students and complement existing curricula. Administrative staff and school district curriculum coordinators are also a key audience. They can provide support in the program's early days and are integral to decisions connected to its longevity, such as adopting Field Science programming into district-level curriculum.

ACTIVITY: Field Science Team Member Readiness

Brainstorm readiness of your organization and potential partners in areas that are important for program implementation. We have listed a few and please add others.

Education Partner

- Is this program at the heart of the organization's mission?
- Are resources available to devote to coordination, teacher training, and student engagement?
- Is such a program likely to receive support from the organization's board, volunteers and donors?

NPS Unit

- Are natural resources staff interested, as well as education staff?
- Can student projects fit into an existing project, like a plant census or study?
- Is the park able to host large groups, or constrained by the fragility of natural resources?

School/School District

- Is experiential learning and/or science or climate literacy a high priority?
- Is there an opportunity to integrate a new program into regular curriculum?
- Is more than one constituency (teachers, principals, district administrators) excited about the program?

Collaborating as a Core Team

One of the main advantages of this team structure is that it provides resiliency. A coordinated group can maintain focus on advancing the program in the face of staff turnover, resource issues, or unexpected changes of any kind. Coordination entails not only joint ownership, but also having effective tools for organizing across partners and sharing learned efficiencies across teams. All three entities need to be engaged at the right level and with an appropriately defined role. During the CS2.0 pilot phase, we learned that a team with minimal NPS input typically had trouble identifying an appropriate field science project at the park. A team with minimal education partner support faced challenges with logistics capacity. And a team with minimal school input was less able to scale the program beyond one or two teachers.

The pilot teams found that managing field trip logistics was a very important role. In some cases, this effort was taken on by the nonprofit partner and in other cases there was collaboration. In several cases, the teams pooled resources or identified new resources to create and support a coordinator position. For more information on this role, please see Appendix A.

Finally, it is critical to facilitate constant communication among partners to flexibly meet the inevitable real-time challenges. Consider regular meetings between the core team of park, nonprofit staff, and school partners to discuss, strategize, learn, and plan the design and implementation of students' learning experiences on campus and in park. This creates a supportive group with the shared goals of connecting students and teachers with their local park, using the park as a resource for learning, and advancing the field science initiative.

ACTIVITY: Field Science Team Members and Contributions

Brainstorm which partner (NPS unit, school/school district, or education partner) could provide resources that would contribute to your program. Some examples of resources are listed below and feel free to add your own ideas.

- Natural site or sites
- Science tools and equipment
- Data management programs and equipment
- Coordination
- Transportation
- Expertise and training for experiential education
- Financial support
- Program evaluation

FOCUS ON THE SCHOOL PARTNER: DISTRICT, SCHOOLS AND TEACHERS

The school partner is a critical participant, but often faces the greatest number of additional priorities, stressful turnover, and resource limits. Because of this, it is critical to give extra consideration to the readiness of school partners. To begin, the nonprofit and NPS partners may consider districts where they have a history of working together. They should also look at opportunities to develop multiple champions within the school and school district. At the school level, it is important to not only have initial support from the school principal, but also to map out an engagement strategy to keep the principal informed during your program timeline. At the district level, within the hierarchy of school administration, successful programs sought support from curriculum coordinators or other district staff to ensure alignment with district goals. District level contacts also typically have good relationships at many schools and may be able to assess schools that demonstrate "readiness factors."

School District Readiness

It is vital to assess the readiness of a school district as a whole to eventually achieve the goal of creating a systemic, lasting program. Readiness factors at a district level might include a state commitment to environmental or STEM education, an existing, multi-school effort to promote place-based education, and connections between park and nonprofit staff and administrators, not only teachers and principals. A pilot partner noted that new administrators may not be ready to adopt a major program, and districts with an established slate of programs may not have bandwidth for another. It can be worthwhile to seek out a district where the leadership has the experience and capacity to grow program offerings and add something new. An existing relationship with the school district "central office" staff can be very useful both in launching and sustaining a successful program. However, if this relationship does not exist, this challenge can sometimes be overcome by achieving demonstrated success with a few teachers or schools and then attempting to forge a relationship within the school system.

CASE STUDY: Science Museum of Minnesota, Mississippi Park Connection and Mississippi National River and Recreation Area

We benefited greatly from ongoing cooperation with the Supervisor for PreK-12 Science at Saint Paul Public Schools. He helped us identify teachers with a commitment to taking kids outdoors and schools where the principal or vice principal would be most willing to join us in this project and support their teachers in this work. This generally meant administrators who were not already committed to starting another large project or those who had just recently transferred to a new school. There were teachers who were highly recommended to us who happened to be at schools without administrators who were ready for this sort of project, and we refrained from recruiting them because we knew they would face challenges.

What we looked for was a teacher in an appropriate school who valued outdoor learning experiences and was motivated to try something new. We started with schools that had already attracted several like-minded educators who shared a commitment to outdoor education; schools where many of the barriers to taking kids to a park had already been overcome. We then looked for teachers with a similar mindset but less institutional support, teachers who had devoted themselves to tackling those barriers almost single handedly.

We also looked for administration staff who were okay with our project being a pilot, where we'd take a few dozen students to the park rather than a full grade level. This allowed us to prototype and iterate our outdoor activities each season, taking lots of input from the teachers themselves. There were schools where a principal might have been open to a community science project like this, but only if there was a ready-to-go curriculum that could be applied across a full grade. We found this option appealing, but wanted to build to it more slowly over the length of the project.

School Readiness

Readiness factors include schools with experience through previous pilots or programs engaging students in place-based learning (even if they were not considered successful), one or more teachers who exhibit willingness to try new approaches, one or more teachers who have participated in place-based professional development, demonstrated school administrator support for a broad range of student experiences and learning styles, and/or existing resources that can be leveraged for place-based learning (school yards, other education partners, other community-based connections, funding).

Teachers as Champions

At the outset of a new program, it is helpful to have a lead or "champion" teacher who can recruit and mentor new teachers. You might also ask if there is an opportunity to have veteran teachers support early career teachers through the professional development experience and/or an ongoing facilitated teacher network. One CS2.0 pilot group found it useful to pair teachers from very small schools with experienced colleagues from other schools, creating mentor relationships that did not exist within a single school. Pairing teachers is important not only for the practical knowledge transfer, but also to ensure continuity in programming by proactively addressing retention or retirement challenges. Focus on developing multiple teacher champions, including a mix of those new to teaching and those with many years of career experience, within a school can make effective use of your time and resources.

As you consider engaging teachers, it is helpful to understand how they are organized in each individual district or school. Some questions to ask include:

- Are teachers working across grade levels but within subject matter?
- Are they operating more independently?
- Are they collaborating across disciplines?

When it comes to a school that does not already have an established practice for taking field trips, the partners will be tasked with navigating this organizational structure to secure buy-in for any trips that take students out of multiple classrooms in a given day. The earlier a site can build relationships with all the teachers who will be impacted by the trips, the easier it will be to make them happen. This is independent of recruiting "champion" teachers who can also be advocating on your behalf.

Scaling Up

Establishing a strong presence in a school or district is critical before expanding, but once this is achieved, it is possible to add new school participants. Consider other schools where you already have strong teacher relationships.

- Do your other school principal champions exist in your network of school partners?
- Can a curriculum coordinator or student learning specialist help you identify other schools that are poised to participate in place-based experiences to enhance in-classroom curriculum based on the previous readiness factors?

PROFESSIONAL DEVELOPMENT

Importance of Teachers as Learners

Many parks and educational nonprofits do wonderful work with students in and out of classrooms. But often outdoor learning can become a one-off program – possibly the only time that year the students will experience that type of experiential learning. Focusing on sustainability is a way to overcome this as is a commitment to professional development for teachers. If teachers become comfortable with taking students into the field and begin to see the benefits, they are much more likely to become committed to Field Science and other experiential learning programs.

EXAMPLE IN ACTION: Four Components of Strong Teacher Professional Development from the Great Smoky Mountains Institute at Tremont

1. Social & Emotional Development

Teachers need to feel comfortably situated in the environment and within the group. They need to feel like they can do it. How do you do this in practice?

- An inviting and approach setting. A warm welcome and asking teachers, "What do you need to be comfortable right now?" can help to reassure teachers. And remind them that your collective goal is better living and learning for their kids!
- An immersive social experience. Situating some portion of your professional development in the outdoors helps to remove the usual schedule and stressors, and connects teachers to both nature and the people around them. This immersive experience might ideally be held in a quiet, nature rich environment, but it can also be a courtyard, a picnic area, or the edge of a wooded area.
- A nurturing environment. Consider how you might model being helpful and paying close attention to the teachers as learners. This translates to the teachers as you being supportive of them, but also reinforces the value of teaching that is truly "student-centered."

2. Experiential education

Some teachers may not be very familiar with experiential education in practice. Participating in place-based activities themselves as a learner, together with other teachers, can provide confidence and comfort in connecting students with the outdoors. As part of their participation, allow for time to process this individually and collectively, through discussion and sharing. This may be a paradigm shift for some teachers, which means leaving the comfort of 'what I have always done' and trying something new.

3. Research/Data

It is helpful to have some research/data for showing the efficacy of experiential learning, but not too much. Data by itself doesn't necessarily change one's mind, but data combined with a personal experience of learning experientially can be powerful – especially when teachers can deconstruct the learning and teaching with each other at the end of the professional development session.

4. Processing

- Reflection time. In the case of the teachers participating in your professional development, generous amounts of solo time outdoors where teachers can reflect on their learning and capture that learning in their journals. Small and large group processing after some solo time is great too!
- Journals! Providing a journal to participants right at the start of the professional development (whether it is a few hours or a few days) and ensuring teachers have time and space to use them throughout the experience is important. This reflection opportunity is the chance for teachers to see their brain at work, which is a powerful tool for learning.

While Field Science seeks to make national parks into classrooms, students can have many experiences closer to home that build up to fieldwork in a park. For example, they can monitor natural occurrences in schoolyards throughout the year. For this to happen, teachers need training, resources, and on-going support and encouragement. Sharing the 'little successes' can lead to teachers realizing that a program like Field Science doesn't have to be a complicated large project – it can be just getting students out to the study plot and letting them explore and have some time to sketch in their journals, write, and describe what they see.

Where to Start

The pilot teams found that when teachers allow themselves to be learners, they come to know what types of teaching are energizing and inspire curiosity, and what is draining and ineffective. This, coupled with a chance to debrief and deconstruct the learning experiences with other teachers, is powerful. The insights gained leads their teaching to be more student-centered and engaging. Strong teacher professional development unlocks (or maybe reminds teachers of) the power of curiosity in learning.

To tailor your approach, consider engaging teachers in your group in planning training activities. The importance of teacher voice is crucial to developing a relevant, meaningful, engaging teacher professional development workshop. Often the first step is just talking to teachers, finding out what their needs are and then figuring out how you can help them meet those needs.

As you design your experience, aim to strike a balance between disseminating critical content and engaging teachers in hands-on field-based training. Incorporating a variety of speakers, including teachers who have previously participated in the program, partner organizations involved in the program, and even students, can provide insights into the rich array of available resources. Scaffolding your professional development opportunities to offer more in-depth training to returning teachers, particularly regarding new technology, can be an important teacher retention tool while also establishing a professional learning community amongst the teachers. For sample professional development materials, please see Appendix B.

Evaluating Your Professional Development

You can develop surveys to gain immediate insights from teachers participating in your training or workshop. Questions might include asking about goals met, insights gained, and specific plans to make use of the processes and resources included in the training.

Provide space for the teachers to define their own success back in the classroom, i.e. "What will it look like if you are successful?" For some teachers, even though projects sometimes fall in the realm of science, we know that this actually leads to further experimentation and new discoveries. Failures in science can also lead to positives like shared experiential learning that leads to social and emotional growth. Consider asking teachers to describe any changes in the dynamics of the student teacher relationships, and student-student relationships. "How did students treat each other after taking part in this project? In what ways was this a game-changer for your classroom?"

Finally, keep an open line of communication with the teachers and constantly assess how your programming and outreach can be recalibrated to better meet their needs. Be open to adapting your program, it might not look exactly the same each year.

DESIGNING AND TESTING YOUR FIELD SCIENCE CURRICULUM

Successful teacher integration is critical to program success and institutionalizing your program, meaning that if you want your program to stick year after year, it is necessary to consult local teachers while in the design process. The program should be designed in accordance with national and state education standards, and teachers can inform you about which sections are most important because this will also help with bringing their administration on board. While there is no one right way to develop a curriculum, we found high success rates with programs that took their cue directly from the local schools' educational programs and/or used pre-existing curriculum developed by reputable partners (including NPS and the education partner). Strategies and examples are given below. For examples of curriculum used in the CS2.0 pilot program, see Appendix C.

Teacher-Led Curriculum Design

In some cases, the program curriculum, activities, research projects, analysis, and other efforts were designed by teachers with the support of parks and education partners. In these cases, the curriculum often served as a type of living document, and regular meetings with teachers ensured that program goals were delivered both in the classroom and on field trips. The advantages to this style of curriculum are that students feel their work is more relevant when teachers and rangers respond to their feedback, it is easier to incorporate the student voice in a more flexible framework, and new curriculum can be shaped to fit the structure in use at a school or across a district. One park site recommended engaging teachers who had written curriculum before so that they could shape new curriculum that fit the "mold" of existing school system curriculum. Often curricula can be structured uniformly, so it is useful to have a teacher participate in the program who knows the formula/particular "curriculum language" of that school system. With this approach, you are not asking the school system to implement "your" program but rather you are creating a program together that meets the needs of all partners.

Existing Curriculum Resources

Other sites used a set curriculum that had pre-defined projects and activities, sometimes developed by the education partner or NPS. Many national parks will have existing curriculum resources identified that align well with the resources and subjects of inquiry found in their park ecosystems. They noted that it was important to stay flexible and open to student and teacher voice, especially when it took the program in new directions.

EXAMPLE IN ACTION: Science Museum of Minnesota and Mississippi Park Connection

In cooperation with teachers we honed in on the value of having a turn-key project that less experienced teachers could start with and then extend as needed for their students. What we eventually implemented was a service project foundation (planting trees in the park) with a community science layer on top (making phenological observations of previously planted trees). We also left space in the field trip days for teachers to add on additional projects or activities (measuring water quality, observing the flow rate of the river, drawing, doing transects, etc). The advantages of this was that all four schools that participated in the second year of the project had similar core experiences, collected similar data, and could (in theory) share those stories between the schools. The disadvantages were two-fold: (1) The tree-planting/observations were not meant to be the full park experience, leaving several details up to the teacher to define. This wasn't an issue for experienced teachers, but was something we hoped to address for less seasoned teachers. (2) The tree-planting/observation did not fit seamlessly into each teachers' classroom curriculum, given that each one was coming at the experience from a different direction. Neither challenge posed much of an obstacle for us, given the high level of dedication and skill in our teacher cohorts.

ACTIVITY: Designing and Testing your Field Science Curriculum

Brainstorm to identify potential avenues of curriculum development that may work for you and your partners. Pilot teams took a variety of approaches in developing curriculum and field projects, from individual teachers creating their own independent projects to adopting projects that had already been fully developed by one or more of the partners.

- Is there an existing project that could become the anchor for your Field Science education effort, such as a tree/species census, an effort to restore a species to an ecosystem, or other effort?
- Are resources available, for example, school or district-level curriculum developers?
- Do teachers have the bandwidth to play a larger or more limited role in developing projects and related curriculum?
- Does the school partner have a standard format for curriculum, and can you save work later by adopting it at the outset?
- Are there state or district-wide guidelines that could help shape a program that would help meet educational expectations or requirements?

THE IN-PARK EXPERIENCE

Thinking Ahead

As you begin to think through where and how you will engage students, planning ahead with your core team of partners will help ease unanticipated (but almost certain) challenges ahead.

- **Location, location, location** – Consider the challenges of transportation as well as the nature of the site. Students can develop and build confidence in the outdoors over several scaffolded trips, from their school yard to a local park to the NPS unit itself. Depending on the burden of transportation logistics, a visit to the national park could serve as a capstone experience for students. Schoolyards can offer a wealth of data collection opportunities that are hiding in plain sight and, through repeated work in the schoolyard, teachers came to have a more favorable understanding of their schoolyards as a lab or classroom.
- **Flexible timeline** – Significant schedule and operational disruptions will happen. From state-wide school closures to weekly/daily class schedule conflicts or even governmental shutdowns, these disruptions are almost inevitable. The important thing is to work around planned school closures or big park events and remember to build flexibility and contingency plans into your timeline where possible.
- **Time management** – Multiple school trips do require time to plan, coordinate, and execute. Core teams should integrate the space for this work as it relates to the number of visits and the length of time needed to successfully use the park site as a resource for learning and/or for the park staff to have the time and approval to visit schools.
- **Permits and permissions** – Projects on NPS lands may require scientific permits, which take time to submit, process and approve. During your planning and coordination with national park staff, be sure to ask about the requirements for permitting and data collection.

Teacher Preparation

Teacher confidence is a critical component of program success. The importance of developing teacher comfort and confidence emerged as a prerequisite for any successful "park as classroom" project across pilot sites. Supporting teacher interest, comfort, and capacity to engage with these hands-on opportunities is key. Some ways to increase teacher comfort include engaging them in experiential learning projects in the schoolyard before taking trips to park sites and allowing them to explore the site in advance.

Project Selection

Projects, like curriculum, can be generated by teacher groups or any partner. The most relevant projects often follow park science protocols and park resource management conservation standards and also meet curriculum standards, as well as responding to the level of students' baseline understanding, knowledge, and experience. This is not an easy feat. The pilot experience suggests that the perfect should not be the enemy of good. Or in other words, remember that student learning is the ultimate goal and allow yourself to be flexible in other areas to meet that goal.

CASE STUDY: Ironwood Tree Experience, Saguaro National Park and Sonoran Desert Inventory and Monitoring Network

A key goal of the SAGU CS2.0 team was to emphasize the importance of the students' enjoyment and engagement in park conservation and stewardship and to reinforce that the park is their park and that folks just like them contribute to conservation efforts. To this end, our efforts focused greatly on student buy-in and teacher support. In the selection of student projects, we offer the following:

1. From the start, encourage the CS2.0 leadership team to visit the students' class and campus and explore it for the program's orientation and introduction presentations. The leadership team ought to include members of the park and the community organizations. This puts the scientists, community educators, and park managers right into the students' territory and builds bridges between students and their local community.
2. Select a CS2.0 project that the student agrees is manageable or doable. This may be a project that takes the following into consideration: the seasons, time of day or night, location, accessibility of the location, and appropriate equipment or tools such as binoculars, hand lens, data sheets, or mobile app or wi-fi connectivity. In addition, the level of data observation and collection, or science understanding and interest may also need to be considered so that the student can manage or participate in the project effectively.
3. Start with an exploratory, experiential C2.0 project that can be introduced and conducted right on the students' school campus or near to the campus, or near their homes. Following this introduction, students can then be introduced to the parks and invited to participate in a shared CS2.0 park project, in our case, the Saguaro Census. This park project greatly served the needs of Saguaro National Park in that nearly 100 students contributed to the 2020 Saguaro Census.
4. Support teachers' efforts to guide students through their projects. This may be in the form of a CS2.0 kit that includes the curriculum, lesson plans, resource list or directory of the participating partners or other local CS2.0 experts, and investigative equipment, tools, materials, or supplies. We found that teachers and students appreciated having these items on hand and that they helped make the activities more manageable and enjoyable for all participants.
5. Schedule manageable and regular check-ins, participation sessions, training or meetings with all partners, but especially the teachers and students, so that they all feel informed and supported.
6. Put the fun and the love of our parks into each student and teacher session!
7. Create opportunities for students to visit their park regularly while on their own, with their class, or with their families. And invite students to partake in park activities, conservation efforts, and events.

Student Engagement

As you design curriculum and projects, it is important to support student voice and ownership. Student engagement will help determine how interesting the project feels, how well it is understood, and their level of ownership. As part of this, students should feel comfortable knowing that they will make mistakes. Students should understand that they are free to fail and feel a sense of freedom and energy, knowing they will be extended some grace. This is the essence of field science – trying boldly, failing forward, and keeping at it so you learn from your missteps.

The core team should develop clear goals and objectives for the student projects and data collection, but leave room for flexibility, so that the student voice can be incorporated. Especially with the Next Generation Science Standards, this true inquiry-based, student-directed type of project is extremely important. Consider creating a list of options or criteria for student projects, but ultimately let the students decide what exactly they want to do. If you have a set project or data collection component that you need to accomplish as part of the program, try to maintain flexibility so the student voice might be incorporated in some way, such as data dissemination or capstone project.

Some pilot teams felt that extra time in the field was important to fully engaging students. For example, they let students explore the study area, including spending solo time with journals. They also made sure that students understood the scope of the project. For example, one group told students, "Depending on what we find out, we may end up writing an article to be published in the paper or be featured on the local news." This empowered students and legitimized their work outside of purely academic objectives.

Sometimes the student voice came out in interesting and innovative ways. For example, at one pilot site a group of students decided to redesign a piece of equipment used in the project (in this case, a floating mussel basket). They changed the device used to keep the baskets afloat, and this unplanned engineering effort was a valuable learning experience. At another site, students were asked to contribute questions to an "I Wonder Board." The students then worked together to narrow down the questions to a few that could be tackled in class. Field Science can be a process by which students look for answers to their own larger questions.

Finally, managing the variance in the level of students' awareness and experiences with science education, place-based education, natural resources management and conservation, and data observation, collection, and analysis can be a challenge. In the pilot groups, some teachers were hesitant to bring students who struggle to sit still in a classroom setting on field trips. Often, they found that a less structured environment provided the perfect setting for learning for those students who may be viewed as disruptive. This hands-on learning experience may enable them to shine in a way they did not in a classroom and help break down barriers around the stereotypes of "smart" and "slow" learners. These benefits can be achieved when it is hard for any students to get left behind, i.e., when there is flexibility that can include all participants. Bottom line: If you can stay flexible and allow for student voice at various parts of the program, you will find students more engaged over the course of the initiative.

THE DATA PROCESS

Data collection is at the heart of the experiential learning model. CS2.0 teachers reported that students were more engaged and on task when they were outside doing field work, which speaks to the strengths of field-based science as a pedagogical tool. Park sites reported that students were collecting authentic data really motivated them to "do it right." Students frequently asked, "Are you really going to use this data?" The fact that it was "real science" was new and exciting to them and motivated them in ways the teachers said they were not often motivated/engaged in the classroom. Field science also contributes to a more scientifically literate population. One in which individuals are able to evaluate and interpret data on their own whether embedded in a school-based project or in a media article referencing raw data, statistics, or the interpretation of the data.

Deciding What Data to Collect

The Field Science program should build on the exposure to data collection and analysis that students have gained in previous science classes. To streamline the process in the field and create opportunities for students to discuss and respond to the data, it is helpful to have a very clear sense of what data are important to collect and why, and to spend time training students in how to do data collection.

One idea might be that once students have defined the problem or project, ask them to list the information they would need to begin to address the problem, and how they would go about getting that information. This can help the teachers understand whether or not they understood the data needed and if they were ready to begin considering the experimental design phase.

Be sure to check with your NPS contacts about the policies for disturbing or collecting resources in parks. Ask, as well, about the collection of sensitive data, such as resource location, and how the park resource managers want to secure it. You must ensure that the educational project does not compromise NPS management of park resources or run afoul of federal law – your NPS contacts will ensure you don't!

Overall, as you consider a data collection protocol, remember to think about teacher capacity to follow through, student experience level, and available resources.

Grounding Your Approach

Authentic data collection via recorded observations can be a motivating factor for student participation. Upon successful completion of the program, we hope students gain an understanding of their place in the scientific ecosystem and will be prepared to ask thoughtful questions when processing new scientific reports or other information.

Generally, data collection was most successful when the students were prepared in advance by park ranger classroom visits, their teachers, or by watching a video. These exercises previewed the expectations, tasks and skills they would use and introduced or reinforced the scientific method. Students then became familiar with tools in the classroom, practicing their use. In one case, students watched the video every time they took measurements for their project, which reinforced standards for data collection. This preparation boosted student understanding and confidence in the field as evidenced by feedback from program managers.

Overall, the pilots found it valuable to collect and study all data, whether valid or invalid. If student data does not match their hypothesis, they will have the opportunity to explain why. It may inspire them to make improvements in their research processes or explain lurking variables that skew the data.

Data Collection

Teams varied between collecting data via digital tools in the field employing mobile-based apps and having students make observations via pencil, paper, and clipboard. Sometimes the same team used both. Each approach has strengths and challenges and a summary of the tools used be the CS2.0 pilot teams can be found in the final report.

If you plan on "going digital," data collection sites need to be vetted. If synchronous data collection is required by an app, reliable connectivity to a Wi-Fi hot spot or cellular network needs to be available. Lack of connectivity was a substantial barrier that set back several programs after they had made considerable headway.

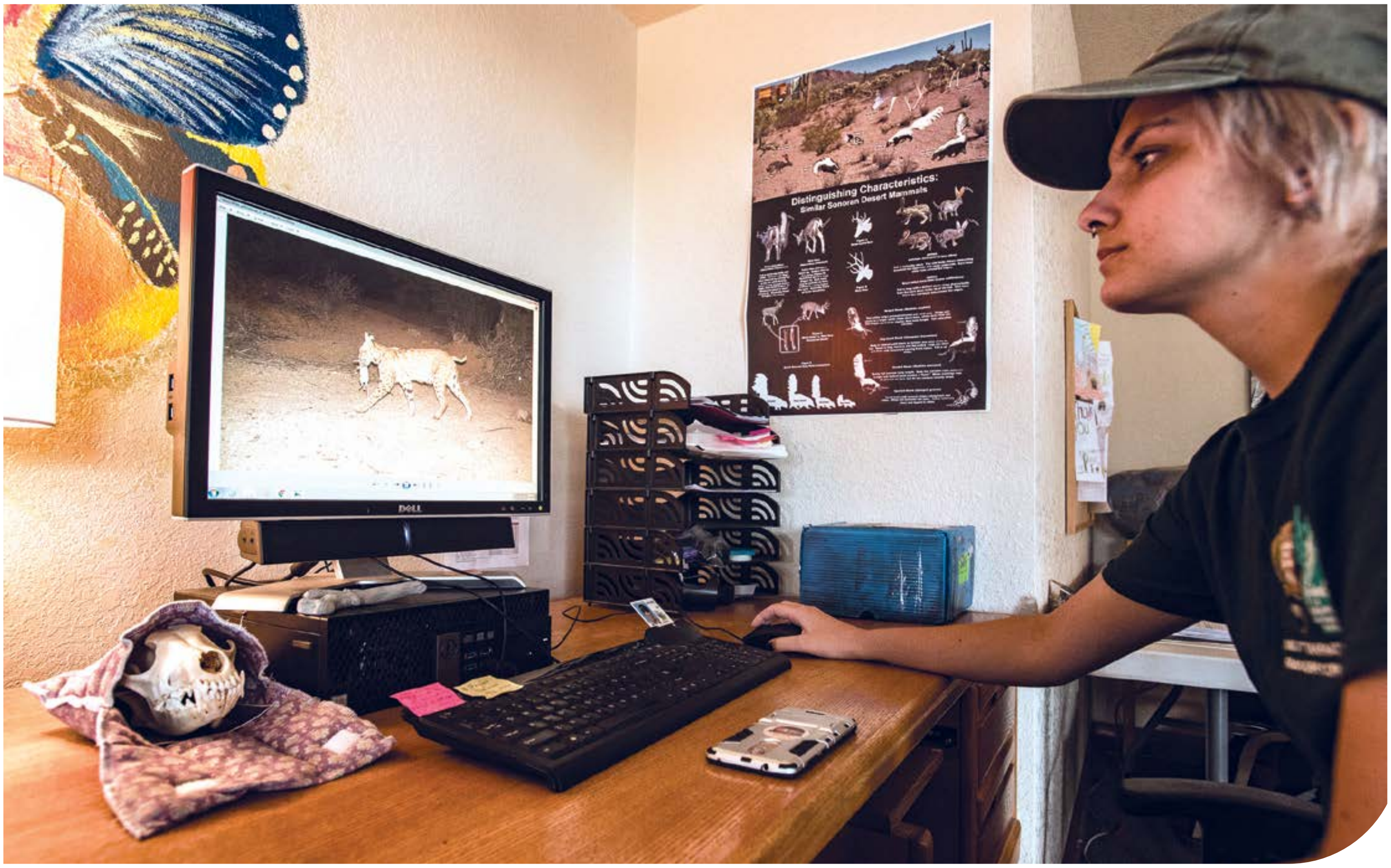
If you plan on "going analog," consider the time it will take once back in the classroom to enter the information from the data sheets into a computer database

Overall, it is very important to explain the reason you are collecting each data point and what the expected or desired parameters are for that data point. For example, if students do not know what dissolved oxygen is and why it is important for the health of a river species, they will not understand why they are taking that measurement in their classroom tanks and in the river while out on their field experiences. It is important to take the time to explain why each parameter is important and then what readings you might expect, why they might vary, etc.

ACTIVITY: The Data Process

Brainstorm about the needs and constraints you will face and how they may shape your choice of data collection tool.

- Where will you collect data? Is Wi-Fi available in this location?
- Do the majority of your students have smartphones?
- Are teachers comfortable using digital technology?
- What do you want students to learn about collecting, managing, and asking questions of data?
- Will data be shared among groups of students, between classrooms, or across different schools?
- How will data be transmitted to NPS to inform management practices or ongoing projects?



Data Analysis

While data collection was generally a strong point of the program in the pilot phase, the teams faced more challenges with data entry, management and analysis. This included choosing data recording systems, downloading data, sharing data among students and classrooms, and interrogating the data to reach conclusions.

In terms of comparing student collected data with other data sets, this is where inconsistent data can challenge the conclusions drawn. However, if common protocols and similar data management techniques are used, students should be able to draw reasonable conclusions comparing their own data to other data sets. Best practices involve deferring to the teacher’s judgement on a case-by-case basis given the degree of inaccuracies in the data and their curricular goals.

Another consideration is to think about sharing a certain data set but have students collect additional data, for the exercise/process of data collection. For example, students might measure mussel growth in the classroom weekly and in some cases daily. This is a very useful activity in helping the students hone their data collection skills, but it is not necessarily useful to share the daily measurements with the other schools as there is not much change. It may be useful for the students to collect data daily, but only share their weekly summaries for example. In summary, it is important to consider the data you want to collect versus the data you want to share, and it might not all necessarily overlap.

On the next page are two observations from teams participating in the CS2.0 pilot:

EXAMPLE IN ACTION: Science Museum of Minnesota and Mississippi Park Connection

We explored a few different avenues for student-led data analysis, though we did not prescribe any single, consistent approach as we did with the field trip experience. This approach made a meaningful distinction between looking at how data collected through a community science project directly contributes to answering the underlying science question and integrating that community data with other available data to answer questions that the students themselves have asked.

The larger question about leaving data analysis up to the students rather than making it a prescriptive part of the curriculum still feels like the best approach for our schools.

EXAMPLE IN ACTION: Anacostia Watershed Society

Students in our program collected data both in the classroom and when they came to the park for their field experiences. We equipped each participating teacher with a mussel tank with 20 live freshwater mussels. The students collected data on the growth of the mussels by measuring them. We asked each school to measure the mussels weekly and log their data, but some schools measured them daily to engage more students/more classes. Some schools recorded this data on the worksheets we provided (hard copies), others recorded it on whiteboards in their classroom, and others recorded it on a google spreadsheet.

We attempted to have all teachers log their data in the same google spreadsheet, but different tabs for each school and/or tank, so that schools could then compare data across schools. This proved to be a challenge for some teachers, but as our program progressed we got closer to that point of having the students be able to look at the data, and analyze it from the other schools. Ensuring that students collect high quality, consistent data is also of the utmost importance. We teach the students how to correctly collect the data/measure the mussels, and also some students made a video that they then shared with all the other students where they modeled how to measure the mussels correctly. We look forward to utilizing more student voice and ideas to make the data collection easier, such as the “how to” video created by some of the students.

A shared platform (in our case a Google spreadsheet) was the most crucial piece to facilitate data comparison. While a Google spreadsheet is a relatively low-tech data repository, we have found it to be helpful for teachers and students because they are already familiar with it as a platform and it allows them to input data and easily view other school’s data.

PROGRAM SUSTAINABILITY

Sustainability is a critical goal for the program. To that end, funds were provided for each of the pilot's first three years. Teams were encouraged to build on this investment by finding additional support, which could be in the form of direct gifts and grants or inclusion in a school district's long-standing curriculum. A pilot site participant noted that, "Multiyear funding allowed us to truly build the CS2.0 program in a collaborative way, knowing we were not just trying to get something done in one year. We had the time to meet and cultivate relationships and develop new components of the program."

ACTIVITY: Program Sustainability

Brainstorm about the near-term and more distant future of your program. One of the goals of CS2.0 was to create a sustainable experience for students and teachers over many years. It is easier to achieve sustainability if it is built into program planning from the beginning.

- What resources will you need for your program in its first three years? Consider expertise, time and coordination as well as "hard costs" like transportation and equipment.
- Which resources have already been committed or donated? Which will you need to procure? Is it possible to engage volunteers or supporters over a three-year span rather than one experience or gift at a time?
- How does the program fit into each partner's mission and priorities? Do one or more partners have an interest in sustaining the program? For example, a school district might adopt it into standard curriculum or an education partner or park might sustain it because it fulfills their mission or needs.
- If volunteers, including volunteers with special knowledge, like teachers in training or retired teachers, can help facilitate the program, where can they be found? How can the program be designed to best engage and retain volunteers?
- What funders might invest in the program to keep it strong or expand it? Are local philanthropists, foundations or corporations interested in achieving the same or similar goals? Can partner staff or volunteers identify potential funders so they can be made aware of the effort? Are there national programs that could be tapped based on priorities and/or geography?

CASE STUDY: Anacostia Watershed Society and Anacostia Park

If your end goal is truly to make your program systemic within a school system/school district, it is essential to consider the readiness of not just individual teachers, but the school system/school district as a whole. We found in our case that the presence of school system central office staff was crucial in the success of our program. Prince George's County Public Schools (PGCPS) is unique in the fact that there is not just one point person at a leadership level for environmental education, but also a team of outreach educators who help to advance environmental literacy efforts.

We were fortunate to have the PGCPS High School Outreach Educator on our Citizen Science 2.0 team. I would advise other teams to look for a point person within the school system who is not a teacher. Of course, it is tremendously important to have teachers who are excited and invested in the program, but I would say it is equally important to have that central office support. Often a teacher will not have the capacity to be the advocate for the program at the school system level, so it is crucial to find a point person who can help facilitate meetings between various offices (Curriculum and Instruction, Science Office, etc).

We had a number of different factors that contributed to the success of our program. The first and most important thing was that we had established working relationships with both PGCPS and NPS. We have worked closely with PGCPS on a number of different environmental education initiatives for over a decade and so have a solid working relationship and a formalized Memorandum of Understanding outlining the roles and responsibilities of both partners. We also have a MOU with the National Park Service- National Capital Parks East and a solid working relationship including a bi-monthly meeting to ensure effective communication on the myriad of issues we work on together, including CS2.0. Additionally, we were able to have the focus of our CS2.0 program be on freshwater mussel restoration, which is one of our latest organizational priorities as we work to identify innovative ways to protect and restore the Anacostia River. Finally, I would once again stress the importance of the school system's focus on environmental education and genuine commitment to supporting environmental literacy efforts.

In the three-year CS2.0 effort, the top expenditures across all sites were staffing and supplies. Sites spent on average 59% of their three-year, $100,000 grant award on staffing, which reflects the intense personnel requirements and the challenges the partners faced in securing coordination from among existing staff or volunteers. It also reveals the lack of stable funding for education partner organization to provide such important capacity. Costs did not appear to go down across the three years of the pilot for most sites, and the importance of all three partners being at the table indicates that continued funding for the education partner organization may always be necessary, particularly as they take on programmatic aspects, such as logistics coordination and supporting the student in-park experience. Some sources for start-up and supplemental funding can be found in Appendix D.

CONCLUSION

The CS2.0 experience demonstrated the potential for a coordinated team of organizations to deliver lasting, engaging, experiential learning programs for middle and high school students. Each team and set of circumstances are different, but we hope that this Field Science Program Guide helps transmit ideas that have been tested and found to be valuable and provides exercises that may be useful in avoiding needless challenges. The National Park Foundation is dedicated to connecting students to using parks as classrooms and helping students and teachers realize that park resources belong to us all. We hope that this Program Guide is useful and that you will continue to increase the number and success of these programs by sharing your experiences with us.

Thank You

This program guide was made possible thanks to the more than 100 years combined experience of five leading education organizations across the country. The National Park Foundation is proud to partner with the organizations listed below to develop the content and resources contained in this Program Guide.

NPF would also like to thank the National Park Service Citizen Science Steering Committee and NPS staff at each of the CS2.0 pilot sites who provided input and guidance.

Finally, the National Park Foundation would also like to thank the Veverka Family Foundation, and Mary Jo Veverka, specifically, for funding, support, and guidance during the CS2.0 pilot and beyond. This program guide would not be possible without that support.

National Park Foundation

The National Park Foundation works to protect wildlife and park lands, preserve history and culture, educate and engage youth, and connect people everywhere to the wonder of parks. We do it in collaboration with the National Park Service, the park partner community, and with the generous support of donors, without whom our work would not be possible. Learn more at nationalparks.org.

Veverka Family Foundation

The Veverka Family Foundation fosters immersive environmental and climate literacy curricula incorporating field studies and stewardship action programs. School districts and their education and NPS partners become eligible to participate in this funding through demonstrated commitment and success with their field-based science curriculum programs. Current efforts focus on expanding programs throughout the state of Maryland.

Anacostia Watershed Society

The mission of the Anacostia Watershed Society is to protect and restore the Anacostia River by bringing partners and communities together to achieve a clean and safe Anacostia River for the benefit of all living in its watershed and for future generations. https://www.anacostiaws.org/

Great Smoky Mountains Institute at Tremont

In partnership with Great Smoky Mountains National Park, our mission is to deliver experiential learning for youth, educators, and adults through programs that promote self-discovery, critical thinking, and effective teaching and leadership. From our home in Great Smoky Mountains National Park, our research and residential programs investigate the diversity that sustains all life, develop a sense of place, and cultivate a stewardship ethic that will influence lifelong decision-making. https://gsmit.org/

Ironwood Tree Experience

The mission of Ironwood Tree Experience is to create healthy and resilient communities, Ironwood Tree Experience makes it possible for young people to engage with the natural world and be stewards of the environment. https://ironwoodtreeexperience.org/

Mississippi Park Connection strengthens the enduring connection between people and the Mississippi River by enriching the life of the river and the lives of all who experience our national park, the Mississippi National River and Recreation Area. https://parkconnection.org/

The Science Museum of Minnesota is a science and technology center with innovative interactive exhibits emphasizing hands-on STEM learning, with scientific research, anthropological collections, and a nationally-recognized educational research and evaluation department. In addition to its 370,000 square-foot headquarter facility in downtown Saint Paul, the museum operates the world-class St. Croix Watershed Research Station in nearby Washington County. https://new.smm.org/

APPENDIX A: Considering a Coordinator

In addition to ready and engaged partners, some pilot sites also benefited from a central program coordinator. This individual can be housed at any of the partner organizations, but consideration should be given to the long-term funding viability of the position.

Other considerations might include:

- Can cost sharing the position (where more than one organization helps pay for the position), or using matching funds, eliminate the funding burden on any one organization?
- Does situating the position at one organization vs. another lead to logistical advantages or challenges? For example, if based at NPS, will the position have access to NPS data sets? If based at a school, will the position be more successful in communicating with teachers knowing their availability throughout the day and/or school-wide events that would preempt field trips on certain days?
- Is the proposed salary or stipend competitive enough to keep a qualified individual in the role? Turnover and the need to recruit, hire and onboard new staff can be a substantial challenge.

Brief sample language on the role and qualifications from a pilot team:

Coordination of Park Experience

- In collaboration with Park staff, coordinate all necessary logistics and safety for student and teacher groups on Park property.
- Work closely with other team members to streamline the Park experiences from school campus to Park property.
- Ensure documentation (through photos) and promotion of park experiences through social media and other venues.

Qualifications

- Experience working closely with and engaging a diverse group of community members from various agencies, organizations, and schools.
- Experience managing and coordinating logistics for group programs on Park property.
- High level of enthusiasm to engage and inspire young people of natural resources.
- Must be available to work during the hours of 8AM-6PM, weekdays.
- Reliable transportation to main work sites is required.

APPENDIX B:
Resourcing Your Program

Consider exploring these sources for potential start-up or growth support for your program.

NOAA B-Wet Grants: This program is designed to advance student understanding of watersheds. It is tied to specific geographies, and each area has its own applications, deadlines, and average size / term of grant. Visit the NOAA website for more information.

EPA Grants: The EPA makes select grants for environmental education. To learn more, visit the EPA grants website.

National Environmental Education Foundation: This group has various programs to advance experiential learning and STEM, including their Hands on the Land programs. For additional information visit the NEEF website.

Several corporations support STEM and environmental education. A few to consider are:

- KEEN Effect KiDS Grants
- The North Face Explore Fund

Some organizations specifically invest in funding fieldtrips. A few to explore include:

- Target
- SYTA Youth Foundation
- VOYA Financial

If you are interested in asking community members to invest in your program through crowdfunding, consider these resources:

- Review of crowdfunding tools
- Facebook fundraisers

NOTES:

National Park Foundation

WONDER CALLS

www.nationalparks.org