

PLACE-BASED EDUCATION AND CITIZEN SCIENCE: RESOURCES FOR LEARNING BEYOND THE CLASSROOM



*Louise Chawla is professor emerita in the program in environmental design at the University of Colorado Boulder. She remains active in the university's Community Engagement, Design and Research Center, which she helped establish and which includes the Growing Up Boulder program to involve children and adolescents in participatory planning and design with city agencies. This program is the foundation of the recent book *Placemaking with Children and Youth: Participatory Practices for Planning Sustainable Communities* (New Village Press, 2018), which she co-authored with her colleagues Victoria Derr and Mara Mintzer. Louise began her career as a Montessori nursery, and then elementary school teacher. She received her training from Phoebe Child and Margaret Homfray, who helped Maria Montessori spread the Montessori Method in Great Britain and who established the St. Nicholas Training Center in London, during a period when they led training courses in Pennsylvania in the summers.*



*Abbey White is on-site naturalist and support director at Forest Bluff School in Lake Bluff, IL. She works with all levels, Young Children's Community through Secondary Level, to connect children with nature, both at school and in the surrounding community. Abbey has a bachelor's degree in biology from Illinois Wesleyan University and a master's degree in plant biology and conservation from Northwestern University. She most recently worked at the Chicago Botanic Garden as a research assistant on various wildlife conservation projects. Her master's work focused on the commercial availability of native plants and the conservation genetics of a rare thistle species. One part of her master's was recently published in the scientific journal *Restoration Ecology*, titled "Restoring species diversity: Assessing capacity in the U.S. native plant industry" (White et al. 2018). Abbey is currently enrolled in the Montessori Institute of Milwaukee's satellite elementary training in Chicago, IL.*

PLACE-BASED EDUCATION AND CITIZEN SCIENCE: RESOURCES FOR LEARNING BEYOND THE CLASSROOM

by Louise Chawla and Abigail White

This fully documented article about place-based education and citizen science offers annotated sources that can be used for Montessori programs at all levels and in all settings for site selection and curriculum connections.

From the beginning, life in the early Children’s Houses flowed out of the classroom into the surrounding world. Even at the first Children’s House in a bleak tenement district of Rome, Maria Montessori believed that one of the circumstances that contributed to its success was that the children could enjoy the building courtyard with pleasant grassy spots and trees (*The Secret of Childhood*, 143, 167). At each stage of a child’s development, she noted, “To go out of a classroom to enter the outside world, which includes everything, is obviously to open an immense door to instruction. . . . Let us take the child out to show him real things. . .” (*From Childhood to Adolescence* 33, 34).

Learning beyond the classroom was also promoted by the progressive philosophy of John Dewey in the early twentieth century. Dewey believed that schools should encourage children to follow their interests, raise questions, collect and analyze evidence to find answers, develop ideas and suggestions, apply their ideas to test their value, and reflect upon results – and do this with others in a spirit of community and service to the world (Dewey, *Democracy*). A primary responsibility of educators, he claimed, is to “know how to utilize the surroundings, physical and social, that exist so as to extract from them all that they have to contribute to building up of experiences that are worthwhile” (Dewey, *Experience* 40). These ideas promoted project-based learning, within classrooms and beyond school walls.

Whether you work in an urban or rural school, the two great interdependent facets of the universe are around you, open to your exploration with students: the natural world in which your city or town is embedded, and the world of human history and constructions. The first invites study through biology, astronomy, geology, and geography. The second engages the social sciences, urban planning, engineering, agriculture, and the fields of design. Ecology, philosophy, the arts, and spirituality bind these dimensions of place together. Just by venturing beyond the school and encountering the surrounding world, natural and social, through study and service, students position themselves as agents in their community, involved with others in action for the common good.

The resources featured here begin with publications and websites for place-based education – an umbrella term for all learning about environments that children can encounter and study directly. The second section addresses citizen science, when children focus on observing, investigating and sharing discoveries about the natural environment in service to the wider scientific community. In addition to material in print and online, do not forget resources in the form of local advisors and experts, such as people in local history societies, environmental organizations, city agencies, and colleges or universities. Studying the world beyond classroom walls and bringing questions and reflection back into the classroom supports diverse approaches to learning: through all five senses, practical skills, and social engagement, as well as through all subjects in the curriculum.

PLACE-BASED EDUCATION

The heart of this approach is connecting people to the place where they live in a spirit of community with their human, built, and natural world. According to definitions in resources featured

here, place-based education is:

. . . the pedagogy of community, the reintegration of the individual into her home-ground and the restoration of essential links between a person and her place. (Laurie Lane-Zucker, The Orion Society, foreword to *Place-Based Education* by David Sobel, iii)

. . . learning that is rooted in what is local—the unique history, environment, culture, economy, literature and art of a particular place. (*Rural Policy Matters* cited in *Place-and Community-Based Education* by Gregory Smith and David Sobel, 23)

. . . the process of using the local community and environment as a starting point to teach concepts in language arts, mathematics, social studies, science, and other subjects across the curriculum. (David Sobel *Place-Based Education*, 7)

Place-based education overlaps with environmental education, civic education, project-based learning, experiential learning, and service learning, within the boundaries that it focuses these approaches on the local environment and community.

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The environment that students explore is their own town, city, natural surroundings or region, and this is the focus of their projects and direct experiences. They learn civics by engaging with local processes of governance, and they direct their service to improving their community while learning about the conditions that have shaped it. As the resources that follow demonstrate, place-based education applies to any age, from preschool through high school and into adulthood, and it can be centered in schools or other local organizations. Invariably, it involves building partnerships with

other institutions and community members.

The resources listed here do not attempt to be comprehensive. This selection emphasizes practical material about how to plan, implement, and sustain place-based projects, rather than academic discussions about pedagogical theory or studies of project outcomes—though a number of the items listed here will lead you into these literatures. It aims to adhere to work that focuses on place-based education rather than related fields such as environmental education, education for sustainability, outdoor education, forest kindergartens, schoolyard greening, nature study, and service learning. Yet given the way that these fields are connected in practice, many of the resources on this list will introduce you to these related topics.



BOOKS

Anderson, Sarah K. *Bringing School to Life.* Lanham, MD: Rowman and Littlefield, 2017

Anderson is the Field and Place-Based Education Coordinator at the Cottonwood School of Civics and Science, a K-8 charter school in Portland Public Schools, whose mission is to provide “authentic, hands-on learning experiences that are closely tied to the community.” After she introduces place-based education, she describes its application to single subjects – such as mapping, history, science, and civics – as well as curriculum integration and partnership building. Each chapter closes with a list of further resources.

Beames, Simon, Higgins, Peter, and Nicol, Robbie. *Learning Outside the Classroom: Theory and Guidelines for Practice.* London: Routledge, 2012

This text for teachers provides a basic background for understanding and implementing outdoor learning rather than specific activities. It discusses how to use the outdoors to learn across the curriculum, encourage student curiosity, and enable students to take responsibility, while investigating local landscapes and possibilities for sustainable development. It also covers partnerships, risk management, and supervising classes outdoors. The final chapter suggests how to prepare an action plan to move learning beyond the classroom.

Braund, Martin and Reiss, Michael (Eds.). *Learning Science Outside the Classroom.* London: RoutledgeFalmer, 2004

This collection of 14 chapters covers everything from developing the school grounds as an outdoor classroom; to making optimal use of field trips to destinations like zoos, museums and industrial sites; to “reading” specific subjects like chemistry and physics in the surroundings; to practicalities like safety, learning assessment, and supplementing field studies with homework on the computer. Chapters close with resources for further reading.

Buxton, Cory A. and Provenzo, Jr., Eugene F. *Place-Based Science Teaching and Learning: 40 Activities for K-8 Classrooms.* Los Angeles, CA: Sage, 2012

This book begins with a history of place-based education and makes a case for the value of place-based science. It presents directions for 40 activities for studying science in school and neighborhood surroundings and engaging with the community, such as interviewing local scientists, visiting a water treatment plant, and conducting a wildlife census in a neighborhood park. These individual activities can be integrated into larger interdisciplinary projects.

Comber, Barbara. *Literacy, Place, and Pedagogies of Possibility.* New York: Routledge, 2016

Written from an Australian perspective, this book focuses on place-based writing and film-making with children from multicultural backgrounds and environments of disadvantage. Its extended descriptions of work in primary and secondary schools are full of practical examples and resources, and situated in theories about the importance of grounding pedagogy in place.

Demarest, A. *Place-Based Curriculum Design: Exceeding Standards through Local Investigations.* New York: Routledge, 2015

This basic book for K-12 teachers is full of practical guidance and examples about how to organize curriculum and assessment around topics that matter to students personally and to their communities. It traces the decisions teachers make as they plan and implement curriculum based on local investigations. The conclusion discusses how school leadership can support teachers and whole schools to move toward learning in community contexts.

Derr, Victoria, Chawla, Louise and Mintzer, Mara. *Placemaking with Children and Youth: Participatory Practices for Planning Sustainable Communities.* **New York: New Village Press, 2018**

This manual for engaging children and teens in the participatory planning and design of parks and other public places can help initiate a single project or create sustained partnerships with city agencies or other community organizations that value young people's creativity and ideas. It is framed by chapters that discuss the significance of this approach to civic learning and how to evaluate and celebrate achievements. At its heart are chapters that present many methods for studying local communities, envisioning new possibilities, and working collaboratively with others for change.

Gruenewald, David A. and Smith, Gregory A. *Place-Based Education in the Global Age: Local Diversity.* **London: Lawrence Erlbaum, 2007**

This collection features many leaders in place-based education, whose work crosses disciplines and student ages. In addition to foundational ideas, it presents accounts of place-based approaches, some at the scale of single classrooms and others involving whole schools and school systems. A book for readers who want to dive deeply into the theory and practice of place-based initiatives.

Haas, Toni and Nachtigal, Paul. *Place Value.* **Charleston, WV: ERIC Clearinghouse on Rural Education and Small Schools, 1998**

This small book begins with five short essays that develop its premise that, "Living well depends on the connections people have with one another and their surroundings." The essays propose how education can encourage a sense of place, sense of civic involvement, sense of worth, sense of connection, and sense of belonging. They are followed by annotated bibliographies of books that will take readers deeper into each essay's theme.

Harrington, Sheila (Ed.). *Giving the Land a Voice: Mapping Our Home Places.* **Salt Spring Island, BC: Land Trust Alliance of British Columbia, 1999**

Out-of-print now but still available, this classic on bioregional mapping shows how to integrate information about local plants, animals, landforms, watersheds, and human cultures, often as a tool for taking action to protect important landmarks, species, and places. Along with technical information and resources for map creation, it presents many beautiful examples, primarily at a level for the upper elementary and high school years and above.

Hart, Roger A. *Children's Participation: The Theory and Practice of Involving Young Citizens in Community Development and Environmental Care.* **London: Earthscan Publications, 1997**

This book documents the potential of children and young adolescents to make valuable contributions to the monitoring and care of their local environments through examples from around the world that demonstrate their creativity, agency, and competence. It distinguishes adult-led actions from adult support for young people's capabilities. It reviews different models for engaging young people, in and out of school, and provides clear directions for a variety of methods that involve children and adolescents in evaluating their local environments, envisioning improvements, and managing and communicating change.

Krishnaswami, Uma. *Beyond the Field Trip: Teaching and Learning in Public Places.* **North Haven, CT: Linnet Professional Publications, 2002**

The author is a writer-in-residence at a national monument, but her suggestions for weaving together writing, art, history, science, and math extend to parks, museums, and historic sites across the country and to all ages from early childhood through high school, as well as children with special needs. She shows how to make optimal use of class visits through advance preparation, active exploration on site, and support for the questions and inspiration that students bring back to the classroom.

Leslie, Claire Walker, Tallmadge, John and Wessels, Tom. *Into the Field.* Great Barrington, MA: The Orion Society, Nature Literacy Series No. 3, 1998

This small book that can be easily taken into the field condenses the experience of three expert teachers: Tallmadge on writing in response to place, using a variety of exercises that encourage observation and interpretation; Leslie on nature journaling through annotated drawings; and Wessels on observing and interpreting clues to a landscape's history. Each section closes with a list of other resources. Although most examples are drawn from undergraduate teaching, they can be readily adapted to high school and grade school.

Pickering, Stephen (Ed.). *Teaching Outdoors Creatively.* London: Routledge, 2017

This book reflects two concurrent movements in primary school education in the United Kingdom: one to encourage creativity in teaching and learning, and one to promote learning outside the classroom. Teachers and teacher educators discuss the use of local environments, fieldwork, "streetwork" that investigates the construction and design of streets and buildings, "storying" the outdoors through storytelling and play, adventure expeditions, and schoolwork in forests, beaches and riverbanks. Chapters contain basic principles, many illustrations, activity boxes, and examples of school practices.

Renshaw, Peter and Tooth, Ron. *Diverse Pedagogies of Place.* London: Routledge, 2018

This book describes the place-responsive teaching that evolved at six environmental education centers that serve schools across Queensland, Australia. Unified by a common history and freedom to experiment, each center represents a distinctive way to express core teaching values: embodiment and sensing a place, "storying" relationships to places, and uncovering contested stories across the history of a place. The book's reflections and practical experience can apply to any site, and the network of shared learning among the six centers forms a model for any region.

Smith, Gregory A. and Sobel, David. *Place- and Community-Based Education in Schools.* New York, Routledge, 2010

This book by two leaders of place-based education research and practice begins by putting persuasive arguments and information into the hands of anyone who wants to advocate for place-based education in their community. It reviews historical antecedents of this approach and suggests that it can address critical issues in contemporary education, then summarizes research that documents impacts on students' academic achievement and social, civic and environmental learning, as well as impacts on teachers and communities. Several chapters feature inspiring examples of place-based projects.

Sobel, David. *Mapmaking with Children: Sense of Place Education for the Elementary Years.* Portsmouth, NH: Heinemann, 1998

This is a basic guide to exploring local places, as well as places in children's literature, with ages 5 to 12 by creating maps and three-dimensional models. Each section comes to life with illustrations and accounts of children's work. Sobel shows how mapping and model-making can be ways to understand geography, biology, botany, and history and form emotional bonds with a place.

Sobel, David. *Place-Based Education: Connecting Classrooms and Communities.* Great Barrington, MA: The Orion Society, Nature Literacy Series No. 4, 2005

This book condenses the author's lifetime of experience spent mentoring teachers in place-based approaches. After explaining place-based principles and concepts, Sobel briefly reviews research on outcomes. At the heart of the book are strategies for creating place-based schools. Descriptions of model projects show how the book's principles can be put into action.

Umphrey, Michael L. *The Power of Community-Centered Education: Teaching as a Craft of Place.* Lanham, MD: Rowman and Littlefield Education, 2007

This extended case study of the Montana Heritage Project that was carried out in partnership with the Library of Congress, written by its director of many years, reflects deeply on core values of education. Its accounts of projects across the state primarily involve English and history, but the processes that the students follow, and the relationships with their communities that they develop, have relevance for every subject in the curriculum. A concluding chapter describes "Eight Practices of Community-Centered Teaching."

Vascellaro, Salvatore. *Out of the Classroom and Into the World: Learning from Field Trips, Educating from Experience, and Unlocking the Potential of Our Students and Teachers.* New York: The New Press, 2011

The author, a professor in the Bank Street College of Education in New York, follows teachers as they lead their classes into extended explorations of present life, history, and possibility in the city. The subjects they investigate include slavery, immigration, Native American history, and bridge building. The book closes with a history of teacher education at the college in preparation for teaching through the environment, inspired by quests for the elements of a more democratic society.

Waite, Sue (Ed.). *Children Learning Outside the Classroom: From Birth to Eleven.* London: Sage Publications, 2011

After an opening chapter that guides teachers in identifying places for learning outside the classroom, their meaning for students and the community, and opportunities that they afford, this edited collection contains 14 chapters about place-based principles and practices in preschools and primary schools. Some consider the basics of learning outdoors and in the community, while others focus on different parts of the curriculum and how to structure and manage outdoor learning. Ideas are illustrated with project activities and many vignettes of children outside.

JOURNALS, MAGAZINES, AND ARTICLES

Clearing - www.clearingmagazine.org

An online magazine that shares best practices in interdisciplinary place-based learning for all ages with the aim of increasing environmental literacy and skills to build a healthy and sustainable future. Rooted in the Pacific Northwest but relevant beyond this region, it features articles on topics like field studies, environmental service learning, community partnerships, and transforming schoolyards into sites for outdoor learning. Back issues and selected papers are available from the year 1998.

Community Works Journal - www.communityworksjournal.org

The online journal of the Community Works Institute (see below under Websites). Selected current articles on place-based service learning for grades K-16 are available as free downloads. Further reading and access to back issues requires an individual or institutional subscription.

Children, Youth and Environments - **special issue on "Place-Based Education Theory and Pedagogy," volume 21.1 (2011), guest edited by Robert Barratt and Elisabeth Barratt Hacking**

A large special issue that includes research articles, "Reports from the Field" that focus on lessons learned from practice, an annotated resource list, and reviews and notices about relevant books and films. Contributions span the United States and Europe, and cover different curriculum areas in primary schools through high schools.

Green Teacher – special issue on “Place-Based Education: A Toolkit for the 21st Century,” volume 110 (2016, Summer), guest edited by Amy Demarest

Articles by teachers for teachers full of inspiration and practical advice, such as how to conduct community explorations, build a green house, uncover “hidden stories” in your community, investigate a zoning issue, and cultivate stewardship for a local place. A subscription provides access to current and back issues as well as webinars.

Kahn, David and Ewert-Krocker, Laurie. “Pedagogy of Place: Becoming Erdkinder,” *The NAMTA Journal* 25.1 (2000, Winter): 145-167

This article describes the beginning of the Montessori Farm School in Huntsburg, Ohio an experiment to realize Maria Montessori’s ideas for a land-based education for adolescents. Written by the project director and head teacher, it discusses the importance of experiences rooted in a particular natural and human-built place and the occupations that the farm affords for meaningful work that challenges the students’ minds and bodies as they expand farm operations and contribute to the larger community. It connects the many occupations involved in developing and maintaining the farm to different areas of study, from practical skills to the liberal arts, math, and sciences.

Ludick, Pat. “The Pedagogy of Place,” *The NAMTA Journal* 26.3 (2001, Summer): 155-173

This article is part of a special issue on “The Montessori Adolescent: Analysis in Retrospect” that contains many articles on *Erdkinder* experiments in the United States and reprints three lectures by Maria Montessori on adolescent education. The author draws on her experiences at the Hershey Montessori Farm School in Huntsburg, Ohio as she shares reflections on the power of place in the lives of adolescents. The study of place connects them to the land, historic sites, ethnic neighborhoods, and metropolitan centers, where they may have transformational encounters with people, living and dead. Ludick outlines an integrated place-based curriculum that can be adapted to any location and she identifies the skills that it fosters.

The NAMTA Bulletin: March 2018 <http://www.montessori-namta.org/PDF/March2018Bulletin.pdf>

Maria Montessori’s vision of land-based learning for adolescents, or *Erdkinder*, remains a radical form of place-based education, where adolescents learn about a bounded place and take responsibility for maintaining it as a productive economic, ecological, and social community. In this special issue, David Kahn traces the history of *Erdkinder* discussions and experiments in the United States. Several authors describe the urban land program for adolescents at St. Catherine’s Montessori School in Houston. Louise Chawla closes the issue with a review of changes in the lives of rural and urban children across the twentieth century, which challenges rural-urban dichotomies and suggests that supportive environments for young people bring nature, culture, and commerce together.

ONLINE REPORTS

Clark, Delia. *Learning to Make Choices for the Future: Connecting Public Lands, Schools, and Communities through Place-Based Learning and Civic Engagement.* Woodstock, VT: Center for Place-Based Education and Community Engagement/A Forest for Every Classroom, 2008 [https://www.nps.gov/civicsources/Learning to Make Choices.pdf](https://www.nps.gov/civicsources/Learning%20to%20Make%20Choices.pdf)

A manual for teachers, park rangers, interpreters, and other community members for engaging students in place-based education and civic engagement. After an introduction to place-based learning and its principles and benefits, the manual covers the nuts and bolts of launching and sustaining a place-based and civic engagement program, building partnerships, teacher development, and evaluation. Appendices include a list of resources, exercises for community building, worksheets, activities for mapping and exploring local landscapes, and brief descriptions of 50 exemplary projects.

Knapp, Clifford. *Just Beyond the Classroom: Community Adventures for Interdisciplinary Learning.* Charleston, WV: ERIC Clearinghouse for Rural Education and Small Schools. ERIC document #388485 <https://eric.ed.gov/?id=ED388485>

Targeted for students in grades 4 through 9 but adaptable to lower or higher levels, this book is organized around 12 themes for local exploration and interdisciplinary learning. It is filled with ideas for inquiry, outcomes, activities, reflection, and performance assessments.

Rural School and Community Trust. *Learning in Place.* Washington, DC: Rural School and Community Trust, 2000. ERIC document #58051 <https://eric.ed.gov/?id=ED458051>

Prepared by the Harvard Graduate School of Education for the Rural School and Community Trust, this report articulates the value of using landscape, family, and community surroundings as foundations for learning. Detailed descriptions of place-based learning in various Rural Trust elementary schools and high schools include helpful suggestions for getting started and sample curriculum materials.

Smith, Gregory A. *Place-Based Education.* Oxford Research Encyclopedias online, 2017 oxfordre.com/education/view/10.1093/acrefore/9780190264093.001.0001/acrefore-9780190264093-e-95

An online overview of place-based education, its historical antecedents, initiatives in the United States and other regions of the world, and obstacles and possibilities that it faces. It concludes with a list of material for further reading.

FILMS

The documentary filmmaker Bob Gliner focuses on telling the stories of initiatives that strengthen participatory democracy and just social and environmental change. His website, docmakeronline.com, includes film descriptions, trailers, and links to order DVDs or streaming video. Four of his films feature place-based education, showcasing inspiring models that other schools can follow:

Communities as Classrooms, 2016 (29 mins.)

In four schools in El Salvador, students build interdisciplinary curricula around solving problems in their communities, after determining the problems that they want to address. The film follows these processes week by week, offering models that can be applied in the United States and other countries.

Growing Up Green, 2014 (28 mins.)

A profile of a statewide program in Michigan, the Great Lakes Stewardship Initiative, that involves students in both rural and urban schools in projects to improve their local environments.

Schools that Change Communities, 2013 (58 mins.)

Features public schools across the United States that use neighborhoods and communities as classrooms and engage students in significant and innovative community service.

Lessons from the Real World, 2011 (57 mins.)

Stories of place-based education in elementary and secondary schools in Portland, Oregon, that show students engaged in cross-curriculum investigations of a nearby wetland, multicultural gardens, neighborhood history, transportation choices, and school beautification, as well as learning respect and care for people from all backgrounds and races.

WEBSITES

Community Works Institute - www.communityworksinstitute.org

An institute that encourages place-based service learning through projects that bring schools and communities together. It provides professional development for K-16 educators in the United States and internationally, publications, and other resources that disseminate information about successful programs. Publications on their website include the *Community Works Journal* (see above), workbooks for curriculum development and assessment, and a collection of videos that feature the stories of teachers, school administrators, and service learning directors.

Discovering Place - <https://www.umflint.edu/outreach/discovering-place>

A program of the Office of Outreach of the University of Michigan-Flint, dedicated to supporting school-community partnerships that enable children and youth to identify and address environmental and social needs in their communities. The site offers a blog, case studies, and a series of seven free videos that cover topics like place-based principles, partnership building, methods, and assessment.

Getting Smart - www.gettingsmart.com/categories/series/place-based-education

The site of a learning design firm that works with schools and other learning organizations and offers services that include place-based education. The site includes blogs on place-based education principles and school examples, podcasts, an infographic, and three reports: “Quick Start Guide to Place-Based Education,” “Quick Start Guide to Place-Based Professional Learning,” and “What Is Place-Based Education and Why Does It Matter?”



Photo by Stephen Cardinale for Growing Up Boulder

Midway through their investigation of a local creek, these girls pause to greet some ducks. Their school project combined a study of the creek and adjoining park with civic engagement to contribute their ideas to city plans for park improvements.

Our Curriculum Matters - www.ourcurriculummatters.com

This website was created by Amy Demarest, author of *Place-Based Curriculum Design* (see above). It includes a section on place-based education, the “big questions” it encourages, a model curriculum for learning about a lake and its water basin, and an extensive list of additional resources.

Promise of Place - promiseofplace.org

A collection of place-based education resources for teachers and school administrators offered by the Center for Place-Based Learning and Community Engagement in New England. It includes an overview of place-based education and answers to frequently asked questions, links to organizations that support place-based initiatives and teacher development, tools for evaluating project processes and outcomes, sample reports, and brief descriptions of many school projects.

Shelburne Farms - <https://shelburnefarms.org/our-work/resources>

In addition to on-site programs, this working farm, forest and National Historic Landmark offers many free downloadable resources for educators. Material includes teacher-written case studies of nature and community-based learning in elementary schools and high schools, guides to establishing farm to school programs, the books *Cultivating Joy and Wonder: Educating for Sustainability in Early Childhood through Nature, Food and Community* and *Healthy Neighborhoods Healthy Kids*, and a handbook for interdisciplinary learning about the Lake Champlain Basin and that can be adapted to other water features. All of these resources are filled with activities and teacher tips.

CITIZEN SCIENCE

Citizen science is a unique form of place-based education in that engages children in real-world scientific inquiry beyond the confines of the classroom and as true naturalists. By definition, citizen science “empowers people from all walks of life to participate in the scientific process” (Havens and Henderson). Participants make observations, collect data, and collaborate with professional scientists to answer large-scale research questions. Through citizen science, children can strengthen their sense of place, connection to nature, and understanding of ecology, all while contributing meaningful data to the wider scientific community (Harris and Ballard).

Although the term was coined as recently as 1996, citizen science has been contributing to our study of the natural world for centuries. Some of the first evidence of this practice date back to the ninth century in Japan, when citizens tracked the timing of peak cherry blossoms in preparation for their annual festivals. More recently, and before the professionalization of science, early naturalists such as Carolus Linnaeus and Henry David Thoreau were among the first practitioners of citizen science with their extensive observations of plants and animals. Then, in 1900, the National Audubon Society launched its inaugural Christmas Bird Count, perhaps the earliest example of organized data collection by a group of amateur naturalists (Miller-Rushing). Today, citizen science programs operate all over the world, enlisting millions of participants and thousands of collaborating organizations. These programs cover an array of ecological topics and often cater to educators and children with simple protocols and easy-to-use equipment.

Citizen science takes advantage of crowdsourcing to collect a far greater volume of data across time and space than individual scientists could possibly collect on their own. One of the many reasons for its success at such a large scale is the use of technology for instantaneous data entry anywhere in the world. However, if technology in the classroom is a concern, there are alternatives. For example, children could send a hard copy of the data to the program headquarters by regular mail, or an adult (e.g., teacher, local expert) could upload the data on the children’s behalf.

The following list of active citizen science programs and resources is by no means exhaustive. Many of the programs are international or national, but regional and local programs are also ubiquitous in communities. Many local nature centers, forest preserves, botanic gardens, zoos, and environmental organizations offer citizen science and place-based experiential learning opportunities. In addition, contact local representatives for the Nature Conservancy, Department of Natural Resources (DNR), Sierra Club, National Audubon Society, or National Wildlife Federation, all of which can provide information about local, regional, national, and international programs.

CITIZEN SCIENCE PROGRAMS

Birds

Audubon Christmas Bird Count - <https://www.audubon.org/conservation/science/christmas-bird-count>

The National Audubon Society has hosted a Christmas Bird Count (CBC) every year since 1900, making it the largest and longest-running citizen science project in the world. This project was created by ornithologist Frank Chapman who proposed a bird census as an alternative to the reigning tradition of Christmas “side hunts” (during these hunts, hundreds of birds were killed in a single game). Each year from mid-December through the first week of January, tens of thousands of volunteers participate in the count, and a sizeable amount of data is generated from their efforts; in one year alone (118th CBC, 2017-2018), over 59 million individual birds were reported. With this expansive, long-term dataset, scientists can detect changes in bird populations over time and space and make informed conservation decisions. The Great Backyard Bird Count (<http://gbbc.birdcount.org/>) is a similar bird census held every February.

eBird - <https://ebird.org/home>

eBird is an online platform for birders of any experience level to report bird sightings in their communities. Users can upload lists of the birds they spot, along with the location and time of day, as well as photos and audio recordings (if available) as evidence of their findings. eBird also offers a portal for communication with other avian enthusiasts, including regional experts and scientists. eBird was created by the Cornell Lab of Ornithology in 2002, but since its inception, the project has expanded significantly to include hundreds of collaborating organizations. Today, eBird boasts “more than 100 million bird sightings contributed each year by eBirders around the world,” making it one of the largest biodiversity citizen science projects in existence.

Celebrate Urban Birds - <https://celebrateurbanbirds.org/>

Celebrate Urban Birds (CUBs) is another Cornell Lab of Ornithology creation, but more targeted to urban and underserved communities, particularly participants without science experience. One aspect of the CUBs mission is to maintain green spaces for birds amid heavily trafficked urban environments. In service of this goal, the organization offers “mini-grants” to support community engagement in birding and environmental stewardship. Data from participants is submitted using bilingual (English and Spanish) “kits,” which include instructions for how to participate, a bird identification guide, and data sheets. Their website features species maps and downloadable data, along with other resources for children and teachers (e.g., art, garden, and science project ideas).

NestWatch - <https://nestwatch.org/>

The goal of this project is to track the reproductive biology of birds (e.g., timing of nesting, number of eggs laid, hatchling survivability, etc.) and learn about nest behaviors. The procedure and requirements for participation are more rigorous than most citizen science projects for a variety of safety reasons (to protect both the birds and the data collectors; see their “Code of Conduct” page for details). Therefore, this project is catered to the seasoned citizen scientist and all children must be accompanied by an adult. NestWatch recently released a “Thinking Outside the (Nest) Box” educational resource for teachers, which may spark some ideas for additional work in and out of the classroom.

FeederWatch - <http://feederwatch.org>

A sister of NestWatch, FeederWatch takes advantage of an activity beloved by many homeowners and school communities. From November to April, participants are invited to count and survey the birds visiting their feeders in service of tracking winter bird populations.

HawkWatch International - <https://hawkwatch.org/>

HawkCount - <https://www.hawkcount.org/>

Although two separate entities, HawkWatch International (HWI) and HawkCount are close partners and share data in an effort to track and quantify diurnal raptor (e.g., hawks, vultures, falcons, eagles) migrations. Like most citizen science programs, HWI generates an annual project report with summary statistics from that calendar year and also within the context of broader trends. HWI's website provides Raptor ID Fact Sheets and a list of their migration sites for ideal bird watching. HWI schedules several hawk-watching field trips and identification programs throughout the year for adults and children of all experience levels.

Avian Conservation Center: Center for Birds of Prey - <http://www.thecenterforbirdsofprey.org/>

In addition to the more general programs mentioned above, there are also countless examples of organizations interested in the conservation of one particular bird species. For example, the Avian Conservation Center, based in South Carolina, has rallied behind the Swallow-tailed Kite, whose populations have been declining in the southeastern United States. The Center is enlisting the help of citizen scientists to track population levels by asking one simple question: "Have you seen this bird?" Very often this type of data is taken into consideration when a species is recommended for federal or state listing (as threatened or endangered). If you would like to contribute to the preservation of one bird species, it is just a matter of finding a project that is appropriate for your region.

Insects/Pollinators

Monarch Watch - <https://www.monarchwatch.org/>

The famous Monarch butterfly migration from Mexico to the United States and Canada is the topic of interest for this large-scale citizen science program. The Monarch Watch Tagging Program uses a mark and recapture method to answer questions about changes in migration patterns, mortality along the way, distance traveled, etc. To participate, citizen scientists are given uniquely-coded tags that are then attached to the underside of the butterfly's hindwings (tags come with detailed instructions to ensure the butterflies are not harmed in this process). Along with placing the tag, participants are asked to report the date, geographic location, and gender of each tagged butterfly. The Monarch Watch website also features information about rearing Monarchs, butterfly gardening, and Monarch biology, as well as a "Milkweed Market" for ordering milkweed.

Journey North - <https://journeynorth.org/>

Journey North is a professed "easy entry point to citizen science." This organization works very closely with children, teachers, schools, and nature centers across the United States, Canada, and Mexico to track wildlife migrations and seasonal weather patterns. Although tracking Monarch butterflies is one of their larger projects, Journey North also follows hummingbirds, songbirds, earthworms, frogs, and leaf emergence. Consequently, there are many ways to volunteer and contribute data to this organization in a meaningful way. Once collected, the data is quickly turned into easy-to-use, interactive maps for visualizing trends.

Monarch Larvae Monitoring Project - www.mlmp.org

Whereas the above-mentioned citizen science projects are more focused on Monarch migration patterns, the Monarch Larvae Monitoring Project (MLMP) is studying their breeding biology. As an MLMP volunteer, you monitor a stand of milkweed plants regularly and record evidence of Monarch larvae, aphids, and other indicators. This might be an ideal activity for a group of children to do together at a nearby stand of milkweed, as it offers an exciting opportunity for repetition and care of an outdoor environment. Peruse the MLMP website to get suggestions for choosing monitoring sites, a list of supplies needed, strategies for improving data accuracy, and other monitoring tips.

Great Sunflower Project - www.greatsunflower.org

In response to the pollinator crisis, the Great Sunflower Project enlists volunteers to count pollinator visitors in their yards, parks, gardens, or while on walks/hikes. The level of involvement could be as active as searching a large section of a prairie for pollinators, or as casual as noting when a hummingbird flies by your window. To standardize that variation, the website offers instructions for stationary counts, traveling counts, area counts, and casual observation. Their website also features bee identification guides, book recommendations, resources for educators, and other materials. The Great Sunflower Project earned its name because historically, volunteers monitored Lemon Queen Sunflowers, which are widely available in stores, easy to grow, and commonly visited by bees and birds.

Caterpillars Count! - <https://caterpillarscount.unc.edu/>

Caterpillars Count! is a citizen science project for measuring arthropod abundance on trees and shrubs. For accurate results, participants are encouraged, but not required, to take an online quiz until they reach a score of at least 9/10 consistently. During the quiz, they are shown an image of an arthropod and asked to pick one of many categories (e.g., bees and wasps, flies, butterflies and moths, beetles, caterpillars, true bugs, spiders, aphids, grasshoppers). People can take the quiz as many times as they like because the pictures change each time. The website also provides a printable arthropod ID guide to take into the field. Caterpillars Count! uses the data to answer several research questions related to arthropod foliage preferences and the relationship between caterpillar emergence and the breeding season for birds.

Lost Ladybug Project - www.lostladybug.org

This project appeals to young children for a number of reasons. Ladybugs are found all over the world in many different patterns and colors. The Lost Ladybug Project (LLP) asks participants to celebrate that diversity by submitting photos of ladybugs in their neighborhood. Children might enjoy counting the spots on each ladybug's wings and using one of the LLP guides to identify them to species. There is growing concern about the dwindling number of native ladybugs in North America, so this activity is both fun for children and important for insect conservation. In fact, the data collected for this project has contributed to several publications in scientific journals (See "LLP Research and Publications" section on their website).

Xerces Society - <https://xerces.org/citizen-science/>

Although not a citizen science program in and of itself, the Xerces Society is worth mentioning here because it has founded several of its own projects. The website provided here links to projects for tracking bumble bees, dragonflies, and Monarch butterflies. It also lists a number of other insect citizen science programs, some of which were already mentioned. The Xerces Society is an international nonprofit organization that is active in research, advocacy, and policy initiatives for the protection of threatened, endangered, and at-risk invertebrates.

Plants

Project Budburst - <https://budburst.org/>

Budburst is a product of the Chicago Botanic Garden, but its reach is far wider. Citizen scientists record the timing of plant life cycle events (e.g., leafing, flowering, and fruiting), also known as phenology, or the "science of appearance." To participate, simply choose a plant (there is a list of 300 plants on their website if you need ideas) and follow the instructions for either a "life-cycle observation" or a "one-time observation." The former necessitates going back to the same plant over a period of time to record all its life cycle events, whereas the latter is a snapshot in time: an observation of a single plant on one particular day, in one particular location, and in one moment of its cycle. For educators, the Budburst directors have included ideas and activities for integrating this project into K-4, 5-8, 9-12, and higher education classrooms. (Note: Nature's Notebook, www.usanpn.org/natures_notebook, is a similar program from the National Phenology Network.)

Plants of Concern - <https://www.plantsofconcern.org/>

The Plants of Concern (POC) program is a rare plant monitoring program for the Chicago Wilderness Region (areas of Illinois, Indiana, Wisconsin, and Michigan). As such, the protocols and requirements for participation are more stringent. Given the sensitivity of rare plant populations and, in most cases, confidentiality required to monitor them, POC hosts training workshops in the spring for new volunteers at the Chicago Botanic Garden. After the required training, volunteers are assigned a site and expected to visit that site once a year during the plant's bloom time. As a POC volunteer, you are also considered a Chicago Botanic Garden volunteer, which comes with several admission perks. Officially, children need to be 15 to volunteer at CBG, but POC "has worked with younger interns on a case-by-case basis."

Wild Spotter - <https://wildspotter.org/>

Wild Spotter takes advantage of crowdsourcing to "help find, map, and prevent invasive species in America's wilderness areas, wild rivers, and other natural areas." As they walk, hikers can download the Wild Spotter app and upload evidence of invasive plants in their local National Forests and National Grasslands. Invasive plants are opportunistic, which means they are often found in disturbed areas with heavy foot traffic, such as along trail edges. So that technology is not the focus of this project, perhaps children can identify and assess the invasive plants and the adults can upload the data. Wild Spotter collaborates with the USDA Forest Service so participants are encouraged to reach out to Forest Rangers and other experts at the preserves prior to volunteering.

Other Wildlife

iNaturalist - www.iNaturalist.org

iNaturalist began as a master's project at the University of California Berkeley and is now one of the leading biodiversity citizen science programs in the world. Its mission is to connect people to nature, as well as to other naturalists. The data iNaturalist collects is not feeding into a specific scientific study, but is instead free to be used by anyone. At its core, iNaturalist is an enormous repository of open data. Anyone is welcome to submit observations of any living organism. If you are unable to identify your submission, very often other volunteers or scientists will reach out and help you solve the mystery. To further encourage collaboration and communication, participants can create "projects" that allow you to pool your observations with others. "Herps of Southern Africa" and "California Oaks" are two examples of active projects.

Habitat Network - <https://habitat.network/home>

The Cornell Lab of Ornithology and The Nature Conservancy partnered to create Habitat Network, a program interested in urban landscaping to support wildlife. Participants draw maps of their property, local parks, gardens, and schools to measure how "wildlife-friendly" the space is.

Keeping Track - <http://www.keepingtrack.org/>

Sue Morse founded Keeping Track in 1994 because she believed there was value in tracking wildlife, not only to monitor population levels, but also to gauge ecosystem health more generally. As top predators in the food chain, mammals such as wolves, bears, and bobcats are considered by many in the scientific community to be keystone species, which means their removal affects change in lower trophic levels. Therefore, learning to identify tracks and other signs from these important animals can help conservationists preserve their dwindling habitats. Their "stories [are] written in the snow, the sand, and the mud" (Sue Morse, Plenary Address at the 2015 Northeast Natural History Conference). Participating in this citizen science project could be a suitable outdoor winter activity for children.

FrogWatch USA - <https://www.aza.org/frogwatch>

FrogWatch USA, created by Association of Zoos and Aquariums (AZA), is a “bioblitz” (short-term, biological surveying) event in the spring and summer. This is a nighttime activity for those with a keen ear. Volunteers are asked to listen to and discern the calls of frogs and toads in wetland environments and report what they hear. Amphibians are proving to be one of the most vulnerable groups to habitat loss and disease, so the AZA is very active in amphibian conservation.

Yellowstone Wolf: Project Citizen Science - <https://www.yellowstonewolf.org/index.php>

Here again is an example of a specialized project for one particular animal, and there are many more like it. The reintroduction of wolves to Yellowstone National Park is one of the greatest conservation success stories in history. However, scientists still have unanswered questions about predator-prey interactions, pack dynamics, and the prevalence of disease (specifically sarcoptic mange) in the park. Thus, this project asks visitors to submit photos and other data if they happen to see a wolf(ves) during their visit. From these photos, scientists can quantify pack size or spot mange lesions, for example.

Abiotic

EarthEcho Water Challenge - <http://www.worldwatermonitoringday.org/>

The EarthEcho Water Challenge engages citizens around the world in an effort to protect water resources and monitor local waterbodies. As it stands now, EarthEcho has more than 1.5 million participants from nearly 150 countries and data from over 70,000 bodies of water. Test kits for testing turbidity, temperature, dissolved oxygen, and pH are available for purchase. Once tested, EarthEcho encourages its participants to use that data as a springboard for taking action to improve water quality and health. “Levels of action can range from visual surveys, to litter pick-ups, to one-time habitat improvement projects.”

GLOBE Clouds- www.globe.gov/web/s-cool/home

GLOBE, or the Global Learning and Observations to Benefit the Environment Program, is principally sponsored by NASA, with additional support from the National Science Foundation (NSF) and the National Oceanic and Atmospheric Association (NOAA). GLOBE manages a number of worldwide Earth science projects, one of which analyzes the role clouds play in shaping the Earth’s climate. Although satellites tell us a lot about cloud formation from above, NASA scientists also need information from an earthly perspective to get the entire picture. This is where citizen scientists come in. Volunteers begin the process by finding their satellite “overpass time” (i.e., when a satellite is passing over a given location) and then submitting cloud data to the NASA Langley Research Center. The next step is to wait for NASA to compare your observations to the corresponding satellite data, at which point you will receive an email with the results. The GLOBE website has a wealth of educational resources related to Earth science and links to many other projects.

Galaxy Zoo - <https://www.zooniverse.org/projects/zookeeper/galaxy-zoo>

Galaxy Zoo is one of many Zooniverse “people-powered research projects.” Zooniverse is a collaboration between institutions from the United Kingdom and the United States and the creator of several physics, climate, and space-related projects. However, Zooniverse’s approach to citizen science is a bit different than most; in this case, scientists already have the data they need in the form of telescope images or historic documents, and they need volunteers to classify and analyze them. For example, Galaxy Zoo aims to classify galaxies from millions of images taken by a telescope stationed in Chile. Users will see an image from that telescope on the computer and be asked to characterize that galaxy (e.g., spiral, elliptical, irregular). Perhaps these images can be printed so children can do this work without looking at a screen. Of note, a field guide can be clicked open at any time during the classification process without losing your work if a refresher is needed.

Globe at Night - <https://www.globeatnight.org/>

Globe at Night measures light pollution, or the excessive collection of artificial light, most often an issue in dense, urban areas. Light pollution hides the stars and planets of the night sky behind a veil of hazy, orange-yellow light, which can confuse migrating nocturnal animals or interfere with astronomical research. To help Globe at Night quantify light pollution globally, you can submit a classification of your night sky based on the number of stars/constellations you are able to see. Globe at Night provides printable images of common constellations to look for, which might be a fun nighttime activity in and of itself.

Community Collaborative Rain, Hail, and Snow Network - <https://www.cocorahs.org/>

CoCoRaHS was created in 1998 in response to a devastating flash flood in Fort Collins, Colorado the year before. A dedicated group of people wanted to develop a program to better predict and map intense storms using citizen science, so CoCoRaHS was born. The program requires participants to obtain standardized gauges for measuring precipitation and snow, which can either be purchased or potentially borrowed from your local area project coordinator (there are several in each state). Participants can look through the CoCoRaHS "Training Slide-Shows" to learn where to place the gauge outside (e.g., height above ground and distance from trees). This organization receives an average of 10,000 daily reports from areas all over the United States, Canada, and the Bahamas and each report is immediately visible online.

CITIZEN SCIENCE RESOURCES

BOOKS

Burns, Loree Griffin. *Citizen Scientist: Be a Part of Scientific Discovery from Your Own Backyard.* New York: Henry Holt and Company, 2012

This book appeals to children and teachers as both an introduction to citizen science and guide to many of the most popular youth-focused projects, complete with photographs of children in action. Burns emphasizes how easy it is to walk outside of your house or school and join reputable scientists.

Cooper, Caren. *Citizen Science: How Ordinary People Are Changing the Face of Discovery.* New York: Overlook Press, 2016

This book is a must-read for those who want to learn more about the power and value of citizen science. In three parts, Cooper describes several ongoing projects, discusses how technology has transformed the practice of citizen science, and champions the work of ordinary citizens in some of the most famous conservation stories.

Dickinson, Janis L. and Bonney, Rick (eds.). *Citizen Science: Public Participation in Environmental Research.* Ithaca, New York: Cornell University Press, 2012

Janis Dickinson is a professor of Natural Resources and former Arthur A. Allen Director of Citizen Science at the Cornell Lab of Ornithology. Rick Bonney is the Director of the Department of Program Development and Evaluation in the same Cornell lab. As two well-known names in the field, they have created a useful resource that shares their insights on implementing a successful citizen science project. The book includes suggestions for project design, data management, and other logistics.

Forrester, Anna. *Bat Count: A Citizen Science Story.* South Carolina: Arbordale Publishing, 2017

Bat Count is Anna Forrester's "fic-informational story" about a young girl who is inspired to count bats each night and send her numbers to scientists. This children's book "introduces the empowering practice of citizen science with a story of action, reassurance, and hope" (<http://www.annaforrester.com/books/>). *Bat Count* was named the 2018 Outstanding Science Trade Book for Students K-12 by the National Science Teachers Association and the Children's Book Council, along

with several other accolades.

ARTICLES

Bonney, Rick, Shirk, Jennifer L., Phillips, Tina B., Wiggins, Andrea, Ballard, Heidi L., Miller-Rushing, Abraham J. and Parrish, Julia K. "Next Steps for Citizen Science." *Science* 343 (2014): 1436-1437

Published in *Science*, a premier scientific journal, this article discusses citizen science's enormous potential as a data source and offers suggestions for reaching that potential.

Dickinson, Janis L., Shirk, Jennifer, Bonter, David, Bonney, Rick, Crain, Rhiannon L., Martin, Jason, Phillips, Tina and Purcell, Karen. "The Current State of Citizen Science as a Tool for Ecological Research and Public Engagement." *Frontiers in Ecology and the Environment* 10 (2012): 291-297

This article considers citizen science's invaluable contribution to ecology and conservation. The authors write, "Citizen science, with its 'many eyes', is an effective way to find rare organisms, track invasions, and detect boom-and-bust events" (293). The article includes a table of online resources that can be used to find current citizen science projects.

Harris, Emily and Ballard, Heidi. "Real Science in the Palm of Your Hand: A Framework for Designing and Facilitating Citizen Science in the Classroom." *Science and Children* 55 (2018): 31-37

Harris and Ballard use the Lost Ladybug Project (LLP, described in this article) as an example for engaging children in the scientific process. The authors explain how the LLP helped children develop expertise, contribute data, draw conclusions, and share their findings with the community.

Havens, Kayri and Henderson, Sandra. "Citizen Science Takes Root." *American Scientist* 101 (2013): 378-385

Written by a senior scientist and Director of Plant Science and Conservation at the Chicago Botanic Garden (CBG), alongside the Director of Citizen Science at the National Ecological Observatory Network (NEON); this is a highly cited publication. It provides a timeline of the history of citizen science as a discipline and introduces Project Budburst, a CBG program supported by a "nation of flower watchers."

Shah, Harsh R. and Martinez, Luis R. "Current Approaches in Implementing Citizen Science in the Classroom." *Journal of Microbiology and Biology Education* 17 (2016): 17-22

As the title suggests, this article is focused on citizen science's role as an educational tool for developing critical thinking and scientific literacy among children. It includes a table of well-known citizen science projects for elementary, middle, and high school levels.

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Harris, Emily & Ballard, Heidi. "Real Science in the Palm of Your Hand: A Framework for Designing and Facilitating Citizen Science in the Classroom." *Science and Children* 55 (2018): 31-37.

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