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Dear Reader,

The Emmett Environmental Law & Policy Clinic is pleased to share with you a Manual for Citizens Scientists Starting or Participating in Data Collection and Environmental Monitoring Projects that we developed to support individuals researching and responding to public health and environmental concerns. Whether collecting, generating, analyzing, or distributing information, citizens from all backgrounds can play an important role in protecting their own communities and the environment. The Manual outlines practical suggestions for how to do this. The Manual also contains an overview of relevant laws and regulations, as well as technical suggestions regarding data collection, analysis, and compliance with relevant scientific and quality standards.

In the wake of Hurricane Harvey, the Clinic prepared an Appendix to the Manual that provides additional information specific to citizen data collection in Texas, and the Houston and Galveston areas more specifically. Although the Appendix can be read as a stand-alone document, it is enhanced by reading it in conjunction with the more comprehensive Manual.

We welcome your feedback on the Manual, and the Texas Appendix, and we thank you for your interest in participating in efforts to promote and protect public health, local communities, and the environment.

Sincerely,

The Emmett Environmental Law & Policy Clinic

A MANUAL FOR CITIZEN SCIENTISTS STARTING OR PARTICIPATING IN DATA COLLECTION AND ENVIRONMENTAL MONITORING PROJECTS

Harvard Law School
Emmett Environmental
Law & Policy Clinic

Preliminary Information

This manual is a project of the Emmett Environmental Law & Policy Clinic at Harvard Law School under the direction of Clinical Professor Wendy B. Jacobs. This manual was researched and prepared by Clinic students, including Curtis Powell (’18) and Phillip Godfrey (’17), together with the Clinic’s lawyers Wendy Jacobs, Shaun Goho, and Aladdine Joroff. Additional Clinic students, in particular Erik Federman (’18), Esther Labrado (‘17), Ellen Park (’17), Gloria Scott (‘17), Amy Chyao (’19), and Michael Shafer (’19) performed research and helped prepare the appendices to this manual. Questions or comments on this manual can be directed to EmmettClinic@lists.law.harvard.edu.

Legal Disclaimer

The manual is not intended to operate as a substitute for legal representation and does not create an attorney-client relationship. This manual generally describes the legal framework within which citizen collection of data and environmental monitoring may occur. It identifies legal issues citizens should be aware of and offers general suggestions. However, if you have specific questions or you encounter legal threats in the course of conducting a citizen science project, you should consult a lawyer with expertise in the geographic locale in which you are working. Please understand that laws vary from state to state and from locale to locale. Laws also frequently change so it is important to educate yourself about the current laws in the area in which you plan to work. This manual will help get you started. Neither the Clinic nor any of the authors assumes any liability for the actions taken (or not taken) by any party in reliance on this manual.

Glossary of Terms

Decision Maker: A person or entity with jurisdiction to make legal decisions or judgments.

Environmental Protection Agency: The federal agency created by Congress to protect human health, natural resources, and the environment from pollution, to set limits for the emission of pollutants, and to enforce those limits. Most states have their own state-created agency empowered to do the same within that state.

Information Collection: The gathering and analysis of information that is already publicly available.

Information Generation: The procurement of information that was previously uncollected, unknown, unreported, or unestablished in the realm of public knowledge.

Information Use: The ways in which information that is collected or generated during a citizen science project can be used.

Jurisdiction: The legal authority to make legal decisions or judgments. It could be a local, state, or federal administrative agency, legislative body, or court.

Pollutant Source: An industrial facility, agricultural facility, land fill, sewage treatment plant, coal mine, etc.

Project Approach: An early design of a project comprised of two components: i) the identification of a **site** (i.e., location) of interest to you and ii) the determination of which pollutant or combination of pollutants are of concern to you and about which you will collect information and data.

Project Focus: The environmental question, theme and/or problem to which a project is directed.

Table of Contents

INTRODUCTION

Purpose of this Manual: This manual aims to empower individuals in their roles as citizen scientists and to promote the practice of community-based citizen science as a vehicle for environmental justice. It is our hope that this manual will increase your awareness of how to identify and contribute to existing projects or to initiate and effectively prove your own project. To that end, this manual outlines practical suggestions for how to design and carry out a citizen science project. It also contains an overview of relevant laws and regulations, as well as technical suggestions regarding data collection, analysis, and compliance with relevant scientific and **quality standards**.

What is Citizen Science?

Citizen science can be defined as a grassroots initiative in which ordinary citizens, sometimes in collaboration with professional scientists, organizations and government agencies, collect, generate, and distribute information either for educational purposes or to address community-centered environmental issues. More simply, it is community-driven science: science engaged in, by, and for the non-scientist populace.

***Citizen science** is community-driven science: science engaged in, by, and for the non-scientist populace.*

There are multiple ways that individuals can get involved in citizen science projects, and these projects can take on a variety of configurations. For example, individuals may choose to *find and collaborate on pre-existing projects* rather than start their own. Existing projects are often offered by professional citizen science organizations, neighborhood organizations, environmental agencies, and local park and wildlife services. Most existing projects have a specific, and often unique, focus that is set by the organization or agency conducting the project. For instance, a project may be designed to assist with the collection or generation of information needed to support the work of a decision-maker or advocate or to motivate individuals to engage with nature and science.

*The EPA has defined **environmental justice** as "the fair treatment and meaningful involvement of all people . . . with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies."*

Alternatively, individuals may *design and initiate their own project*, either for similar goals or with an eye toward regulatory or private enforcement of environmental laws. Individuals may start by identifying an issue in their communities (*e.g.*, groundwater pollution, lead contamination, high asthma rates), and then develop a plan to collect and analyze samples near potential sources of the problem. They might then use these results to educate community members and decision-makers, including by submitting the results of their work to a regulatory agency (*e.g.*, the local board of health or the state or federal **Environmental Protection Agency**) to petition the agency to take action necessary to protect the community (e.g., enforcement against a polluter).

In short, citizen science projects are and can be organized for many different purposes and with many opportunities for varying levels of involvement. Recognizing the many forms citizen science projects may take, this manual generally focuses on those projects designed to remediate environmental problems that threaten community health and wellbeing.

Example of Citizen Scientists in Action: In 2004, residents of Tonawanda, New York, home to some of the state's largest industrial manufacturing facilities, noticed a marked decrease in local air quality and an increase in chronic health problems and banded together to form the Clean Air Coalition of Western New York. They collected local air samples using simple air sensors readily available online, and their analysis of these samples revealed the presence of high levels of benzene, a known carcinogen, in the town's air. The residents then presented this information to New York's Department of Environmental Conservation, which worked with the federal Environmental Protection Agency to perform further air quality tests. Once the state and federal agencies became involved, the local manufacturing facilities tightened operating procedures, ultimately decreasing benzene levels in the air by 86 percent.

Many successful citizen science projects tend to follow the process demonstrated by this example. A community of citizens comes together through grassroots organizing to identify and solve a problem through the collection or generation of information. They then leverage this information to gain traction with the relevant enforcement agencies and put pressure on the polluting parties to reform.

Technical and Legal Limitations of this Manual

This manual describes the legal and technical framework governing citizen science and offers practical suggestions. These suggestions are general and not specific to your locale. Nor are these suggestions comprehensive. It is important that you check the current rules in the specific **jurisdiction** in which you will carry out or are currently carrying out your project. This manual provides references to resources for those seeking more information. However, these resources are non-exhaustive and are subject to change.

*It is **important** that you check the rules in the specific jurisdiction in which you carry out or are currently carrying out your project.*

Concerning legal suggestions: Many of the laws referred to in this manual are administered and regulated at the state and local levels, with potentially significant differences across **jurisdictions**. This manual does not attempt to compile and detail every state statute, local ordinance, or agency regulation that may be relevant to a citizen scientist's efforts. Instead, the manual is intended to give a broad overview of the relevant laws by distilling governing principles and common statutory elements across **jurisdictions**. Having canvassed these laws generally, the manual identifies types of laws that restrict citizen science – meaning laws that could result in a citizen scientist facing either criminal or civil liability for actions (such as trespass) not conducted in compliance with such law. It is important that you seek to educate yourself about statutes, regulations, and ordinances specific to your own **jurisdiction** before setting off into the field to engage in sample collection. The tools available in this guide will assist you in doing so.

*It is **important** that you seek to educate yourself about statutes, regulations, and ordinances specific to your own jurisdiction before setting off into the field to engage in sample collection.*

Concerning technical suggestions: The problems addressed by citizen science projects are diverse.[1] This manual is primarily focused on citizen science projects that are directed at environmental pollution concerns, and in particular, pollution of air, water, and soil. However, many of the suggestions in this manual are highly generalizable. If your project lies outside the focus of the manual, we recommend that you use

This manual is primarily focused on citizen science projects that are directed at pollution concerns, and in particular, the environmental pollution of air, water, and soil.

[1] *See, e.g.*, Anne Bowser & Lea Shanley, *New Visions in Citizen Science*. Washington, DC: Woodrow Wilson International Center for Scholars (2013).

the chapter headings and introductions to rapidly assess whether the content of the chapter will be relevant to your particular project.

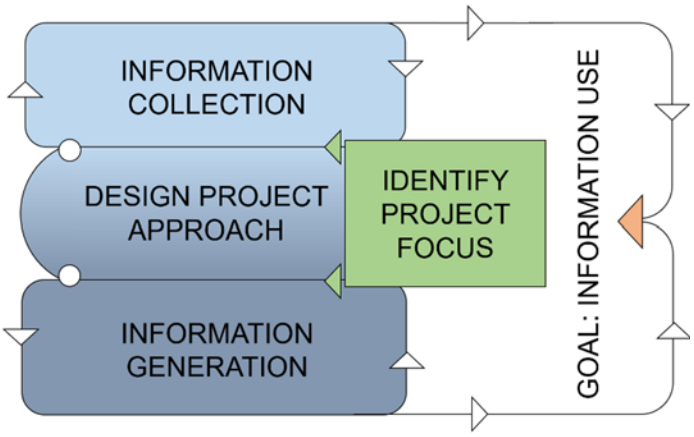
Manual Overview

This manual is divided into seven major chapters. The needs of individual citizen scientists can differ greatly, and therefore, there are various ways in which the content of this manual might be presented. We have chosen to structure the manual to reflect the sequence of steps that one might follow when initiating a new citizen science project. But, we emphasize that no two projects will follow the exact same path from beginning to end.

The manual is organized to reflect the sequence of steps one might follow when initiating a new citizen science project.

The following graphic provides a visual representation of how the different chapters relate. This graphic highlights: (i) that there are many paths that can be taken from the beginning of a project ("Identify **Project Focus**") to completion of that project ("Goal: **Information Use**"); (ii) that the chapters of this manual are highly interrelated and need not be thought of as separate steps; and (iii) that many times citizen science projects are iterative: they may involve some cycling back to previous steps as new information is uncovered or if circumstances change.

No two projects will follow the exact same path from beginning to end.



Graphic Legend:

Each chapter of this manual relates to one or more of the major categories outlined in this graphic. Areas of the graphic will be expanded in each chapter to highlight information that may be of use to you as you carry out your project.

Chapter 1, "Identifying Your Project's Focus and Designing Its Approach," describes the initial steps of a citizen science project. This includes guidance on how the focus of your project, or the central environmental issue to which it is directed, should influence your project's approach.

Chapter 2, "Identifying Your Project's Goals - Evaluating Potential Information Uses," assists you in brainstorming the potential goals of your efforts before engaging in **information**

collection or field research. For example: Do you intend to give your data to a regulatory agency for use in an enforcement action? Does that agency have the resources and political will to pursue such an enforcement action? Are there other uses for your data that do not involve an agency enforcement action (*e.g.*, community organizing, media attention)? Your answers to these questions can shape the scope and direction for your project.

Chapter 3, "Information Collection: Gathering Publicly Available Information," assists you in identifying what is already known about the problem with which you are concerned. Specifically, it provides guidance on how to acquire publicly available information with respect to pollutants and **pollutant sources**. After reading this chapter, you should know how to efficiently gather publicly available information and to determine whether or not it is sufficient to resolve the problem you have identified.

Chapter 4, "Information Generation: Potential Liability," reviews potential legal limitations on **information generation** by citizen scientists as well as positive rights and privileges you can take advantage of to design the most effective project possible. Think of this as a primer on which laws might be most relevant to citizen science. While we anticipate that most readers will not encounter legal complications in conducting their projects, we nonetheless want to arm you with the knowledge and resources to carry out your project without fear of adverse consequences. To that end, this chapter summarizes a wide range of legal issues like trespass, drone use, and privacy rights. The analysis of these laws canvasses the full 50-state spectrum, highlighting similarities and differences across **jurisdictions**. This chapter should be read in conjunction with the material in Appendices 1 and 2 of this manual, which compile specific state statutes and resources. Ultimately, this chapter will help you *begin* to develop a sense of which actions you can take and which you should avoid, allowing you to plan your project more effectively.

Appendices include:

1. *High-level comparisons of state laws*
2. *Individual State Law Summaries*
3. *Pollutants Monitored by the EPA*
4. *Publicly available Data and Permits*
5. *EPA Reference Methods, Standards and Protocols*

Chapter 5, "Information Generation: Design of Sample Collection, Sample Analysis, and Data Interpretation Methodologies," highlights ways of increasing the quality of new information that you generate from any field work that your project may involve. Importantly, increasing the

quality of the information you generate promotes its utility or usefulness. This chapter also stresses the value of making this process a community endeavor. For example, look for experts in your community who can help you overcome any technical hurdles you may encounter.

Finally, Chapter 6, "Information Use: Making the Most Out of Your Information," provides a few examples of ways in which you can increase the value of the work that you have performed.

Use of This Manual

Citizen scientists have diverse needs that depend on the nature and status of the projects in which they are involved. As such, we anticipate that readers will differ in how they will use this manual. Some may read the manual from cover to cover; others will seek out specific topics.

While most of the examples and discussion provided in each chapter of this manual are geared toward helping citizen scientists begin and complete their own projects, the suggestions are applicable to all citizen science projects that are directed at air, water, and soil pollution concerns. Thus, whether you are interested in finding and getting involved in an existing project or are already involved in an ongoing project, this manual can still be a valuable resource to you.

Below are examples of how readers may use this manual:

- Individuals interested in initiating a citizen science project: because the manual is structured to reflect the sequence of steps that one might follow when initiating a new citizen science project, these readers may benefit from reading the manual from cover to cover.
- Volunteers who are seeking to join an ongoing citizen science project: because Chapter 1, "Identifying Your Project's Focus and Designing Its Approach," includes a section with resources for those interested in joining an ongoing project, people looking for a project to join may benefit from starting with this chapter. After joining a project, these readers can explore the chapters of the manual that are most relevant to their specific project roles.
- Organizers, Project Managers and Volunteers who are currently engaged in a citizen science project: for these readers, the manual's most useful content will likely relate to the project roles in which they are involved (*e.g.*, project design, collecting samples,

There is not a "correct" way to use this manual. Depending on your project's needs and status, and your type of involvement, you may choose to read the text in full, focus on the chapters that you anticipate will be most relevant, or dig deeper into the references cited in the text or into the appendices.

analyzing available data, interpreting results, preparing forms, disseminating a project's results, etc.). These readers may refer to the table of contents and to the chapter headings and introductions to identify sections of the manual containing content that addresses their current project needs.

This manual is designed to be useful for readers with a broad range of technical and legal backgrounds. Those who are just starting to learn about these topics may find it most useful to focus on the complete text of the chapters. Readers who are more familiar with the issues, and those who possess a technical or legal background may prefer to spend more time investigating the references cited in the text and appendices.

Problem Solving as You Read: Some readers may not have a specific problem in mind as they review the contents of this manual. Because reading the manual with a specific problem in mind may help highlight the relevance and application of the topics discussed, the following are hypothetical scenarios that you could consider when reading the manual:

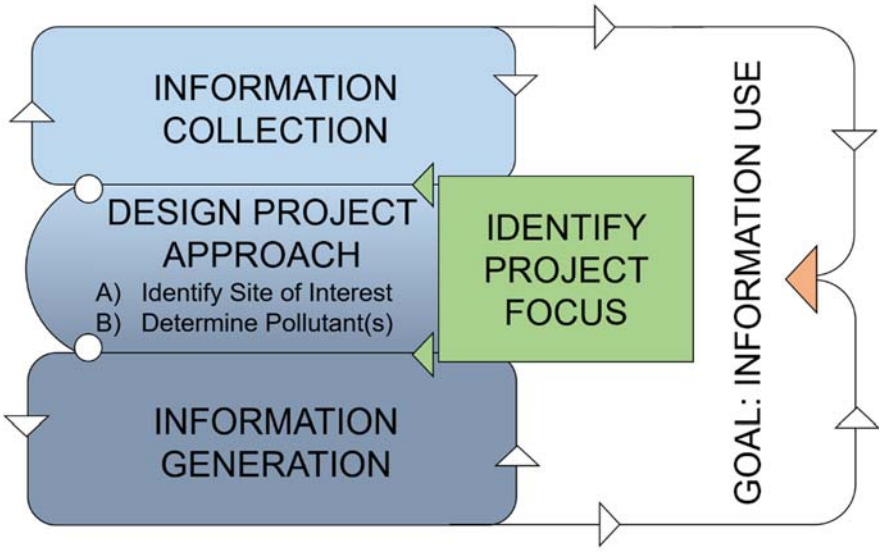
First scenario: Imagine that you have just retired and moved to Wyoming for the clean air and fresh water. You bought a home on a hill overlooking and within a short distance of a river. You are hankering for something to do in retirement and decide to become an observer of nature and the environment. You soon learn that there are a couple of ranches near the area in which you have settled. How would you initiate a project to monitor any potential pollution of the river associated with ranching activities?

Second scenario: Imagine that you live in a small Pennsylvania community. Many individuals in your community are suffering from headaches and skin rashes, and they are complaining that their tap and well water is discolored with a bad odor. With a little investigation, you discover that some members of the community have recently leased their land to a gas company but cannot discuss the situation because of confidentiality provisions in their leases; others have not leased their land or given the gas company any rights to access or use their property. How would you design a project to determine whether there are pollutants in the water that are causing health impacts? Suppose that the successful completion of your project will require the comparison of water pollution levels that existed prior to the arrival of the gas company (*i.e.*, baseline pollution levels) with levels after its arrival?

Third scenario: Imagine that you live in North Dakota and that you are worried that a recently constructed pipeline will leak oil into a lake that is the source of many important resources for the residents in the area, not the least of which is drinking water. How would you initiate a project that will allow you to detect a leak in the pipeline?

CHAPTER 1: IDENTIFYING YOUR PROJECT'S FOCUS AND DESIGNING ITS APPROACH

Why You Should Read this Chapter: Starting your project in the right way will help assure your overall satisfaction with your project. This chapter provides guidance for those taking these beginning steps. By the end of it, you will know how to identify your **project's focus** and how to use that focus to design your **project's approach**, which includes (i) the identification of a **site** (i.e., location) of interest to you (*e.g.*, a river, forest, industrial activity) and (ii) the determination of which pollutant or combination of pollutants will be examined during your project. In addition, this chapter provides resources for those seeking to join an ongoing citizen science project.



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After identifying your project's focus, or the environmental problem to which you project will be directed, your first step will be designing your project's approach. This approach should be driven by the project focus that you have identified.

Identifying the Focus of a Project of Interest

Before beginning a new citizen science project, you should identify the **project focus**, which is the environmental question, theme, and/or problem at issue. Some who are reading this manual may already have a **project focus** in mind; others may not. Recognizing the vast breadth of environmental problems that may be of interest to citizen scientists, we do not attempt to list them all here. Instead, we mention a few types of projects and examples of each.

Monitoring the condition of an environmental interest – Your project's focus might relate to protecting an environmental resource or habitat that is currently unthreatened or thought to be

unthreatened. By monitoring this resource, your efforts may facilitate the rapid detection of changes in pollution levels. Examples include:

- Monitoring water pollution levels in a river or in a national forest.
- Monitoring air quality in your community following the construction of a new local **pollutant source** (*e.g.*, an industrial facility, agricultural facility, land fill, sewage treatment plant, coal mine, etc.) or an announcement that an existing **pollutant source** in your community will be expanding or increasing its activity levels.
- Monitoring water quality in your community because you suspect an increase in pollution resulting from accumulated wear and tear of a known **pollutant source** near your home.

Verifying reported emissions of pollution from a known **pollutant source** – Your project's focus might relate to verifying that a known **pollutant source** is accurately reporting its environmental footprint. For example:

- Verifying that a known **pollutant source** is accurately reporting how much or what it pollutes.
- Verifying that a known **pollutant source** is complying with its current permit obligations.

Redressing a known environmental pollution problem – Your project's focus might relate to correcting a known pollution problem. Examples include:

- Identifying the source of an environmental pollutant.
- Redressing poor air or water quality.
- Decreasing the environmental impact of an oil spill in a national or state forest or in a body of water.

Diagnosing a problem that you suspect is caused by pollution – Your project's focus might relate to solving a problem that has arisen in your community when the cause of the problem is uncertain. You might desire to determine whether the problem's cause relates to a pollutant present in your community. For example:

- Diagnosing unexplainable health problems that individuals, animals, or plants in your community are suffering.

*Determine Whether Existing Projects Are Already Directed at the **Project Focus** that You Have Identified*

The **project focus** that you are interested in may already be the focus of an ongoing citizen science project. If so, you might consider supporting that project instead of initiating one of your own. Indeed, supporting an existing project can alleviate the burden that some individual citizen scientists may feel in planning and mobilizing their own projects. If your interests align with those of an ongoing project, supporting that project can be ideal for you.

There are a variety of resources to help citizens identify ongoing citizen science efforts:

- Media Outlets: Local news agencies often cover major ongoing citizen science projects. Moreover, many community-driven citizen science projects increase public awareness through social media. For example, details concerning the citizen science project in Tonawanda, New York were reported in local news. In addition, the project's task force, the Clean Air Coalition of Western New York, used a Facebook page to advertise public meetings and other ways of getting involved in the project.
- Organizational Websites: Various citizen science organizations host websites that consolidate ongoing citizen science projects. Examples include the Citizen Science Alliance, the government-sponsored https://www.citizenscience.gov, and SciStarter (https://scistarter.com/finder).
- Agency Websites: State and federal environmental agencies also maintain citizen science databases on their websites. The EPA, for example, hosts a robust page dedicated to promoting citizen science involvement at https://www.epa.gov/citizen-science. In addition, many state and local park and wildlife departments host links to ongoing citizen science projects.
- Appendices: Appendices 1 and 2 of this manual provide references to various projects that are open to public involvement.

Initiating Your Own Project: Designing Your Project's Approach

Many important environmental problems are not addressed by existing citizen science projects. Projects sponsored by government agencies may be limited and constrained by budget cuts, changes in priorities, and changes in political administrations. Ultimately, you may seek to initiate your own project.

The first step in initiating your own citizen science project is designing your project's approach. A "**project approach**" has two components: i) the identification of a **site** of interest to you and ii) the determination of which pollutant or combination of pollutants you will examine. Importantly, the design of your project's approach should be driven by the **project focus** that you identified previously (*see* the first section of this chapter). For example, suppose that your **project focus** is:

- *Verifying* that a known **pollutant source** is accurately reporting how much or what it emits to the environment. This project's **site** of interest might be the known **pollutant source**.
- *Improving* the quality of air or water in your community. Here, the project's **site** of focus might be your community itself or a known **pollutant source** located near your community.
- *Monitoring* a natural habitat that you consider valuable (*e.g.*, a river, forest, ocean, etc.). In this instance, the **site** of interest might be the natural habitat or a known **pollutant source** located near that habitat.

After you have identified your project's **site** of interest, you should determine which pollutant or combination of pollutants will be examined during your project. This aspect of your project's approach is critical because if you spend all of your time examining the wrong pollutant, your project's goal will not be met. For some projects, determining which pollutant or combination of pollutants to examine will be a straightforward process. In others, this process may be the most difficult aspect of your project's design.

Use what you know about your project's **site** of interest to guide you in determining which pollutant or combination of pollutants you will examine during your project (*see* Chapter 3). For example:

- Source Indicators: **Pollutant sources** are often associated with strong source indicators – meaning that some pollutants are commonly produced by a certain kind of **pollutant source**. Suppose for instance that your project's goal is to measure the impact of a newly constructed facility that produces plastics. These facilities are known to emit volatile organic compounds (VOCs). Therefore, your project may seek to examine VOC emissions. If you are interested in monitoring water quality in a stream, you could research sources of water pollution flanking the stream to determine which pollutants they discharge and, therefore, which you should examine.

- Use Your Senses: Your eyes, ears, and nose can help you figure out which pollutants you should examine (*e.g.*, a distinct smell in the air, the sight of an oil slick on the surface of water, a distinct taste in your drinking water, etc.). Likewise, the health symptoms associated with exposure to a pollutant may prove insightful. For example, the pollutant benzene, which is associated with petroleum products, has a sweet smell and exposure to abnormal levels of benzene in ambient air is associated with a heightened risk of asthma. If you notice a correlation between these two things in your community – a gasoline-like smell and an increase in asthma diagnoses – you might then consider initiating a citizen science project focused on local sources of benzene pollution.
- Media Outlets: Local news reports may also provide valuable information. For example, if a local news agency reports that residents of your community have been suffering from exposure to lead, the approach of your project may be determining the lead content of your drinking water.
- Smartphone Apps: Some regions may have smartphone applications set up to report pollutants or evidence thereof. For instance, Pittsburghers can use Smell PGH to report air quality on their smartphone; the app can then alert the Allegheny County Health Department to the data.[2] Apps such as this may provide useful information as you begin to decide which pollutants require attention in your area.

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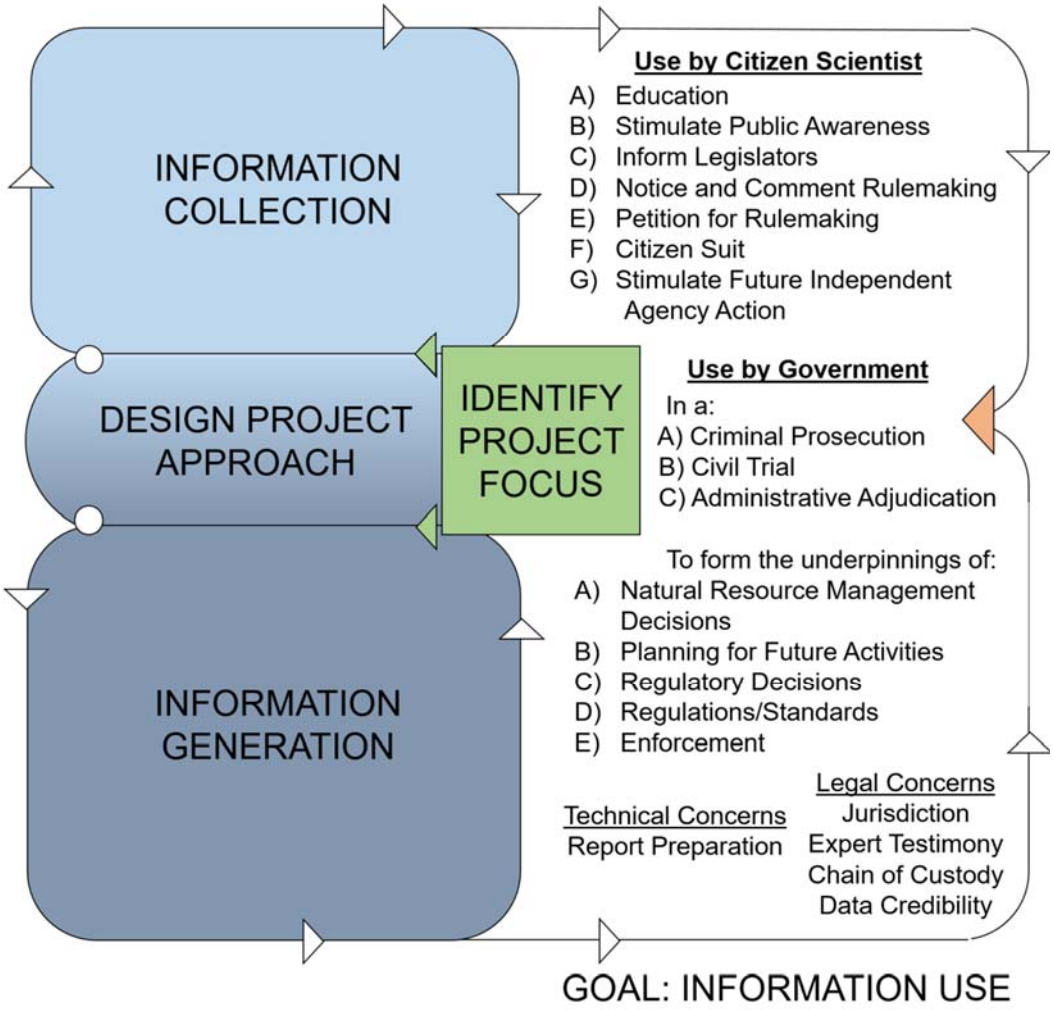
We conclude this chapter by emphasizing that your project's approach need not be static; it is possible that it will require modification as your project progresses. For example, suppose that the focus of your project is diagnosing the sudden and unexplainable health problems recently afflicting members of your community. Your original **project approach** may have involved determining the levels of pollutant X in the community's water supply, but the results of your examination could indicate that the pollutant is absent or within safe levels. In response, you should revisit and modify the design of your project's approach (*e.g.*, modify it so that you will determine the levels of pollutant Y in the water supply, the levels of pollutant X in the air, or otherwise).

[2] Ashley Murray, *Carnegie Mellon Scientists Use App to Track Foul Odors in Pittsburgh*, PITTSBURGH POST-GAZETTE, July 3, 2017

CHAPTER 2: IDENTIFYING YOUR PROJECT'S GOAL

Why You Should Read this Chapter: If you don't know where you want to end up, you will never get there. Thus, it is important to identify your project's goals early. This process involves the evaluation of potential uses of the information that you collect or generate as you carry out your project (*i.e.*, **information use**). Here, we outline examples of **information use** and, at the same time, explain the **quality standards** that can limit the use of information that is collected or generated by citizen scientists. Understanding this information will help assure that your project's goals are achieved.



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The information that you might collect or generate during your project can be used in a variety of ways, either by you or the government. However, various issues, in particular legal standards, can limit the potential uses of your information.

Introduction

The use of citizen science-generated information is subject to various legal standards (i.e., "**quality standards**").[3] These standards serve to establish a level of quality that the information must meet before it can be used in a certain way (for example, in a court proceeding or agency decision). The terms "credible information" or "reliable information" may be used in place of "quality information" in some contexts.

Two simple inquiries can help you identify the **quality standards** that are relevant to your project's ultimate goals. First, who will use the information? Potentially, you seek to use the information yourself. Alternatively, you may want the government to use the information (*e.g.*, use by a federal, state, or local governmental agency, etc.). Second, how will the identified user ultimately use the information?

Making Connections Between Chapters: Chapter 1 was directed at helping you take the first steps of your project. Now that you have established your project's beginnings, you should take time to consider its possible endings. This involves an examination of the potential uses of the information that might be collected or generated during your project's progression (*i.e.*, "**information use**").

This chapter highlights examples of **information use**. Along the way, we identify legal standards that can limit the use of information that is collected or generated by citizen scientists. Doing so will help reveal the path that you should take to achieve your project's goals.

It may also be useful for you at this point to note that **information collection** is the topic of Chapter 3, and that **information generation** is the topic of Chapter 4 and Chapter 5.

[3] We emphasize that this chapter is only introductory in nature. Additional background information can be found in Appendices 1 and 2 of this manual and in a recent report published by the Commons Lab of the Science and Technology Innovation Program. *See* James McElfish, John Pandergrass & Talia Fox, *Clearing the Path: Citizen Science and Public Decision Making in the United States* (2016).

You can use the information that you collect or generate during your project in many ways. Depending on how you want to use the information, it will be subject to different **quality standards**, which can range from lenient to strict. While the laws and regulations that establish **quality standards** are too varied to allow a strict differentiation into clear "lenient" and "strict" categories, we attempt below to indicate where different standards fall along this continuum. It should be stressed at the onset of this discussion that even when use of information is not formally limited by **quality standards** or when it is limited only by lenient **quality standards**, the information's quality still impacts how effective it will be in advancing your goals.

Uses by Citizen Scientist
No Legally Imposed ***Quality Standards***

1) Education
2) Stimulate Public Awareness
3) Inform Legislators

Some potential uses of information that you have collected or generated are not subject to legally imposed **quality standards**. For example, you may use the information to increase knowledge in educational campaigns, to stimulate public awareness, or to foster community engagement. Or you might want to contact your elected representatives to influence the development of new laws. You can provide them with the information that you have collected or generated by phone, email, letter, or otherwise. Although there are no legal rules governing the quality of the of the data for these uses, you obviously still want to ensure that it is of as high a quality as possible so that you can make a compelling argument.

You might instead want to provide the information to a regulatory agency or use it as evidence in a court case such as a citizen suit against a polluter. In these situations, the use of the information, either by yourself or by a government agency, will be subject to legally-imposed **quality standards**.

You can provide information to regulators in a variety of contexts. First, you can provide an agency with the information that you have collected or generated to influence the development of new regulations. For example, when an agency uses notice and comment rulemaking to propose the adoption of a new regulation, members of the public can submit comments in response to the proposed regulation during an allotted window of time. After closure of this time window, comments are no longer accepted. At the federal level, opportunities for public comment during notice and comment rulemaking are generally published in the Federal Register or can be found

on the agency's website.[4] Each year, the EPA receives millions of comments on its proposed rules, notices, and other actions which are posted on its dockets at regulations.gov.[5]

If an agency is going to rely on the information you have submitted as a basis for its eventual decision, then the information must satisfy certain **quality standards**. Federal and state agency decisions are subject to judicial review. For example, the Administrative Procedure Act (APA) directs courts that review federal agency actions to "hold unlawful and set aside agency action, findings, and conclusions found to be *arbitrary*, *capricious*, an abuse of discretion, or otherwise not in accordance with law" or "unsupported by *substantial* evidence."[6] Standards in state courts are similar. Although these standards are not particularly burdensome, because courts grant considerable deference to agencies' scientific expertise, they nevertheless provide a check on the quality of the information that forms the basis for agency decisions.

If an agency does not have an ongoing rulemaking proceeding to which your information is relevant and if you believe an agency should issue new or revised rules to address the situation, then petitions for rulemaking provide an additional opportunity for you to use the information that you have collected or generated. Indeed, the APA requires each federal agency to provide "an interested person the right to petition for the issuance, amendment, or repeal of a rule."[7] Federal agencies have implemented different processes for the submission of petitions. The EPA, for example, provides opportunities for the public to submit and view previously submitted petitions on its website.[8] Similar opportunities for public engagement to influence the development of new regulations exist at the state level.

You might also submit the information to agency in the hope that the agency will use it to bring an administrative or judicial enforcement action against someone who is violating the law. For example, a government may use the information as evidence in a civil lawsuit or a criminal prosecution in a federal or state court. In these instances, the **quality standards** discussed below

[4] For a comprehensive source compiling pending agency actions available for public input, *see Regulations.gov*, https://www.regulations.gov/ (last visited May 1, 2017).

[5] Additional information can be found on EPA's website: *See* Environmental Protection Agency, *EPA Docket Center*, https://www.epa.gov/dockets (last visited May 1, 2017).

[6] 5 U.S.C. § 706 (emphasis added).

[7] 5 U.S.C. § 553(e).

[8] *See* Environmental Protection Agency, *Petitions for Rulemaking*, https://www.epa.gov/aboutepa/petitions-rulemaking (last visited May 1, 2017).

concerning citizen use of the information in a citizen suit would apply. Alternatively, a state or federal agency may use the information in an administrative adjudication. The hearing officer in an administrative adjudication will follow **quality standards** that are similar to those in federal and state courts, though generally somewhat more flexible and lenient. For example, at the federal level, the APA indicates that "any oral or documentary evidence may be received, but the agency as a matter of policy shall provide for the exclusion of irrelevant, immaterial, or unduly repetitious evidence."[9] At the state level, the Revised Model State Administrative Procedure Act (MSAPA) provides similar guidance;[10] not all states, however, have adopted this model statute.

Finally, you may use the information that you have collected or generated to *stimulate* future independent agency action. In these instances, the information serves *to call an agency's attention to the problem.* The agency may then *independently act to verify* the information through its own **information generation** procedures and may initiate enforcement proceedings.[11] Some federal regulations expressly require states to solicit public participation in the collection of information and require state agencies to comment on citizen-generated information. For example, an EPA regulation requires states that implement the Clean Water Act (CWA), the Resource Conservation and Recovery Act (RCRA), and the Safe Drinking Water Act (SDWA) to "provide for, encourage, and assist the participation of the public."[12] With respect to the CWA, EPA regulations require each state that is developing and updating its list of impaired waters to "assemble and evaluate all existing and readily available water quality-related data and information."[13] Moreover, the CWA regulations specify that state agencies should actively solicit the help of members of the public "for research they may be conducting or reporting."[14] EPA regulations also specify that "[e]ach agency administering a permit program shall develop internal procedures for receiving evidence submitted by citizens about permit violations and ensuring that it is properly considered. Public effort in reporting violations shall be encouraged, and the agency shall make available information on reporting procedures. The agency shall investigate alleged

[9] 5 U.S.C. § 556(d).

[10] M.S.A.P.A. § 404.

[11] For example, Tonawanda, NY is a success story on this front.

[12] 40 C.F.R. § 25.3.

[13] 40 C.F.R. § 130.7(b)(5).

[14] *Id.*

violations promptly."[15] Some state statutes also require state agencies to actively investigate complaints made by citizens concerning violations of environmental laws (see Appendix 2).[16]

State and federal laws also provide standards that may limit agency use of some types of information in all kinds of administrative actions. For example, the Information Quality Act (also known as the Data Quality Act) directs the Office of Management and Budget (OMB) to adopt guidelines for federal agencies to address the goals of ensuring and maximizing the "quality, objectivity, utility, and integrity of information."[17] Among other ways of promoting these goals, OMB guidelines direct federal agencies to develop a process for reviewing the quality of information before it is disseminated by the agency.[18] In a second example, the Endangered Species Act requires federal agencies to make species listing determinations (*e.g.*, as threatened or endangered) "solely on the basis of the best scientific and commercial data available."[19]

At the federal level, EPA's "Information Quality Guidelines" limit the agency's uses of "existing data and information generated by third parties to inform its decisions."[20] These guidelines require "the quality and scientific soundness of this type of data to be reviewed and documented prior to use."[21] These **quality standards** are expounded upon on EPA's website.[22]

State agency regulations or guidelines function similarly to the EPA's Information Quality Guidelines. For example, various state agencies have express authority to consider "credible" information in enforcement actions, administrative actions, or both (*see* Appendix 2). The

[15] 40 C.F.R. § 25.9.

[16] *See, e.g.*, N.J. Admin. Code § 7:7A-16.19; N.Y. Envtl. Conservation Law § 19-0503; Utah Admin. Code § R317-8(1.9); Vt. Stat. Ann. tit. 10, § 8020.

[17] Information Quality Act of 2001, Pub. L. No. 106-554, § 515, 114 Stat. 2763 (Dec. 21, 2000).

[18] *Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies*, 67 Fed. Reg. 8452, 8460 (2002).

[19] 16 U.S.C. § 1533(b)(1)(A); 50 C.F.R. § 424.11.

[20] Environmental Protection Agency, *Scientific Integrity Policy* (2012), at 2. As of June 2017, the EPA continues to refer to the 2012 policy document. Environmental Protection Agency, *Policy on EPA Scientific Integrity*, https://www.epa.gov/osa/policy-epa-scientific-integrity (last visited June 21, 2017). In February 2017, a bill on scientific integrity was introduced in the Senate, and in March 2017, a similar bill was introduced in the House. Scientific Integrity Act, S. 338, 115th Cong. (2017); Scientific Integrity Act, H.R. 1358, 115th Cong. (2017). The former aims to promote open exchange of data and findings. Both have been referred to a relevant committee or subcommittee.

[21] Scientific Integrity Policy, *supra*.

[22] Environmental Protection Agency, *Doing Business with EPA: Quality Specifications for non-EPA Organizations*, http://www.epa.gov/quality/exmural.html (last visited June 21, 2017).

definition of "credible" varies between states. In some states, information is credible if its collection conforms (i) to accepted scientific practice; (ii) to federally recognized standards; or (iii) to state-specific protocols. Iowa law provides an example of a relatively stringent **quality standard** imposed to ensure that the information is credible. To submit water data to the Iowa Department of Natural Resources (DNR), citizen scientists must first submit a "volunteer water quality monitoring plan" for DNR approval. The plan must include a "statement of intent[,]" the names of all participants, the duration of the monitoring effort, the "[l]ocation and frequency of sample collection[,]" the "[m]ethods of data collection and analysis[,]" and "[r]ecord keeping and data reporting procedures."[23] In addition to this, citizen-submitted data must be approved before being considered credible.[24] To be approved, data must be submitted by a "qualified volunteer" who must request that it be deemed credible at the time of submission.[25] "[Q]ualified volunteers must have the training and experience to ensure quality assurance and quality control for the data being produced, or be under direct supervision of a person having such qualifications."[26]

You may want to use the information to bring a lawsuit against a polluter yourself. One mechanism for such a lawsuit is a **citizen suit** under one of the federal environmental laws. Citizen suits are lawsuits that are brought by a private citizen (i) against an individual, corporation, or government body for engaging in conduct prohibited by a statute or (ii) against a government body for failing to perform a duty required by law. Various federal environmental statutes, including the CWA, RCRA, SDWA, the Clean Air Act (CAA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Endangered Species Act (ESA), and the Emergency Planning and Community Right to Know Act (EPCRA), allow private citizens to bring lawsuits against violators.

Various **quality standards** govern citizen lawsuits.[27] First, the quality of the information must be sufficient to bring a claim. Federal courts require that an attorney filing a complaint to initiate a lawsuit must certify "that there is (or likely will be) 'evidentiary support' for [each]

[23] Iowa Admin. Code 567-61.11(455B).

[24] Iowa Admin. Code 567-61.12(455B).

[25] *Id*.

[26] Iowa Admin. Code 567-60.2(455B).

[27] There are a variety of requirements that you must satisfy to successfully bring a citizen suit (*e.g.*, sending a notice letter in advance, establishing that the plaintiff has standing to sue, etc.). Here, our primary topic of interest relates only to the quality of the evidence you will use to support a citizen suit.

allegation, not that the party will prevail with respect to its contention regarding the fact."[28] Generally, requirements in state courts are comparable (*see* Appendices 1 and 2).

Second, when submitting evidence at trial or in support of a motion for summary judgment, you must authenticate that evidence, which requires, among other things, maintaining records establishing the "chain of custody" of the evidence. To satisfy the requirement of authentication in federal courts, "the proponent must produce evidence sufficient to support a finding that the item is what the proponent claims it is."[29] Generally, requirements in state courts are comparable (*see* Appendix 2). You should also note that if you are relying on government-generated information or monitoring reports that the permittee submits to the government, then the information is self-authenticating.

Finally, **quality standards** specifically serve to limit the introduction of "scientific" evidence in trial. It should be noted that some information that you may collect or generate will not be considered scientific (*e.g.*, a picture of an industrial facility that is discharging a pollutant into surface water). In these instances, layperson testimony is sufficient to introduce the information. However, if the information is deemed scientific (*e.g.*, information generated via an interpretation of a data output from a technical instrument), it must be introduced through expert testimony and is subject to stricter quality requirements. This is because scientific evidence is believed to carry greater weight in the minds of jurors than evidence deemed non-scientific. In federal courts, judges use an approach known as the *Daubert* standard to make a preliminary assessment of the quality of the information. In doing so, federal judges consider whether:

> "(a) the expert's scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue; (b) the testimony is based on sufficient facts or data; (c) the testimony is the product of reliable principles and methods; and (d) the expert has reliably applied the principles and methods to the facts of the case."[30]

While judges in many state courts also use the *Daubert* standard when assessing the quality of scientific evidence, others use different standards, although these are generally similar (*see*

[28] Fed. R. Civ. P. 11.

[29] Fed. R. Evid. 901(a).

[30] Fed. R. Evid. 702.

Appendix 2). Importantly, under each standard, the method by which data is collected and interpreted impacts whether the information will be allowed in a trial.

A final point is applicable to multiple uses of the property, but only in certain states. Several states explicitly forbid the use of certain illegally-collected information in court or in administrative decision-making (*see* Appendix 2). Of these, Wyoming most directly implicates citizen science: information collected in violation of the state's data trespass law is not "admissible in any civil, criminal, or administrative proceeding."[31] Moreover, any information fitting this description that is "in the possession of any government entity . . . shall be expunged from all files and databases, and shall not be considered in determining any agency action."[32] Several other states forbid the use of information illegally collected by drones under some circumstances.[33] (*see* Appendix 2)

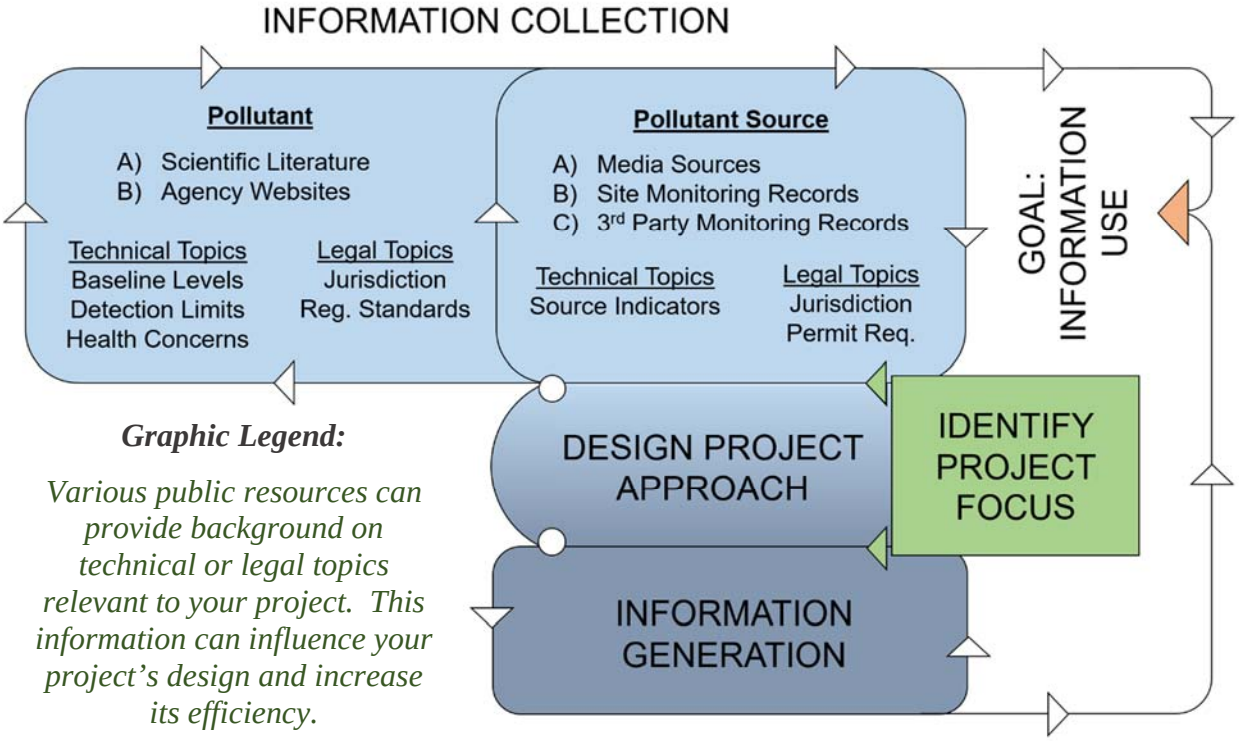
[31] Wyo. Stat. Ann. § 6-3-414(f).

[32] *Id*. § 6-3-414(g).

[33] At the time of writing, these were Nevada, *see* Nev. Rev. Stat. Ann. § 493.112(4); North Carolina, *see* N.C. Gen. Stat. Ann. § 15A-300.1(f); and Vermont, *see* Vt. Stat. Ann. tit. 20, § 4622(e); *see also* Appendix 2.

CHAPTER 3: INFORMATION COLLECTION – GATHERING PUBLICLY AVAILABLE INFORMATION

Why You Should Read this Chapter: Every citizen science project has limited resources (*e.g.*, limited time, finances, volunteer involvement, etc.). You will increase the efficiency of your project by taking time to examine information that already exists (*i.e.*, "**information collection**"). This chapter provides suggestions as to what information, if publicly available, might be of use to your project. In particular, this chapter focuses on the collection of information related to pollutants and pollutant sources. Resources are provided to aid in your search for this information. Because all citizen science projects *should* involve this type of "**information collection**," we anticipate that this chapter will be useful to all citizen science projects, whether just beginning or ongoing.



Introduction

Information collection serves various purposes. It informs and directs the design of your project in both technical and legal ways. It also helps assure that your efforts are not redundant, as there may already be useful information in the public domain. It may lead you to other

individuals who are monitoring the problem that you have identified. Here, we provide examples of information that may be worth collecting.

Importantly, if you feel unable to collect this information, we recommend that you seek out expertise in your community. High school teachers, university professors, scientists, engineers, lawyers, and many other individuals in your community are likely willing and able to help.

Making Connections Between Chapters: In Chapter 1, you identified your **project's focus** and used that focus to identify a **site** of interest to you (*e.g.*, a natural resource or a **pollutant source**) and to determine which pollutant or combination of pollutants will be examined during your project. In Chapter 2, you identified how you hope to use the information that you collect or generate during your project and the type of **quality standards** that might apply.

This chapter's focus is "**information collection**," gathering and analyzing information that is already in the public domain. In some instances, the process of **information collection** alone will provide you with the tools you need to meet your goals. However, many projects will need to supplement the process of **information collection** with **information generation**, which is discussed in Chapter 4 and Chapter 5

Collecting Available Information Concerning a Pollutant

A large amount of information concerning specific pollutants is already available in the public domain. Spending time upfront to research your pollutant(s) of interest will help to assure that you get the most out of your efforts and could also help shield you from potential health risks.

We recommend that you begin your research by addressing the following technical and legal questions:

- Technical Questions Related to Determining the Identity of a Pollutant: Is the pollutant visible, and if so, what does it look like? Can the pollutant be sensed in other ways, such as smell? What health risks are associated with the pollutant? How are potential health

risks manifested (*e.g.*, vomiting, dizziness, skin rash, etc.)? What information is available on the pollutant's material safety data sheet (MSDS) (*e.g.*, health effects, first aid measures, flammability and explosiveness, proper storage and disposal, physical properties, toxicity, and necessary protective equipment)?

- Technical Questions Related to Determining the Source of a Pollutant: What sources are typically associated with the pollutant (*e.g.*, natural sources or human sources such as industrial facilities, landfills, sewage treatment plants, mining operations, etc.)? What is the pollutant's Chemical Abstracts Service (CAS) number (a unique chemical identifier that can help you locate sources of a pollutant and any relevant characteristics)?
- Technical Questions Related to Collecting, Handling, or Storing Samples: What is the stability of the pollutant in the air, water, or soil? Is the pollutant soluble in water? What instruments or methodologies can be used to measure the amount of the pollutant in air, water, or soil? What is the lowest amount of pollutant that is instrumentally or methodologically detectable (*i.e.*, its detection limit)? What are the baseline/background levels of the pollutant (*e.g.*, in some contexts pollutants are ubiquitous, and so detecting a pollution problem involves showing that the level of the pollutant is higher than previously recorded)? What are appropriate safety measures for the handling of the pollutant?
- Legal Questions: Is the pollutant regulated by a federal or state agency (*i.e.*, does a state or federal agency have **jurisdiction** over the pollutant)? If so, what regulations are in place that are specific to the pollutant (*e.g.*, permissible or reportable quantities)?

Various resources exist that can be of aid in answering these or other related questions. Substantial technical and legal information can be found online; however, care should be taken to assure the quality of the references that you rely upon. Generally, peer-reviewed medical or scientific articles are a very good resource to gain technical knowledge; these articles can be found by searching online with Google Scholar (https://scholar.google.com/) or in various public databases (*e.g.*, Web of Science, PubMed, MedlinePlus, etc.) that might be available through a public library.

Federal and state agency websites, such as epa.gov, also contain reliable information. For example, the Substance Registry Services (SRS) is the EPA's "central system for information about substances that are tracked or regulated by EPA or other sources. It is the authoritative resource for basic information about chemicals, biological organisms, and other substances of interest to

EPA and its state and tribal partners."[34] The EPA website also provides links to state health and environmental agencies that play a role in monitoring pollutants.[35]

Finally, federal and state regulations contain information on how pollutants are monitored. These regulations may be very relevant to your project. For example, in many instances regulations will specify pollution quantities, that if exceeded, *must* be reported to a federal or state agency. Various federal regulations that may be relevant to your project are listed in Appendix 3. For many facilities, reporting requirements will also be contained in a permit, a topic discussed in the next section.

*Collecting Available Information Concerning a **Pollutant Source***

A large amount of information concerning specific **pollutant sources** is also already available in the public domain. Investing time in researching the **pollutant source** will help to fine tune your project design and will help you avoid wasting time on the wrong potential **pollutant source**. For example, since news coverage and public records differ based on the individual **pollutant source**, it is crucial to start your research with the correct one. Identifying the correct **pollutant source** will allow you to conduct searches to obtain further information more easily.

Here, we recommend that you begin your research by addressing the following questions: Are there any media reports that involve the **pollutant source**? Are third-party monitoring records available? Is this source monitored by a federal or state agency (*i.e.*, does a state or federal agency have **jurisdiction** over this source) or is the source responsible for self-monitoring and reporting?

A good place to begin researching a **pollutant source** is by reviewing public media releases that might implicate the **pollutant source** with an environmental concern.[36] You should also seek out publicly available monitoring records (*e.g.*, generated by the source, a third party, and/or a government agency) and permit records. Additional public records may include prior inspections

[34] *See* Environmental Protection Agency, *Substance Registry Service*, https://iaspub.epa.gov/sor_internet/registry/substreg/home/overview/home.do (last visited May 1, 2017).

[35] See Environmental Protection Agency, *Health and Environmental Agencies of U.S. States and Territories*, https://www.epa.gov/home/health-and-environmental-agencies-us-states-and-territories (last visited May 1, 2017).

[36] For a resource that will help you locate these information releases, see U.S. ENVIRONMENTAL PROTECTION AGENCY, *Envirofacts*, https://www3.epa.gov/enviro/ (last visited May 1, 2017); *see also* U.S. ENVIRONMENTAL PROTECTION AGENCY, *Toxics Release Inventory (TRI) Program*, https://www.epa.gov/toxics-release-inventory-tri-program (last visited May 1, 2017); U.S. ENVIRONMENTAL PROTECTION AGENCY, *Enforcement and Compliance History Online (ECHO)*, https://echo.epa.gov/ (last visited May 1, 2017).

of the **site** of interest, prior compliance records, or reports submitted to governmental agencies by the **site** of interest. Appendix 4 lists several resources provided by the EPA. Various state agencies also provide similar resources.

Additional information can be obtained through a Freedom of Information Act ("FOIA") request. FOIA requires federal agencies to disclose any records requested by the public unless they fall into one of nine exemptions.[37] These exemptions include information that bears on national security and personal privacy, among other concerns.[38] Before making a FOIA request, you can conduct a search of information already made available by federal agencies at FOIA.gov to see if the information you seek has already been released.[39] If that fails, then you may want to consider filing your own FOIA request.

Submitting a FOIA request does not involve any special forms and does not require any kind of legal expertise. You can simply write a letter to the agency most likely to possess those records detailing the records you would like a copy of. Generally, the more specific your request is, the better; broader requests take considerably longer to process and are more likely to yield irrelevant results. Additionally, some agencies require individuals to submit a fee to cover the cost of record retrieval.[40] Broader requests, which tend to require more work on the agency's part, are likely to be more expensive. For a sample FOIA request letter you can fill out with your specific details, visit the National Freedom of Information Coalition's website.[41] Once you have written your request, you can locate the relevant agency's FOIA request contact information on FOIA.gov.[42]

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[37] U.S. Department of Justice, *What is FOIA?*, FOIA.GOV, https://www.foia.gov/about.html (last visited May 1, 2017); 5 U.S.C. § 552(a)(3)(A), (b).

[38] *Id.*

[39] U.S. Department of Justice, *Search for Released Information*, FOIA.GOV, https://www.foia.gov/about.html (last visited May 1, 2017).

[40] That being said, there are certain provisions that limit fee collection on FOIA requests. The reasonableness of such fees may vary according to whether the information sought is to be used for commercial or noncommercial purposes, with the latter meriting a lesser fee. 5 U.S.C. 552(a)(4)(A)(ii). Fees may also be waived if the information sought is in the public interest. 5 U.S.C. §552(a)(4)(A)(iii). Furthermore, the government agency waives its right to collect fees if it does not respond to the request within 10 days. OPEN GOVERNMENT ACT OF 2007, Pub. L. No. 110-175, §6.

[41] National Freedom of Information Coalition, *Sample FOIA Request Letters*, http://www.nfoic.org/sample-foia-request-letters#foireq (last visited May 1, 2017).

[42] U.S. Department of Justice, *Where to Make a FOIA Request*, FOIA.GOV, https://www.foia.gov/about.html (last visited May 1, 2017).

If the information you seek is more likely to be held by a state agency, then you will want to acquaint yourself with your state's public records law and see if you can make a similar document request. Every state has its own public records laws pertaining to public requests for information from state agencies. While some are very similar to FOIA, others are broader or more limited. To learn more about your state's public records law, you can access the National Freedom of Information Coalition's database of state public records laws.[43] This helpful resource also includes sample FOI request letters by state.[44] As with federal FOIA requests, you will want to make sure that your state records request is as detailed and specific as possible. If you encounter any difficulty in securing a response to your state FOI request, the Freedom of Information Coalition and its affiliates have offices in every state that you can contact for advice and assistance.[45]

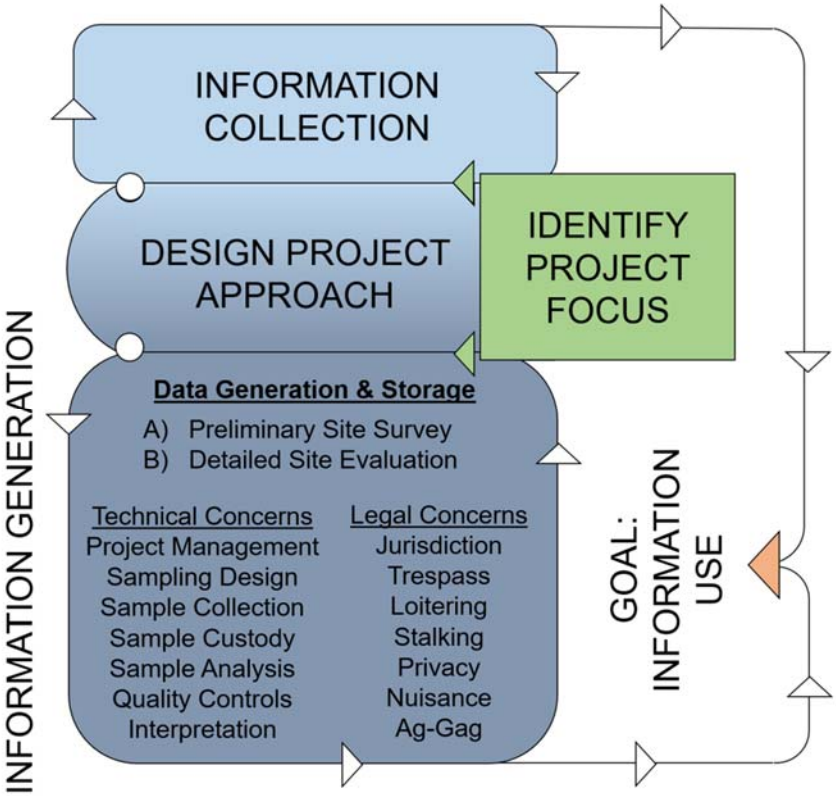
[43] National Freedom of Information Coalition, *State Freedom of Information Laws*, http://www.nfoic.org/state-freedom-of-information-laws (last visited May 1, 2017).

[44] National Freedom of Information Coalition, *State Sample FOI Request Letters*, http://www.nfoic.org/state-sample-foia-request-letters (last visited May 1, 2017).

[45] National Freedom of Information Coalition, *NFOIC State and Regional Affiliates*, http://www.nfoic.org/members (last visited May 1, 2017).

CHAPTER 4: INFORMATION COLLECTION – BEWARE POTENTIAL LIABILITY

Why You Should Read this Chapter: While most citizen science projects will not implicate legal concerns, there are nonetheless various laws that can limit your ability to gather information. This chapter gives an overview of these laws and provides suggestions on how to remain in compliance with them. It also notes areas where you may have a legal privilege to engage in certain activity, so that you can respond proactively. The content of this chapter is supplemented by Appendices 1 and 2, which provide a state-by-state analysis of the laws discussed.



Graphic Legend:

*Before you begin collecting samples from your project's site of interest, you should arm yourself with knowledge of legal issues that might be relevant to the design of your **information collection** strategy. A primary concern is property ownership. Verifying property ownership will help you avoid trespass, for example.*

Introduction

In most instances, we anticipate that you will not encounter legal difficulties in conducting research for your citizen science project. Your project's **site** of interest (which you identified as part of your **project approach** in Chapter 1) may be open to all citizens – meaning there are no legal barriers in collecting samples of air, water, and/or soil quality, or taking photographs. Many

federal and state agencies have issued guidelines that are favorable to the practice of citizen science. In sum, you should not let the fear of legal troubles deter you from pursuing your project. But, you should be aware of the laws that might apply to your project.

Legal topics covered in this chapter include:

1) *Trespass*
2) *Loitering*
3) *Stalking*
4) *Privacy*
5) *Drone use*
6) *Agency regulations*

This chapter outlines the various legal claims that have been asserted (rightly or wrongly) against citizen scientists. It aims to arm you with some general knowledge, including things you are well within your rights to do as well as things you should avoid doing. Should you encounter a legal threat in the course of your project, our hope is that you will be able to figure out whether that threat is real or mere puffery, allowing you to take full advantage of your legal rights. Because many types of potential liability relate to actions you might take on private property, we begin by discussing property ownership.

Making Connections Between Chapters: In Chapter 1, you identified your **project's focus** and used that focus to design your project's approach, which included the identification of a site of interest to you (*e.g.*, a natural resource or a pollutant source). In Chapter 3, you collected publicly available information on any pollutant sources relevant to your project.

This chapter provides resources for you to extend this previous work, helping you to determine or verify property ownership of land on and surrounding your project site (*e.g.*, where you will collect samples). It then gives an overview of legal issues relevant to your sample collection design. This information can guide the scope of your **information generation** strategy (discussed in Chapter 5).

Property Ownership: Who owns the land where you want to gather information or collect samples?

In addition to securing any publicly available records that are relevant your project goals (discussed in Chapter 3), you should take steps to learn about ownership of the land where your project **site** is located, as well as the land surrounding it. One way to determine the ownership status of your project's **site** of interest is to use Geographic Information System (GIS) maps. GIS maps layer data over geography, allowing interactive visualization of geographic information on the map.[46] Many GIS maps display property lines and ownership information.[47]

A related resource is your local assessor's office, which maintains a public database of local property ownership. You can submit a request to your assessor's office to determine a given parcel's ownership information so long as you have the property's parcel number (oftentimes, this parcel number can be found using GIS maps). Note that many offices provide this information online – meaning you do not have to go in person to find certain information or submit a request for further information.

Property ownership determines whether you may access a property and whether you may collect samples, photos or other information.

Property ownership determines whether you may access a property and whether you may collect samples, photos, or other information. For example, strict trespass and privacy laws apply to private property. Public property is managed by various government agencies that have their own special rules about who can access the land and for what purposes. Public lands can be roughly split into the following categories:

- *Federal Land*: Land owned by the federal government is managed either by the Department of the Interior or by the Department of Agriculture's Forest Service.[48] Within the Department of the Interior, the Bureau of Land Management is tasked with overseeing the majority of the federal government's on-shore landholdings,

[46] *See What is Geographic Information Systems (GIS)?*, GIS Geography, http://gisgeography.com/what-gis-geographic-information-systems/ (last visited May 1, 2017).

[47] *See, e.g.*, *Mass. Interactive Property Map*, Mass. Exec. Office of Admin. and Finance, http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/online-mapping/massgis-par-vwr.html (last visited May 1, 2017) (GIS map of property in Massachusetts); *Tennessee Property Viewer*, State of Tenn., http://tnmap.tn.gov/assessment/ (last visited May 1, 2017) (GIS map of property in Tennessee).

[48] Congressional Research Service, *Federal Land Ownership: Overview and Data*, https://fas.org/sgp/crs/misc/R42346.pdf (last visited June 21, 2017).

which add up to about 1/8 of the nation's land.[49] These federal landholdings are especially concentrated in western states; 48.4% of Montana, for example, is federally-owned land.[50]

- *State Land*: Each state has its own land-holding agencies that oversee the use of state-owned property. These generally include a state-wide Parks Department and a Department of Natural Resources. A great deal of state-held land – about 3/4 – is in the form of trust lands—lands held by the state to benefit specific public purposes, most commonly to support public schools.[51] While some of these trust lands are commercially leased and unavailable to the public, in many cases they are open to public access. You should check with the state's Department of Natural Resources or Parks Department to see what activities are permitted in state parks and trust lands.
- *Local/Municipal Land*: A lot of public property is also managed at the local or municipal level. Municipalities can own and rent land within city limits.[52] Many local parks, cemeteries, and waterways are subject to local ownership and control.[53] Generally, a municipality's Parks & Recreation Department or Water Department will have authority to administer such lands—and control access.
- *Maritime Territory*: Management of the oceans is split between the state and federal governments. The first three miles from the coast are considered state property and are managed by the states.[54] The next nine miles are U.S. territorial waters that are managed by the federal government. Different federal agencies are responsible for regulating particular types of activities in federal waters. The Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE), both part of

[49] Bureau of Land Management, *Public Land Statistics*, https://www.blm.gov/public_land_statistics/ (last visited June 21, 2017).

[50] *Supra* note 49 at 9.

[51] *See* Steven M. Davis, *Preservation, Resource Extraction, and Recreation on Public Lands: A View from the States*, 48 Nat. Resources J. 303, 306 (2008).

[52] Municipal Association of South Carolina, *Forms and Powers of Municipal Government*, https://www.masc.sc/SiteCollectionDocuments/Administration/Forms%20and%20Powers2.pdf (last visited May 1, 2017)

[53] *Id.*

[54] While most state managed waters only extend out to three miles beyond the shore, Texas and the Gulf Coast of Florida extend to nine miles. *See* NOAA GENERAL COUNSEL, *Maritime Zones and Boundaries* (last visited May 1, 2017), http://www.gc.noaa.gov/gcil_maritime.html.

the Department of the Interior, manage offshore energy exploration and development.[55] The National Marine Fisheries Service regulates fisheries and is responsible for the stewardship of marine protected species. The EPA has general authority over pollution discharges not associated with energy development and minerals (which would fall under BOEM/BSEE's purview). The Coast Guard is the primary law enforcement authority in these waters.

Knowing the property lines and ownership status of properties you want to access is an important first step when it comes to determining what you are allowed to do on the property. Knowing who owns the property on which you want to conduct research may have another benefit: in many cases, reaching out to the property owner or managing agency ahead of time to see if you can conduct your citizen science project on their land will resolve any disputes at the outset. For example, you can avoid the risk of trespass liability if you have already received permission from the property owner to conduct research on his or her land.

Potential Legal Challenges

In this subsection, we identify categories of laws that restrict access to land. Appendices 1 and 2 provide a 50-state survey of the laws discussed in this chapter. Neither this subsection nor the appendices provides complete and detailed answers about the applicable laws in any given state; instead, they are intended to give you a broad overview of the applicable laws. We encourage you to use the tools at your disposal, such as local libraries and the Internet, to conduct further research about the local laws where you live. Laws change and evolve; please remember that the resources in this manual do not constitute legal advice, and that you should seek representation should you encounter any legal issues.

[55] Bureau of Safety and Environmental Enforcement, *Agency Roles*, (last visited May 1, 2017), https://www.bsee.gov/site-page/decommissioning-0.

1. Trespass

Summary: You commit a trespass only when you go on someone else's land without the owner's permission. If you stay on public or private lands where you have permission to be, then trespass laws will not be a problem for your research. If you need to take samples on private land or cross private land to get to your sampling location, then you can seek permission from the property owner. Otherwise, you will generally be safe if you avoid areas that are marked off by fences or "no trespassing" signs. In a few states (indicated in this subsection), you need to use GIS maps to identify property boundaries and therefore avoid accidentally crossing onto someone's property. Additionally, a few states have specialized laws that punish trespass and even photography around industrial and agricultural sites. You will want to be aware of whether your state has such a law. For the most part, you can avoid trouble under these laws by not entering any clearly off-limits sites – the same advice as with trespass generally. Nonetheless, it would be wise to utilize GIS maps and to be aware of property lines when conducting research around such a facility.

Broadly defined, a trespasser is someone who physically enters or remains on another person's property without that person's consent.[56] Liability for trespass generally takes two forms: criminal (prosecution by the government) and civil (private lawsuits). In addition, certain states impose heightened liability for trespass—or even taking photographs—around industrial or agricultural facilities.

a. General Criminal and Civil Trespass

Every state has its own criminal trespass statute. If you are interested in learning more about your state's criminal trespass statute, you can begin by locating your state's criminal code online.[57] These statutes generally define trespass as unauthorized entry onto someone else's land. Beyond that basic definition, many states have varying degrees of criminal trespass, meaning that

[56] *Cf.* RESTATEMENT (2ND) OF TORTS §329.

[57] Cornell University's Legal Information Institute has compiled each state's criminal code at https://www.law.cornell.edu/wex/table_criminal_code (last visited May 1, 2017). Upon locating your state's criminal code, you can follow the hyperlink to its criminal trespass laws in the table of contents.

certain forms of trespass may be punished more severely than others. In Alabama, for example, first degree criminal trespass occurs when a person knowingly enters someone else's home without permission;[58] second degree trespass occurs when a person crosses, without authorization, onto private land that is fenced off or otherwise bears markers of private property.[59]

The role of notice varies among state criminal trespass statutes. Most states require that, to be guilty of criminal trespass, an individual must have had notice that he or she was entering private property without authorization (*e.g.*, a "no trespassing" sign or a fenced off area). Eight states, however, do not require notice: ***Colorado, Delaware, Hawaii, Kentucky, Missouri, Tennessee, Wisconsin, and Wyoming***. In these states, trespass is an absolute liability crime – meaning that being unaware that you were not supposed to be on the property in question is not a valid defense in these instances.[60] If you are conducting your project in one of these states, you should carefully scrutinize current GIS maps and property records before entering your project's **site** of interest.[61] In other states, common sense should suffice: avoid entering fenced or marked-off areas without permission.

In addition to criminal statutes, every state also allows landowners to bring civil lawsuits for trespass. These are generally governed by common law – meaning there is no statute to look at when determining what constitutes civil trespass; the law is developed by judges in their decisions. Many judges define it in the same way as criminal trespass: voluntary entry onto someone else's property without consent or authorization.[62] Ultimately, this means that you may be liable for any damage you cause to someone else's property while conducting research on that property. Moreover, even if no quantifiable damage is done, many courts will allow the property owner to recover nominal damages for the very fact of the trespass.[63] However, these nominal damages are typically very small.

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[58] ALA. STAT. 13A-7-2.

[59] ALA. STAT. 13A-7-3.

[60] *Cf. State v. Hunt*, 630 S.W.2d 211 (Mo. App. 1982).

[61] For further information on what these informational tools are and how to access them, *see* Chapter 3.

[62] Restatement (Second) of Torts §158.

[63] *See Foust v. Kinney*, 80 So. 474, 475 (Ala. 1918); *see also Brown Jug, Inc. v. Int'l Brotherhood of Teamsters, Chauffeurs, Warehousemen & Helpers of Amer.*, 688 P.2d 932, 939 (Alaska 1984); *Hale v. Brown*, 323 P.2d 955, 963 (Ariz. 1958) (It is a "well-established and deeply-rooted legal principle that a person has the right to vindicate any trespass upon his legal rights . . . for at least nominal damages.").

b. Specialized Trespass Statutes: Industrial Trespass and Ag-gag Laws

In addition to basic trespass liability, some states treat it more seriously when someone trespasses on certain industrial or agricultural facilities. Industrial trespass laws impose heightened liability for trespass on "critical infrastructure." This term often encompasses various **sites** that may be of interest to citizen scientists (*e.g.*, power plants and factories).[64] If your project has identified such a facility as its **site** of interest, you will want to take extra care to identify whether your state has an industrial trespass statute. For this, you can refer to the comprehensive state spreadsheet in Appendices 1 and 2 but recognize that the laws change so you will need to double-check the current accuracy of the spreadsheet before you rely on it. On a positive note, states laws that have heightened criminal sanctions for trespass on critical infrastructure typically include a notice requirement, meaning liability for trespass occurs when someone has (i) crossed a fence or passed a "no trespassing" sign to get to a sample collection **site** or (ii) received personal notice to leave the premises from the property owner and refused to leave. Therefore, in those states, you will not be liable for industrial trespass as long as those situations do not apply to you.

Many states also have specialized statutes that address trespass on and monitoring of agricultural facilities, colloquially known as "ag-gag laws." At the time of writing, 24 states had such laws. Ag-gag laws are compiled in the spreadsheet in Appendices 1 and 2. These statutes tend to have the same basic elements: an alleged trespasser entered or remained on an agricultural facility (i) without effective consent, (ii) intending to disrupt or damage the enterprise conducted at the animal facility, and (iii) had notice that entry was forbidden or received notice to depart and did not. Some also include a separate legal claim for taking photos or videos of such a facility with the intent of damaging its enterprise (*e.g.*, by publishing damning information about it).[65] In summary, when seeking to monitor an agricultural facility, you should check to see if your state has an applicable ag-gag law.

Wyoming is currently unique in that it has a trespass law that specifically targets citizen scientists.[66] This statute creates a new criminal offense called "trespassing to unlawfully collect

[64] *See*, *e.g.*, Texas Penal Code §30.05.

[65] *See*, *e.g.*, Kan. Stat. Ann. §47-1827.

[66] Wyo. Stat. §6-3-414

resource data."[67] The offense is defined as trespassing on private property for the purpose of collecting "data relating to land or land use, including but not limited to data regarding agriculture, minerals, geology, history, cultural artifacts, archeology, air, water, soil, conservation, habitat, vegetation or animal species."[68] The statute is triggered either by collecting resource data on private land or by crossing private land to collect resource data on public land. A violation of this statute triggers enhanced penalties, compared to ordinary trespass. For a first offense, the punishment is up to one year in prison plus a fine of up to $1,000; the maximum fine is increased to $5,000 for repeat offenders.[69] A related statute allows property owners to bring a civil damages action against trespassers.[70] Someone can be liable under both the criminal and the civil statutes even if the private property boundaries are unmarked.

A number of environmental groups have challenged this law in court, arguing that it violates their free speech rights under First Amendment of the U.S. Constitution. A federal appeals court found that subsection (c) of the statute, which defines the prohibited conduct to include crossing private property in order to collect resource data on nearby public lands, implicates protected speech. The court therefore sent the case back to the trial court to determine whether this impact on protected speech violated the Constitution.[71] This decision leaves in place, however, the portions of the law that provide enhanced penalties for trespassing for the purpose of collecting resource data on private property.

Citizen scientists in Wyoming should be especially careful about identifying private property boundaries, particularly because these are often unmarked. One way to accomplish this is by using GIS maps and public records to identify the ownership and property lines in any locations where you want to take samples and along your routes to reach those **sites**. If you are conducting your project on public property, then you will want to check the relevant agency's regulations and guidelines to see what type of activity is allowed on that land. For more information on how to do this, see Chapter 2.

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[67] *Id.*
[68] *Id.*
[69] *Id.*
[70] Wyo. Stat. § 40-27-101(d).
[71] *W. Watersheds Project v. Michael*, No. 16-8083, 2017 WL 3908875 (10th Cir. Sept. 7, 2017).

Citizen scientists in Wyoming should be especially careful about identifying private property boundaries, particularly because these are often unmarked. One way to accomplish this is by using GIS maps and public records to identify the ownership and property lines in any locations where you want to take samples and along your routes to reach those **sites**. If you are conducting your project on public property, then you will want to check the relevant agency's regulations and guidelines to see what type of activity is allowed on that land. For more information on how to do this, see Chapter 2.

2. Loitering

Summary: Loitering laws are generally written by local governments rather than states, so it is not possible for us to compile all of the potentially relevant laws. In general, however, you cannot be liable for loitering just because you are hanging around a public place. Courts have held that such "pure" loitering laws are unconstitutional. Instead, loitering laws are typically constitutional only when they target loitering in connection with some otherwise illegal activity. This means that if you follow the suggestions given with respect to the other laws discussed in this chapter, you will likely avoid the possibility of loitering liability. And, you can inform anyone who threatens you with loitering that your conduct is protected.

Loitering is a second offense potentially relevant to your citizen science project. Defined broadly, loitering means hanging around a public place or business without an apparent legal purpose.[72] Generally, loitering laws are established at the local or municipal level. Thus, you will want to check your local area's anti-loitering provisions before spending time around your identified project **site**. At least one state, California, includes loitering within its criminal trespass laws. California's industrial trespass statute provides that "it is unlawful to loiter in the immediate vicinity of any posted property."[73] While this statute does not separately define "loitering," another part of the California criminal code defines the term as "to delay or linger without a lawful

[72] *See* The Free Legal Dictionary, *Loitering*, http://legal-dictionary.thefreedictionary.com/loiter (last visited May 1, 2017).

[73] Cal. Penal Code § 555.2.

purpose for being on the property and for the purpose of committing a crime as opportunity may be discovered."[74] This definition limits liability to instances when the person is lying in wait to commit a separately criminalized offense.

The U.S. Supreme Court has invalidated loitering laws that do not include a separate, objective element of criminal behavior (*e.g.*, criminal and specialized trespass, etc.).[75] This undermines the validity of any criminal loitering statute that simply criminalizes loitering in and of itself.[76] As a result, your potential liability for loitering is likely low if you are not also breaking a separate *criminal* law. You should feel comfortable taking advantage of this aspect of loitering laws: if someone accuses you of loitering when you are otherwise participating in perfectly innocent activity, then you can respond by saying that whatever loitering law they are referring to is not likely to include your conduct.

Summary: Generally, it is a good practice to maintain a comfortable distance from and to avoid repeated contact with the same individuals in the course of your research (unless they have invited the contact or interaction!). You should especially avoid photographing or filming the same individuals on a recurring basis, which might be interpreted as harassing behavior.

You should also review relevant state stalking laws to determine the point at which conduct is considered stalking and whether "stalking" requires general or specific intent. Typically, stalking laws that require "specific intent" will not apply to your role as a citizen scientist. If the stalking laws relevant to your project's site of interest require "general intent," you might consider letting the local community know about your project ahead of time to eliminate any cause for alarm.

[74] Cal. Penal Code §§ 647(h), 653.20(c).

[75] *See generally Papachristou v. City of Jacksonville*, 405 U.S. 156 (1972); *City of Chicago v. Morales*, 527 U.S. 41, 41-45 (1999).

[76] *See* Note, *Striking a Balance: The Efforts of One Massachusetts City to Draft an Effective Anti-Loitering Law Within the Bounds of the Constitution*, 39 Suffolk U. L. Rev. 1069, 1081 (2006); Kim Strosnider, Note, *Anti-Gang Ordinances After City of Chicago v. Morales: The Intersection of Race, Vagueness Doctrine, and Equal Protection in the Criminal Law*, 39 Am. Crim. L. Rev. 101, 126 (2002).

3. Stalking

If your project involves recurring interaction with or surveillance of the same individuals (*e.g.*, photographing or video recording), you will want to familiarize yourself with your state's stalking laws.[77] Generally, you can avoid stalking liability if you space your research out temporally and if you avoid repeated contact with the same individuals (unless they have invited the contact or interaction).

Every state has a criminal anti-stalking statute (*see* Appendices 1 and 2 for specific references to each state).[78] States tend to define stalking as repeated and willful following of another person, often paired with some malevolent purpose or action, such as threatening or harassing behavior.[79] A person violates California's anti-stalking law, for example, if he or she "willfully, maliciously, and repeatedly follows or harasses another person and makes a credible threat with the intent to place that person in reasonable fear of death or great bodily harm or to place that person in reasonable fear of the death of or great bodily injury of his or her immediate family."[80]

While state anti-stalking statutes are similar in some respects, they can differ in a few key ways. One difference relates to the point at which conduct is considered sufficiently repetitive and continuous to be considered stalking. For example, Arkansas's statute requires "a pattern of conduct composed of two (2) or more acts separated by at least thirty-six (36) hours but occurring within one year."[81] Other states require conduct that is more repetitive and continuous. For example, Alabama requires "a series of acts over a period of time which evidences a continuity of

[77] As with criminal trespass laws, stalking laws are often classified into varying degrees. Generally, higher degree stalking crimes include the issuance of credible threats, repeated convictions, contact in violation of a restraining order, stalking of a minor, and harassment on the basis of sex, race, religion, or sexual orientation. Because your behavior as a citizen scientist will not likely encompass any of these aggravating factors, this subsection and Appendices 1 and 2 focuses on lower degree stalking violations.

[78] *See* Kathleen G. McAnaney, Laura A. Curliss & C. Elizabeth Abeyta-Price, Note, *From Imprudence to Crime: Anti-Stalking Laws*, 68 Notre Dame L. Rev. 819, 821 (1993).

[79] *Id.*

[80] Cal. Penal Code § 646.9.

[81] Ark. Code Ann. § 5-71-229(f)(1)(A).

purpose."[82] Louisiana also requires a "series of acts" for the conduct to rise to the level of stalking.[83]

State stalking laws also differ in whether they require general or specific intent. For stalking laws requiring specific intent, you are only guilty of stalking if you intended to harass or threaten the person alleging the violation; for those requiring general intent, you can be guilty of stalking even if you did not intend to harass the person(s) alleging that you stalked them.

If the relevant state defines stalking as a specific intent crime, it is unlikely that your work as a citizen scientist will expose you to liability for stalking because the purpose of your activity is to conduct research, not to harass anyone.

If the relevant state defines stalking as a general intent crime, however, then you may want to take the extra step of notifying anyone residing on or near the property on which you want to conduct research. You might, for example, post flyers in the neighborhood notifying individuals that you are conducting a citizen science project. If people understand what you are doing in or around their neighborhood, then they should not have reason to be threatened by your presence. It might also mobilize the local community around your citizen science project, in keeping with the spirit of citizen science.

While stalking is generally a crime, thirteen states—Arkansas, California, Kentucky, Michigan, Nebraska, Oregon, Rhode Island, South Dakota, Tennessee, Texas, Virginia, Washington, and Wyoming—also allow civil lawsuits for stalking,[84] so that individuals may recover damages for the emotional distress they experience. As with the criminal stalking laws, these are included in Appendices 1 and 2.

[82] Ala. Code. § 13A-6-92 (1975).

[83] La. Rev. Stat. 14:40.2 (2015).

[84] STALKING RESOURCE CENTER, *Civil Stalking Laws by State*, https://victimsofcrime.org/our-programs/stalking-resource-center/stalking-laws/civil-stalking-laws-by-state (last visited May 1, 2017).

4. Invasion of Privacy

Summary: Privacy laws are relevant when you are working in or around residential areas. If this is true of your project, you should try to notify area residents of your project ahead of time to ease any apprehension they may otherwise feel about your presence. You should also avoid taking and, in particular, publishing photos or videos of people in their homes.

Repeated contact with the same individual(s), especially involving photographing or video recording, may constitute an invasion of privacy. Privacy claims are only available to individual persons and not corporate entities.[85]

There are four basic kinds of legal causes of action for invasion of privacy: (i) unauthorized use of name or likeness; (ii) public disclosure of private matters; (iii) publicity placing one in a highly offensive false light; and (iv) intrusion upon private affairs.[86] Intrusion upon private affairs occurs when someone intentionally intrudes, physically or otherwise, upon another's solitude or private affairs in a manner that would be offensive to a reasonable person.[87] This could occur when the person alleging the intrusion was at his or her own home or yard when another is taking photographs of him/her; one who enters public space cannot reasonably expect a great degree of privacy.[88]

[85] *Id.*; *see also Ion Equipment Corp. v. Nelson*, 110 Cal. App. 3d 868, 879 (Cal. App. 1980).

[86] VINCENT R. JOHNSON, ADVANCED TORT LAW: A PROBLEM APPROACH 312 (1st ed. 2010).

[87] Restatement (Second) of Torts § 652(B).

[88] Phillip Hassman, *Taking Unauthorized Photographs as Invasion of Privacy*, 86 A.L.R. 3d 374; *see also Truxes v Kenco Enterprises, Inc.* 119 N.W.2d 914 (S.D. 1963) (post office worker's invasion of privacy claim for an unauthorized photo taken of him while at work failed due to his place of employment not being a private space).

In general, you can go a long way in avoiding claims of intrusion upon private affairs if you (i) do not enter people's private space and (ii) exercise caution when taking pictures or videos around people's homes or publishing those pictures or videos.[89] If your work occurs near private residences and entails visual evidence, make sure that any materials you publish do not include images of persons within those residences. Taking photographs of individuals who are standing outside on their own property, so long as the photographer does not enter the private property, is not considered an invasion of privacy because the conduct is clearly visible to passersby and is therefore effectively public conduct.[90] It can be worthwhile to notify any community members around whom you are working of your project's goal and scope. Let people know why you are working near their properties, and they will have less reason to feel that you are intentionally intruding upon their privacy.

Summary: Drones may be subject to three different kinds of law: state drone statutes, Federal Aviation Administration (FAA) regulations, and common law. Because state drone law is still developing, you should routinely check state laws. In addition, you should always comply with FAA regulations by appropriately registering your drone. Moreover, you should be careful about using drone photography, as certain states have passed laws criminalizing drone footage of industrial facilities. Finally, drone footage of people in their private residences is also likely forbidden in your state, either by statute or common law.

5. Drone Laws

Drones, or unmanned aircraft systems ("UAS"), are an increasingly popular tool for environmental data collection. UAS have been used for, among other things, identifying the trajectory of an oil spill, tracking toxic algae blooms, measuring water temperature, detecting air contaminants, producing high resolution aerial surveys, and taking water samples. Lawmakers are just beginning to respond to UAS use. As such, the current body of law related to drone use is still developing. It is very likely that some of the information contained in this section, especially the status of state drone legislation, may have changed by the time you read this manual. Therefore,

[89] *See* Hassman, note 29.

[90] *Swerdlich v. Koch*, 721 A.2d 849, 857 (R.I. 1998); *see Sundheim v. Board of County Comm'nrs*, 904 P.2d 1337, 1351 (Colo. App. 1995).

you should be careful to double check the status of drone laws in the state(s) where you are conducting citizen science.

Currently, drone usage is governed by (i) federal law, (ii) state statutes, and (iii) state common law. The following subsections cover each of these categories in turn.

a. Federal Law

The FAA has statutory authority to regulate airspace to the extent necessary to maintain its safety.[91] Drones are considered to be "aircraft" and as such are subject to federal regulation. The treatment of small drones (those weighing less than 55 pounds) varies, depending upon whether they are being used for commercial or recreational purposes. As long as the person operating the drone for a citizen science project is not being paid to do so, citizen scientist use of drones probably falls on the "recreational" side of this dichotomy.[92]

Recreational use of small drones is governed by the Special Rule for Model Aircraft, which Congress adopted as part of the FAA Modernization and Reform Act of 2012.[93] The Special Rule requires that UAS operators follow a community-based set of safety guidelines; fly the UAS within visual line-of-sight; give way to manned aircraft; and provide prior notification to the airport and air traffic control tower, if one is present, when flying within 5 miles of an airport.[94] Operators who comply with the Special Rule do not need to get pre-approval from the FAA or a Remote Pilot Certificate.[95] The FAA has also required that operators who seek to use UAS pursuant to the

[91] The use of small drones, defined as those weighing fewer than 55 pounds, is governed by 14 C.F.R. pt. 107. While small drones do not need to undergo the extensive airworthiness certification requirements imposed on larger aircrafts, they are still subject to many of the same rules. Drones weighing more than 55 pounds will need to undergo the airworthiness exemption process outlined in Section 333 of the FAA Modernization and Reform Act of 2012. *See* FAA, *Waivers to Certain Small UAS Operating Rules*, https://www.faa.gov/uas/beyond_the_basics/ (last visited May 1, 2017).

[92] Commercial use of drones is governed by the "Part 107" rules. *See* 14 CFR Part 107. Under these rules, an operator must obtain a Remote Pilot Certificate or be under the direct supervision of someone who holds such a certificate, register the UAS with the FAA, and adhere to a set of operating rules, including: (1) fly within Class G airspace; (2) keep aircraft in visual line-of-sight; (3) fly under 400 ft.; (4) fly during the day; (5) fly at or below 100 mph; (6) yield right of way to manned aircraft; (7) not fly over people; and (8) not fly from a moving vehicle. *See* FAA, *Fly for Work/Business*, https://www.faa.gov/uas/getting_started/fly_for_work_business/ (last visited Apr. 24, 2017).

[93] Pub. L. No. 112–95, § 336, 126 Stat. 11, 77 (2012) (codified at 49 U.S.C. § 40101 note).

[94] *Id.* § 336(a).

[95] *See* "Fly for Fun," U.S. Department of Transportation: Federal Aviation Administration (last visited Apr. 16, 2017), available at https://www.faa.gov/uas/getting_started/fly_for_fun/.

Special Rule register their UAS with the agency, but a federal court recently struck down that requirement.[96]

Because the FAA is primarily tasked with enforcing the safety of public airways, federal law does not touch upon issues of privacy implicated by drone use.[97] The federal government has instead left this area of lawmaking to individual states. Once you have verified that your drone complies with the relevant federal laws and regulations, you should determine whether your state has passed any drone privacy laws.

b. State Statutes - Drone Privacy Laws

Many states have begun to pass statutes pertaining to drone usage and privacy. To date, 16 states impose criminal liability for unlawful drone usage, including the unauthorized surveillance of individuals and certain types of industrial facilities. For an overview of these states, including their specific language, *see* Appendices 1 and 2. Importantly, these laws apply to drone photography rather than ordinary handheld photography. In most instances, taking pictures and video on your own, without drone assistance, will be less susceptible to legal challenges.

The most common and potentially problematic drone privacy statutes prohibit the use of a drone to surveil the operations of critical infrastructure. Arizona, Arkansas, Delaware, Louisiana, Nevada, Oregon, Oklahoma, Tennessee, and Texas each have such a law. Arkansas's law provides that:

> "A person commits the offense of unlawful use of an unmanned aircraft system if he or she knowingly uses an unmanned aircraft system to conduct surveillance of, gather evidence or collect information about, or photographically or electronically record critical infrastructure without the prior written consent of the owner of the critical infrastructure."[98]

While the definition of critical infrastructure varies by state, it generally includes power plants and factories. If the target **site** of your project fits this description, you will generally want to avoid the use of a drone to take pictures or video of that **site**.

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[96] *Taylor v. Huerta*, 856 F.3d 1089 (D.C. Cir. 2017).

[97] Patrice Hendriksen, Note, *Unmanned and Unchecked: Confronting the Unmanned Aircraft System Privacy Threat Through Interagency Coordination*, 82 Geo. Wash. L. Rev. 207, 228-38 (2013).

[98] Ark. Code Ann. § 5-60-103(b).

Some drone privacy laws contain exceptions. The Arkansas statute excerpted above, for example, provides an exception for "[a]n unmanned aircraft system used under a certificate of authorization issued by the Federal Aviation Administration."[99] Certificates of authorization, however, are available only to public operators of UAS (e.g. state or local governments).[100] A few states, including Louisiana[101] and Texas,[102] have exceptions for UAS that are flown by universities for research or educational purposes.

Some drone privacy statutes only impose liability for drone surveillance in furtherance of a criminal offense. Arizona's for example, states that "[i]t is unlawful for a person to operate or use an unmanned aircraft or unmanned aircraft system to intentionally photograph or loiter over or near a critical facility in the furtherance of any criminal offense."[103] Thus, this statute is presumably inapplicable to drone usage around critical infrastructure in Arizona so long as the conduct does not further a criminal offense, such as trespass. There is not yet any court interpretation of the law, however.

In summary, you should ascertain whether your state has passed a drone privacy law before using a drone for surveillance. Indeed, it may be worth considering alternative ways of gathering the information you seek.

c. Common Law Causes of Action

Even when states have not adopted drone privacy laws, civil common law causes of action against drone use may apply. These include nuisance, trespass, and privacy.

i. Nuisance

[99] Ark. Code Ann. § 5-60-103(a)(2)(B)(v).

[100] *See* FAA, *Certificates of Waiver or Authorization (COA)*, https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/systemops/aaim/organizations/uas/coa/ (last visited June 19, 2017).

[101] La. Stat. Ann. § 14:337(D)(2).

[102] Tex. Gov't Code Ann. § 423.002(a)(1).

[103] Ariz. Rev. Stat. Ann. § 13-3729(B).

A private nuisance claim is typically brought when a landowner's quiet enjoyment of his or her land is disturbed.[104] To succeed on a nuisance claim, a plaintiff must prove: (i) substantial harm; and (ii) that the imposition of the harm is unreasonable.[105]

To date, we are not aware of any cases in which a plaintiff has brought a common law nuisance claim against a drone operator; however, plaintiffs have brought common law nuisance claims and succeeded against airplane operators.[106] Most of these claims have depended on factors like dust production, noise, vibration, and flight frequency.[107] While each of these factors would likely be considered in the context of a nuisance claim brought against a drone operator, they are arguably less applicable to drones than to airplanes. After all, drones produce significantly less dust, noise, and vibrations than airplanes.

There are various steps you can take to avoid claims of nuisance. For example, you can avoid flying your drone over the same space with great frequency. In addition, you can determine whether the noise emitted by your drone exceeds your locality's noise ordinances, which often outline acceptable levels of noise by property type and time of day. Many localities make this information available online.[108]

ii. Trespass

Operating a drone over someone's private airspace may also constitute common law trespass. This is less likely than in the case of physical, ground-level trespass because ownership of airspace above a property is not as clearly established. Landowners own as much space above the ground as can be *reasonably* used in connection with the land.[109] What constitutes *reasonable* use of this airspace remains uncertain; however, one thing is clear: a person's ownership of airspace above a property is not infinite. At some point, the airspace is in the public domain.

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[104] Restatement (Second) of Torts §821D.

[105] *Id.*

[106] *See* Michelle Bolos, *A Highway in the Sky: A Look at Land Use Issues that will Arise with the Integration of Drone Technology*, 2015 U. Ill. J.L. Tech. & Pol'y 411, 422 (2015).

[107] *See* Jack L. Litwin, *Airport Operations or Flight of Aircraft as Nuisance*, 79 A.L.R.3d 253 (1977).

[108] *See, e.g.*, Noise Control Ordinance of the City of Cambridge, available at http://www.tomstohlman.org/2009ElectionBlog/wp-content/uploads/2009/10/2009-Cambridge-Noise-Ordinance.pdf (last visited May 1, 2017).

[109] *United States v. Causby*, 328 U.S. 256, 264 (1945).

Ultimately, the higher you fly your drone, the less likely you are to commit a trespass.[110] Recall, however, that federal law includes both implicit and explicit height limitations for drone operators—recreational users under the Special Rule must maintain a direct line of sight to the drone and commercial users under the Part 107 rules must operate the drone below 400 feet.

ii. Privacy

A final type of claim worth mentioning in relation to drone use is common law privacy, which has already been covered in this chapter. Many of the suggestions relating to privacy that were previously given are equally applicable in the context of drone use: avoid flying your drone near private residences; try to maintain a healthy distance and keep flight frequency to a minimum; and make sure to notify any local residents of your citizen science project before commencing drone operation. If your drone carries a camera, you should avoid taking and, in particular, publishing pictures of people on their private property.

Summary: This subsection pertains only to public property, which is managed by different agencies at several levels of government. If your project's site of interest is on public property, you should first identify which agency manages that property. You should then locate that agency's regulations to identify the permitted uses of that property. Oftentimes, personally contacting the agency is good way to learn about permitted uses of its properties.

6. Agency Regulations

If your project's **site** of interest is on public property, you should first identify which agency manages that property. You should then locate that agency's regulations to identify the permitted

[110] The Restatement (Second) of Torts provides an indication as to how this rule might be interpreted: "[i]n the ordinary case, flight at 500 feet or more above the surface is not within the 'immediate reaches,' while flight within 50 feet, which interferes with actual use, clearly is, and flight within 150 feet, which also so interferes, may present a question of fact." *See* The Restatement (Second) of Torts § 159(2), comment 1. You should remain attentive to any developments in this area occurring after the publication of this manual. To that end, many online blogs and journals offer up-to-date posts on major developments in drone law. *See, e.g.*, DRONE LAW JOURNAL, http://dronelawjournal.com/ (last visited May 1, 2017); Rupprecht Law, DRONE LAW BLOG, http://jrupprechtlaw.com/drone-law-blog (last visited May 1, 2017).

uses of that property. Some agencies are very permissive with respect to the public's use of their lands.

The BLM, for example, does not require a permit for "casual uses" of the lands it manages.[111] "Casual use" is defined as "any short term non-commercial activity which does not cause appreciable damage or disturbance to the public lands, their resources or improvements, and which is not prohibited by closure of the lands to such activities."[112] Thus, if your research does not noticeably damage BLM lands, then, you should be able to conduct research on this land without fear of repercussion.

Likewise, the United States Forest Service permits data collection that does not cause appreciable damage. For example, it allows: "[t]he collection of minor forest products, such as flowers, plants, berries, acorns, nuts, or small amounts of medicinal roots, from areas other than designated recreation, research, natural, or other areas closed to such activities. However, such collections are limited to reasonable quantities for personal use; there can be no disturbance of surface resources; and the products must not be protected by Federal or State laws or regulations."[113]

Of course, not all agencies will make guidance materials available to the public, nor will those materials always be clear. In the above excerpted regulation from the Forest Service Manual, for example, you may have questions as to what constitutes "reasonable quantities for personal use" or "disturbance of surface resources." The answers to these questions might affect the extent of sample collection you feel comfortable conducting in national forests. If you encounter any ambiguity like this in your background research, a logical first step is to contact the agency directly for clarification. Generally, an agency's contact information is available on its website. Your inquiry should be as specific as possible. While the response will not constitute binding legal advice, it will often be the most authoritative feedback you can get on the particular rules governing publicly-held property.

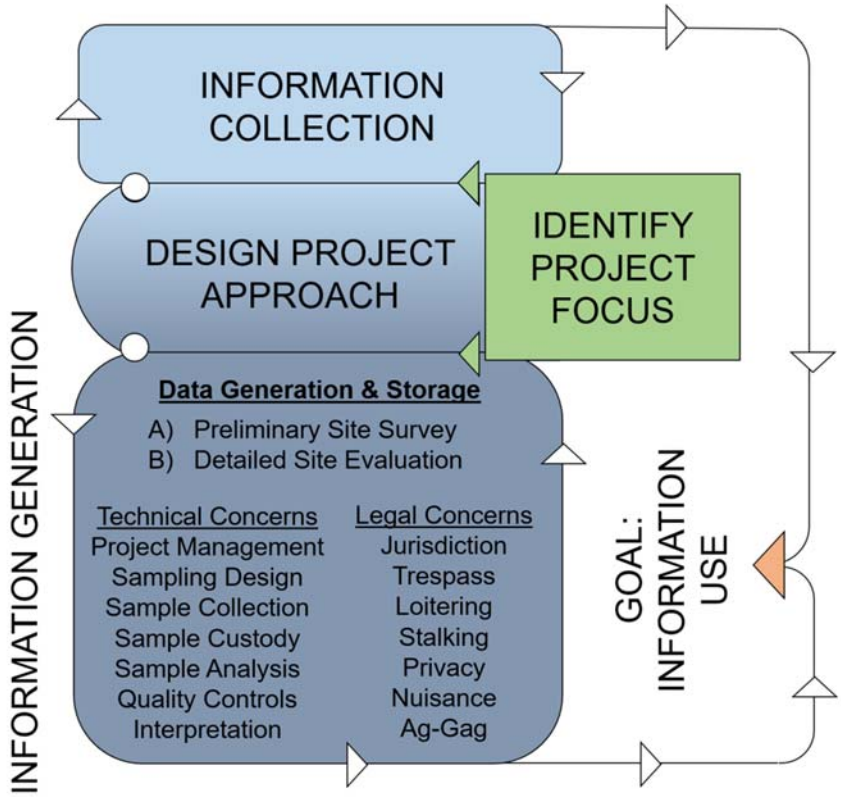
[111] 43 C.F.R. § 2920.0–5(k).

[112] 43 C.F.R. § 2920.1–2(a).

[113] FOREST SERVICE MANUAL § 2719.

CHAPTER 5: INFORMATION GENERATION – DESIGN OF SAMPLE COLLECTION, SAMPLE ANALYSIS, AND DATA INTERPRETATION METHODOLOGIES

Why You Should Read this Chapter: Most citizen science projects that you join or initiate will require generating information that was previously uncollected, unknown, unreported, or unestablished in the realm of public knowledge. Because most projects will involve this type of "**information generation**," it is important, and often critical, to your long-term success to think about how you will perform: (i) sample collection (*i.e.*, how will you gather samples of air, water, soil, etc.?); (ii) sample analysis (*i.e.*, how will you examine the samples you collect?); and (iii) data interpretation (*i.e.*, how will you interpret the results of your sample analyses?).



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Your purpose for generating information might vary over time. For example, you might be interested in performing a preliminary site evaluation before beginning a detailed evaluation. Regardless of your purpose for generating information, it can be helpful to consider various technical concerns that can impact the quality of the information that you generate before you begin your field work.

Introduction

The focus of this chapter is to help you generate high quality information. For some, this may seem like a daunting process. We emphasize that even if it is currently too difficult or expensive for you to comply with the most stringent state or federal quality assurance requirements, any information that you generate can have some use (discussed in Chapter 2). Indeed, in some instances this information could – and perhaps should – still suffice to trigger agency action. In this way, you can play the critical role of alerting the agency to potential environmental problems and enabling the agency to follow-up by utilizing appropriate **information collection** protocols. Nonetheless, understanding how the design and performance of your project impacts information quality will help assure that your project ultimately meets your goals.

As discussed previously, the use of citizen scientist-generated information can be limited by the information's quality (discussed in Chapter 2). At one extreme, state and federal agency regulations require that only high quality information be used to form the underpinnings of their actions (*see* Appendix 1 and 2). For example, the Minnesota Pollution Control Agency requires that citizen monitoring data meet the credibility requirements established in its "Volunteer Surface Monitoring Guide" when implementing the state clean water act.[114] Likewise, many federal regulations include specific requirements to assure information quality. Although these requirements vary in different contexts, EPA-funded programs generally require the preparation of an EPA-approved Quality Assurance Protection Plan (QAPP) *before* people begin collecting samples.[115]

Ultimately, high quality information has the highest utility or usefulness. Therefore, this discussion explains several technical suggestions that can increase the quality of the information you generate. In particular, we distill general suggestions that the EPA has established to promote information credibility and provide you with supplemental resources for additional information. We draw upon public EPA documents including "The Volunteer Monitor's Guide to Quality Assurance Project Plans," "The Citizen Science QAPP Guidance," and "Guidance for Choosing a

[114] Minn. Stat. Ann. §114D.

[115] *See* CIO §2105.0

Sampling Design for Environmental Data Collection."[116] Other resources, such as the Federal Crowdsourcing and Citizen Science Toolkit,[117] are available to aid citizen scientists in the design of sample collection, sample analysis, and data interpretation methodologies.

[116] *See* Environmental Protection Agency, *Citizen Science QAPP Template* (April 2013); Environmental Protection Agency, *Guidance for Choosing a Sampling Design for Environmental Data Collection*, EPA/240/R-02/005 (December 2002); Environmental Protection Agency, *The Volunteer Monitor's Guide to Quality Assurance Project Plans*, EPA 841-B-96-003 (September 1996).

[117] Federal Crowdsourcing and Citizen Science Toolkit, https://crowdsourcing-toolkit.sites.usa.gov/ (last visited May 1, 2017).

Making Connections Between Chapters: Before designing your data collection, sample analysis, or data interpretation methodologies, it is helpful to review key points from the preceding chapters:

- What is your site of interest and which pollutant or combination of pollutants will you be examining? (discussed in Chapter 1).
- Who will use the information you collect and for what purpose? (*e.g.*, what legal standards might limit the use of information you generate) (discussed in Chapter 2).
- What is known about the pollutant or combination of pollutants you will be examining? (*e.g.*, stability, detection limits, detection methodologies, environmental baseline levels, reporting thresholds, etc.) (discussed in Chapter 3).
- What is already known about the source of the pollutant of which you are concerned? (*e.g.*, the source's current permit requirements and compliance records) (discussed in Chapter 3).
- What are potential sources of liability to which you might be exposed when collecting the information (*e.g.*, trespass, stalking, etc.) (discussed in Chapter 4).

Answering these questions will shed light on the type and quality of information that is currently lacking (*e.g.*, information that you may seek to generate) and how to acquire the information.

Assessing Information Quality

Indicators of Quality Data

1) *Precision*
2) *Accuracy*
3) *Representativeness*
4) *Completeness*
5) *Comparability*
6) *Instrumentation*

When you present information that you have collected or generated (*e.g.*, a summary of your tests of the water quality in a stream) to a **decision maker**, he or she must assess the quality of the information without having a chance to perform his or her own data collection or testing. Instead, **decision makers** often look for "indicators" of high quality data. Examples include: precision, accuracy, representativeness, completeness, comparability and instrumentation. Therefore, by considering these elements as you design and conduct your project, you will increase both your confidence in the information that the project generates and the ability of a **decision maker** to consider and rely on your findings. The indicators of quality data are each discussed below.

Precision relates to the degree of agreement (*i.e.*, similarity) between (i) multiple measurements taken from a single sample or (ii) measurements taken from multiple samples collected as close together in time and place as possible. Collecting multiple independent samples from a single **site** at roughly the same time in the same manner (*i.e.*, "replica" samples) and analyzing the samples at the same time and in the same manner, allows for robust statistical calculations of precision (*e.g.*, calculation of standard deviation, standard error, or relative percent difference). A high level of precision suggests that your sampling and testing methods are consistent and can be reproduced; this is an indication of high quality information.

Accuracy ensures that your data represents reality. You can facilitate the measurement of accuracy by collecting quality control samples that have known values. Examples of various quality control samples are discussed in greater detail in the next section of this chapter. Quality control samples should be collected along with, and in ways that mimic your collection of field samples, and they should be analyzed using the same instrumentation. When the values reported from the control samples consistently and precisely reflect their known values, it suggests that the accuracy of your field samples is high; this is an indication of high quality information.

Representativeness relates to whether a sample collected from a **site** is actually representative of that **site**. Here, the central concern is to avoid biases in the generated information. How, when, where, and by whom samples are collected will influence the representativeness of

your information. For example, if you are collecting samples to determine the *typical concentration* of a pollutant *in* a stream, the following factors could bias your results:

- How: the samples were collected with unclean tools. This creates a risk of bias because any pollutant detected in the analysis of the samples may have actually arisen from the unclean tools.
- When: the samples were collected just after heavy rainfalls. This may create a risk of bias because various pollutants that are not normally in the river might be washed there from various sources due to the rain. Note: this risk of bias would not be present if rain is typical of the location studied or, alternatively, if you were interested in determining the concentration of a pollutant in a stream following heavy rainfalls.
- Where: the samples were collected just below a pipe outfall that is entering the stream. This creates a risk of bias because the concentration of pollutant just below the pipe will be higher than the concentration of pollutant in the stream generally. Note: this risk of bias would not be present if you were interested in determining the concentration of a pollutant just below the pipe or, alternatively, if you were interested in determining the abundance of pollution entering the stream from the pipe.
- By Whom: samples were collected by a person untrained in proper sampling technique. This creates a risk of bias because it will be less certain that the samples were collected properly (*i.e.*, in a way that is representative).

As demonstrated in these examples, what constitutes a bias that impacts representativeness may be different in each situation.

Completeness involves a comparison of the number of measurements you originally planned to collect (*i.e.*, the number that you anticipated would be necessary for the information to be useful) and the number that you actually collected. Collecting more samples than you think will be necessary can help assure information completeness; this is an indication of high quality information.

Comparability refers to the relationship between results of multiple studies or a single study over time. Multiple studies that report similar conclusions suggests that data quality is high. Moreover, information reported from a single study that presents realistic results over time (*e.g.*, consistent, gradual changes, or explainable rapid changes) is of higher quality than information reported from a single study that presents sporadic, unexplained fluctuations in values.

Instrumentation used to analyze the samples you collect can also impact the quality of the generated information. Each analytical instrument has a range of values, such as the amount of a pollutant in a sample, which it can detect in a reliable manner. If the presence of a pollutant in a sample (sometimes referred to as an analyte abundance) is below the instrument's lowest detection limit (*i.e.*, limit of blank, limit of detection, or limit of quantitation) the pollutant's presence will be reported with a value of zero, or less than zero. If the presence of a pollutant in a sample is greater than the instrument's highest quantifiable limit, the pollutant's presence will be reported with a value that is no greater than the instrument's maximum reportable value. As readings approach these detection limits, they become less reliable. In short, if reported values fall within an instrument's measurement range, it suggests that the values are reliable, which is an indication of high quality information.

Information Quality Needs Can Change Over Time: Your anticipated use of the information can change over the lifetime of your project, causing its information quality requirements to increase or decrease (*see* Chapter 2). Your purpose for collecting data can change over time. For example, your project might originally be directed at monitoring a currently unthreatened natural resource to facilitate a rapid response to any potential increases in pollution. The information quality that you seek may change if a pollution increase is detected.

Likewise, you might perform a general preliminary site survey to verify the identity of a potential pollutant or pollutant source before performing a detailed site evaluation. A preliminary site evaluation can include documentation of evidence of: the scent of air at the site of interest; oil slicks on the surface of water; stained soil or pavement; stressed vegetation on land or in water; solid waste (*e.g.*, mounds or depressions suggesting solid waste disposal); wastewater entering a stream; or unmaintained septic systems. In some instances, you might collect and analyze a few field samples from the site to identify pollutants on the site. Perhaps, in this instance, the information quality that you seek will increase after the pollutant or pollutant site has been verified.

Ultimately, **information generation** is, in many instances, an iterative process, so the type of information that you seek to generate can change over time.

General Quality Assurance Protection Plan Guidelines

A **Quality Assurance Protection Plan** (QAPP) is a formal document that describes how a project will achieve its information quality requirements. In other words, a QAPP lists the quality assurance mechanisms that will be used to assure that the information generated by the project meets the quality criteria discussed above. Importantly, this document is prepared *prior* to any sample collection. Ultimately, the QAPP is a project feature that **decision makers** will use to assess the overall quality of the generated information. Preparing a QAPP is part of a project's quality assurance (QA) activities. (Another term you may see is quality control (QC), which refers to the overall system of technical activities that are designed to *measure* the quality of information.)

*Prepare or review a project's QAPP before collecting samples or information. Put your QAPP into a written format that can be shared with volunteers and **decision makers**.*

Although the EPA lists twenty-four distinct issues that can be addressed in a QAPP, we focus here on various themes that we deem especially important and useful in the context of citizen science projects: (i) management description, (ii) sampling design, (iii) sample collection methodology, (iv) sample handling and custody, (v) sample analysis, (vi) quality controls, and (vii) data interpretation. We stress that the nature or type of pollutant and the **pollutant source** heavily dictate the content of the QAPP. The EPA has issued a vast number of very specific and detailed protocols for the measurement of pollutants in various contexts (*i.e.*, "EPA Reference Methods" or "EPA Standard Protocols"). A collection of these methods and protocols can be found on EPA's website.[118] They delineate detailed descriptions of accepted sampling methodologies, quality controls, instrumentation functionalities, etc. Including this level of detail here is impractical. Instead, we offer broad, generalizable suggestions and provide additional resources for those who seek greater detail for their individual project needs.[119]

Key elements of QAPPs

1. *Management description*
2. *Sampling design*
3. *Sampling collection*
4. *Sample handling & custody*
5. *Sample analysis*
6. *Quality controls*
7. *Data interpretation*

[118] Environmental Protection Agency, *Collection of Methods*, https://www.epa.gov/measurements/collection-methods (last visited May 1, 2017).

[119] *Id.*

Project Management Description

While some projects are small enough that a single person can successfully complete them, many will require the coordinated efforts of many individuals. Indeed, the most successful projects may involve a "community" of individuals. When projects involve groups of individuals, establishing and describing management roles at the onset of the project is important for ensuring project consistency and cohesiveness.

Project managers must (among many other things): identify funding resources and control expenditures of funds; establish what, when, how, and by whom samples will be collected, analyzed, and interpreted; ensure that volunteers understand how to clean and calibrate instrumentation; and assure, if needed, the proper training of those involved in the project (*e.g.*, in proper sample collection) and otherwise ensure information quality.

Project managers should also seek to maximize the use of community expertise. For example, even if you lack the training or expertise to design or complete a project, your community may include individuals with technical or scientific training who are willing and eager to participate (*e.g.*, teachers or professors, scientists and engineers, or even members of environmental agencies).

Sampling Design

Sampling design includes considering the types of samples that will be collected and when and where they will be collected. Sampling design decisions implicate multiple factors that impact information quality, but it is primarily concerned with the representativeness of the information. A well-developed sampling design plays a central role in ensuring that conclusions are adequately supported by data. Thinking about your sampling design at the beginning of a project can help avoid introducing bias at the onset of **information generation**. Avoiding bias is important; as the saying goes, "Garbage in, is garbage out."

In some aspects, your sampling design will be dependent on the type of sample you are collecting. For example, the placement of air monitors depends on the sampling objective: ground level monitoring, air mass (*i.e.*, circulating air), or source-oriented (*e.g.*, as the air exist a smoke stack), and it is important for air flow around the monitor to be representative of the general air flow in the area to prevent sampling bias. Likewise, water and soil sampling designs can include details concerning the location and depth at which samples will be collected. When contemplating

the types of samples that will be collected, you should consider the chemical/physical properties of the pollutant and the potential source of the pollutant (discussed in Chapter 3).

The sampling design should include documentation of when and where samples will be collected, including, for example, the following types of information:

- The number of times that a sample will be collected per week, month or year;
- The duration of the sampling program (*e.g.*, the period of time during which samples will be collected);
- At what time of the day or night the samples will be taken (*e.g.*, during or after an industrial facility's hours of operation);
- How weather will impact sample collection (*e.g.*, will samples be collected during rain, wind, or unusual temperature events); and
- Where samples will be collected. The chemical/physical properties of the pollutant and the source of the pollutant, along with potential sources of liability (discussed in Chapter 3), should be central to determinations of where to collect samples.

Addressing these issues will help reduce potential bias in the ultimate conclusions and promote the quality of the information generated in a project.

Selecting sampling **locations** typically involves one of two approaches: (i) random or probabilistic sampling and (ii) judgmental sampling. While each approach has advantages and disadvantages that can be discussed at length, this discussion merely serves to introduce the topics. In random sampling, as its name implies, sampling locations are chosen randomly. It is most useful when the pollutant of interest is relatively homogeneous in the sampling medium (*i.e.*, it is uniformly distributed, and thus, there are no expected "hot spots"). Because citizen science projects concerned with environmental problems often focus on a **pollutant source**, random sampling may be less commonly used relative to judgmental sampling. Judgmental sampling, as its name implies, involves the selection of sampling locations based on judgment. Judgmental sampling is most useful when there is historical or physical knowledge of the feature or condition under investigation: for example, when the impact of the pollutant can be visually discerned or when the location of pollutant release is known.

Ultimately, the sampling design should match the needs of the project with the resources available (*e.g.*, recognizing constraints of resources related to finances, time, expertise, and geographic access).

Sample Collection Methodology

A well-designed sample collection methodology helps ensure the precision and accuracy of the information that is ultimately generated. The primary question addressed by a sample collection methodology is: how will samples be collected during each sampling event (*e.g.*, **site** visit)? The answer to this question may include, among other things, a description of: (i) the number of samples to be collected during each sampling event (*i.e.*, the number of "replica" samples that will be collected); (ii) how samples will be taken; (iii) the equipment and containers used to collect the samples (*e.g.*, their composition and procedures for their decontamination); and (iv) holding time length (*i.e.*, the time between taking samples and analyzing them).

Some aspects of sample collection methodologies are highly generalizable across projects. For example:[120]

- Sample collection should be documented (*e.g.*, time, place, name of collector, equipment used, etc.).
- The collector should wear "a clean pair of new, non-powdered, disposable gloves each time a different location is sampled and the gloves should be donned immediately prior to sampling. The gloves should not come in contact with the media being sampled and should be changed any time during sample collection when their cleanliness is compromised."[121]
- The collection equipment should be clean and sterilized.
- "Sample collection activities shall proceed progressively from the least suspected contaminated area to the most suspected contaminated area."[122] Samples that are expected to contain high levels of contaminated media should be kept separate from samples thought to contain low levels of contaminated media.
- "All . . . control samples shall be collected and placed in separate ice chests or shipping containers."[123]

[120] *See, e.g.*, Environmental Protection Agency, *SESD Operating Procedure: Soil Sampling*, SESDPROC-300-R3 (August 2014); Environmental Protection Agency, *SESD Operating Procedure: Surface Water Sampling*, SESDPROC-201-E3 (February 2013); Environmental Protection Agency, *SESD Operating Procedure: Pore Water Sampling*, SESDPROC-513-R2 (February 2013); Environmental Protection Agency, *SESD Operating Procedure; Groundwater Sampling*, SESDPROC-301-R3 (March 2013).

[121] *Id.*

[122] *Id.*

[123] *Id.*

- "During sample collection, if transferring the sample from a collection device, make sure that the device does not come in contact with the sample containers."[124]
- "All samples requiring preservation must be preserved as soon as practically possible, ideally immediately at the time of sample collection."[125]

Other aspects of a project's sample collection methodology may be specific to the medium being sampled or type of instrument being used. For example, air sample collection methodologies are generally highly specific to the instrumentation used.[126] Water and soil sampling designs, however, have various aspects that are more generalizable.

Water samples should be collected with as little agitation to the water as possible. Wading or streamside sampling increases the probability of agitation. In instances when agitation is a concern, samples should be collected while facing upstream. Moreover, water sample containers should be filled to their capacity (*i.e.*, no bubbles or headspace should be present after the container is capped). Unpreserved and preserved samples have holding times of one week and two weeks, respectively. (Holding times indicate the period during which the samples should be tested.)

Soil samples must be "thoroughly mixed to ensure that the sample is as representative as possible of the sample media;" this rule does not apply if the soil sample will be analyzed for the presence of volatile organic compounds (VOCs).[127] Moreover, the collector should "place the sample into an appropriate, labeled container(s) by using the alternate shoveling method and secure the cap(s) tightly. The alternate shoveling method involves placing a spoonful of soil in each container in sequence and repeating until the containers are full or the sample volume has been exhausted."[128] Unpreserved samples have a forty-eight-hour holding time.

Sample collection methodologies may also contemplate other ways of documenting sample collection. For example, a methodology could direct volunteers to photograph, videotape, or otherwise record the actual sample collection to demonstrate that the activity complies with the sample collection methodology. Typically, notes of visual and olfactory observations should be recorded in a log book to describe, for example, the depth of each sample, whether its color and

[124] *Id.*

[125] *Id.*

[126] *See, e.g.*, Environmental Protection Agency, *List of Designated Reference and Equivalent Methods* (June 2016).

[127] *See Operating Procedure: Soil Sampling supra*, note 38.

[128] *Id.*

texture, any odors, etc. The log can also be used for demonstrating sample handling and custody and any field analyses of the samples.

Sample Handling and Custody

Precision and accuracy are the main information quality concerns addressed by the establishment of sample handling procedures. These procedures apply to projects that do not perform sample analysis in the field. In these instances, the samples must be transported to an alternative **site**, such as a laboratory. All samples should be properly labeled including: (i) the sample location; (ii) the date and time of collection; (iii) the sampler's name; and (iv) whether the sample was preserved, and if so, how. Chain-of-custody procedures should be established to keep track of all samples that will be shipped or transported to a laboratory for analysis (*i.e.*, documentation requirements for any changes in the handler of the sample or the sample's storage location). This information is important for authentication of any information generated by analysis of the samples (discussed in Chapter 2).

Sample Analysis

Analysis of samples may occur in the field or in a laboratory. In either case, the analytical methods and equipment used in the analysis should be documented. For example, if an EPA Reference Method or approved protocol is used, the method/protocol number should be listed; if the methodology differs from the Reference Method or approved protocol, list the ways in which it differs. In addition, documentation of instrumental calibration, inspection and maintenance should be provided. These procedures promote precision and accuracy of the data.

Generally, analytical tools that are EPA approved are documented in the Federal Register. In some instances, the EPA provides lists of analytical tools that are EPA-approved when used in specific contexts. [129] Other EPA approved devices can be found in EPA-approved operating procedures or reference methods (*see* Appendix 5).

[129] *See, e.g.*, Environmental Protection Agency, List of Designated Reference and Equivalent Methods (June 2016).

Quality Control Samples

The design of a project should include methods for collecting and testing quality control samples; examples include field controls, equipment controls, split samples, replica samples, and spiked samples.

- A field control is a sample "collected" in the field that lacks a detectable quantity of the analyte of interest (*i.e.*, the pollutant). While regular sample containers are filled with air, water, or soil from the field, a field control is filled in the same way but with air, water, or soil with a known composition that is brought to the **site**. If preservation steps are performed to the field samples, they should likewise be performed on the field control sample.
- Equipment controls are samples used to verify the cleanliness of sample collection or analysis equipment. Generally, distilled water is used to test equipment's cleanliness.
- A split sample is one that is divided into two or more sample containers and subsequently analyzed independently.
- Replica samples or duplicate samples are samples that are collected and analyzed at the same time and in tandem (*i.e.*, they are representative of the same environmental condition).
- Spiked samples are samples to which a known amount of the analyte has been added.

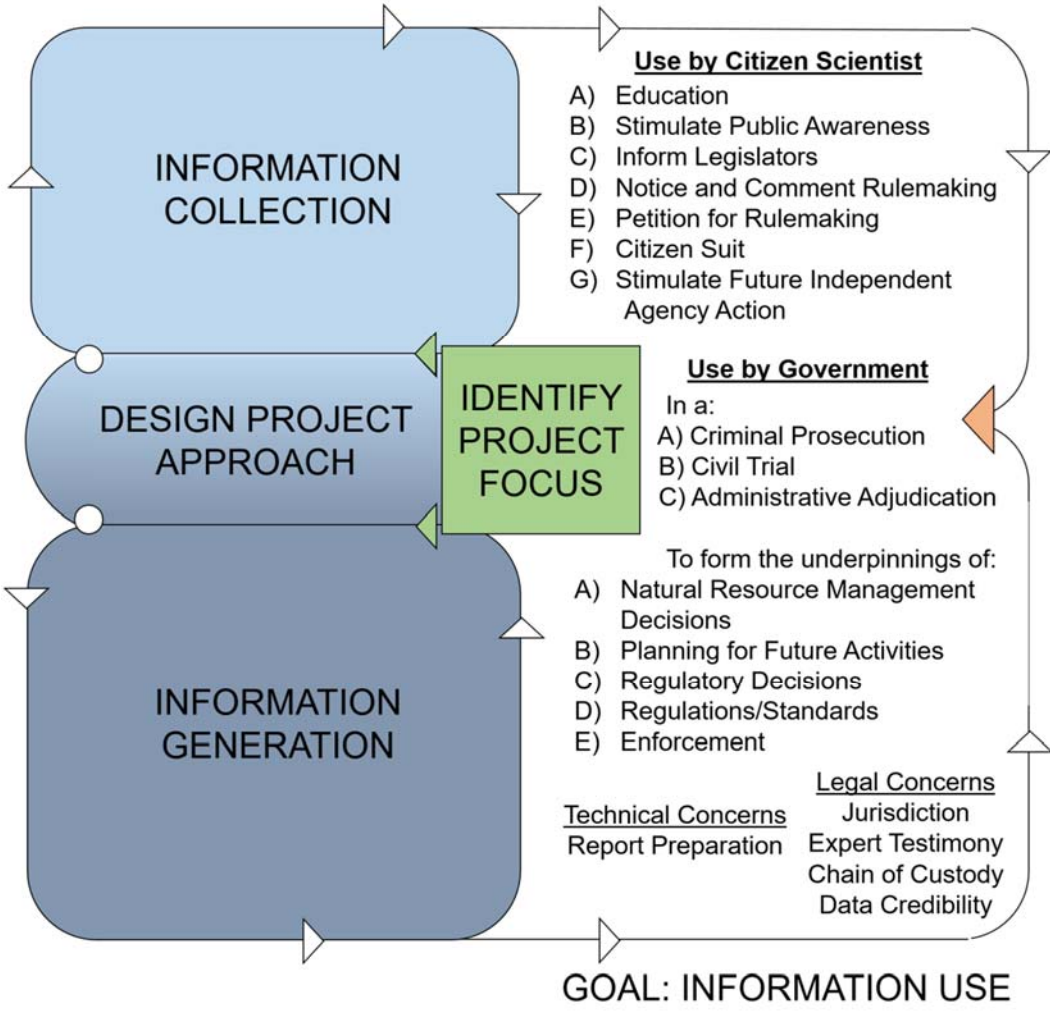
Because the abundance of the analyte (*i.e.* pollutant) is known in each of these control samples, they are useful in assessing the precision and accuracy of the data that is ultimately generated.

Data Interpretation

The project design should include considerations of how the data generated from sample analysis will be interpreted. It is from this interpretation that conclusions will be drawn. In some instances, you, the citizen scientist, may be able to interpret the data. However, as mentioned in Chapter 2, some uses of information generated from your project will require expert interpretation. When data is interpreted by a qualified expert, the quality of the information is enhanced. There are likely to be qualified experts in your community who are willing to assist you. Think about universities, community colleges, high schools, and locally-based environmental engineering companies.

CHAPTER 6: INFORMATION USE – MAKING THE MOST OUT OF YOUR INFORMATION

Why You Should Read this Chapter: After all your efforts in carrying out your project, you should put your results to good use. Here we provide suggestions concerning the presentation and sharing of your information.



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After the information collection and generation phases of your projects are complete, it is time compile all of your results. Now is a good time to remind yourself of the various ways in which this information can be used. This reminder can help you put your results to good use.

General Suggestions

After you, the citizen scientist, have put forth the effort to identify the problem (discussed in Chapter 1), to collect currently available pubic information (discussed in Chapter 3), and to generate new information (discussed in Chapter 5), you should put the results of your efforts to good use. As delineated in Chapter 2, there is a broad spectrum of potential uses of your

information (*e.g.*, to stimulate public awareness, to influence lawmaking, for enforcement mechanisms, etc.). There are various ways to make the most out of your information. Here, we provide a few suggestions.

First, structure your information to make it presentable. Begin by considering ways in which you can present your work concisely and clearly to a broad audience. In many instances, simplicity empowers an argument. Translate your results into plain language and use graphs, tables, and other visualization techniques to facilitate emphasis and rapid understanding of your arguments. Next, consider your primary target audience. In some instances, this audience will require that the information be submitted in a certain format (*e.g.*, documents submitted for court proceedings). Take time to research whether your **information use** has a formatting requirement. Importantly, when in doubt, seek outside advice and guidance.

Second, use your information in any way you can. Although you may have begun your work as a citizen scientist with a specific use or goal in mind, consider other ways in which your information can be used. Maximize the value of your efforts by thinking creatively about other uses of your information.

Finally, build upon the information that you have collected and generated. In some instances, you can consider collecting or generating more information to make your argument more sound and convincing with increased evidence. In other instances, your work may bring to light additional issues that merit exploration. Alternatively, you can provide opportunities for others to build upon your work by making your information as accessible as possible. For example, you can consider making your information publicly available on an internet platform. To some extent, this sharing can serve as a "peer-reviewing" mechanism. When other independent individuals reproduce your results, the credibility (*i.e.*, quality) of your information increases. In this way, quantity can be equated with quality.