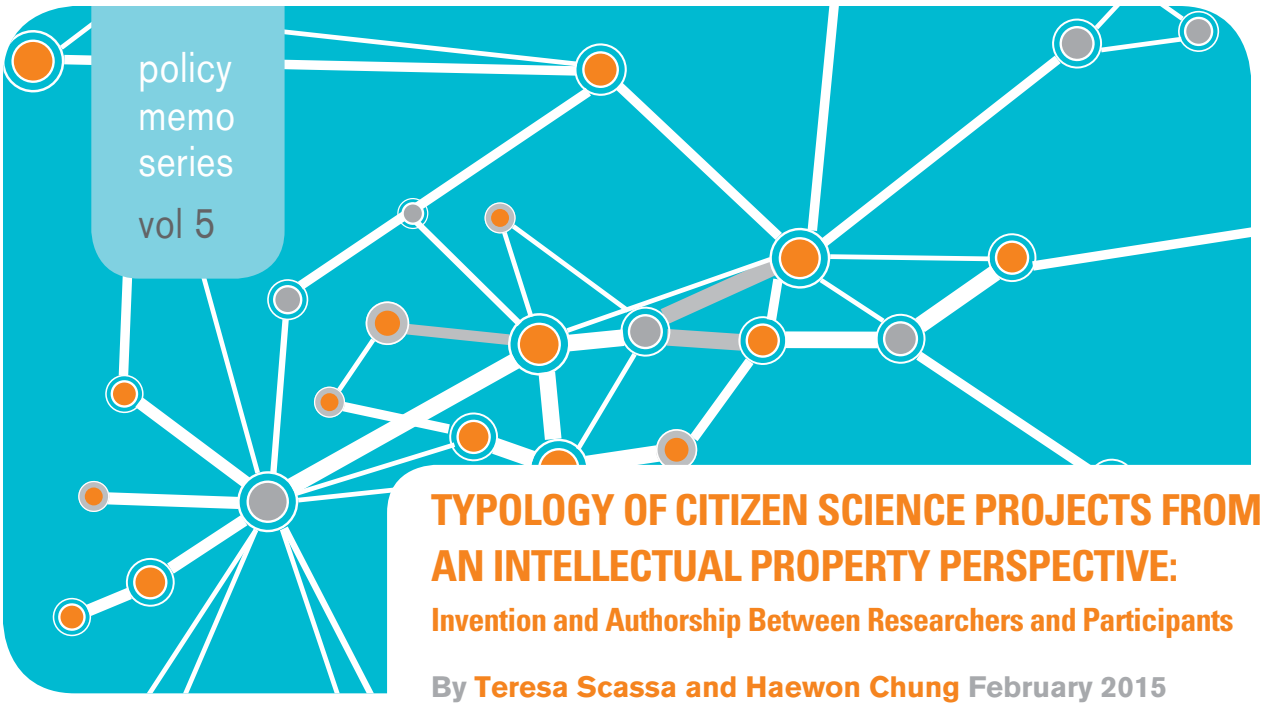

TYPOLOGY OF CITIZEN SCIENCE PROJECTS FROM AN INTELLECTUAL PROPERTY PERSPECTIVE:

Invention and Authorship Between Researchers and Participants

By **Teresa Scassa and Haewon Chung** February 2015

EXECUTIVE SUMMARY

Citizen science is an emerging field that encourages collaboration between scientists and the general public, leading to new research and discovery. But coordinators of citizen science projects need to be aware of intellectual property rights because of their potential to lead to unanticipated consequences that may hinder the dissemination or use of the research produced by these projects. This paper outlines a typology of citizen science projects based upon intellectual property issues, focusing largely on issues that may arise from contributions to the research project by the public and that may arise from project output.

Our typology classifies citizen science projects according to four broad categories, which are defined in terms of the nature of participants' contributions, specifically involving:

1) classification or transcription of data;
2) data gathering;
3) participation as a research subject; and/or
4) the solving of problems, sharing of ideas, or manipulation of data.

Our findings show that some forms of participation are much less likely to involve intellectual property considerations than others. In the first three activity types, intellectual property rights will largely depend on the form in which contributions are made: Photographs, videos, and written observations may all raise questions about copyright, but help with transcriptions or entering data into online forms is unlikely to give rise to any intellectual property rights. Cases where the participant is also a research subject could spark ethical concerns,

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but the intellectual property analysis likely does not change. In the fourth category – where participants engage in problem-solving and data manipulation – it is possible that the contributions of particular participants may rise to the level of inventorship or authorship, thereby raising intellectual property questions.

Ideally, these intellectual property issues should be addressed when drafting of the terms of participation (also referred to as "terms of use") for a project. ***Scientists who seek to address intellectual property issues at this stage should consider two main questions:***

1) Are the contributions that are being sought from the public ones in which participants may have intellectual property rights?
2) Is the public participation of a kind which may give some participants intellectual property rights in the research output?

Beyond the organizers, participants in citizen science projects may also seek to understand how issues of authorship, inventorship, and ownership may arise in relation both to their contributions and to the overall output of the project.

INTRODUCTION

Citizen science is a name given to a rapidly evolving and diverse set of projects that adopt public participation as a means of advancing a research team's scientific goals. A number of different typologies for citizen science have already been proposed, based on factors such as the degree of public participation or the goals and technological sophistication of the project.[1] The typology we propose in this paper is one that examines citizen science through the lens of intellectual property law, using features significant in the intellectual property context to categorize different types of projects.

We propose a typology to assist developers of citizen science projects and participants in citizen science to understand the nature of contributions from an *intellectual property* point of view. Intellectual property rights are rights in intangibles – generally the product of some exercise of human intellect or ingenuity. Scientific research typically results in the production of intellectual property in one or more forms. Rights may arise in texts (including published papers), images, graphs, charts, compilations of data, and inventions that are the product of research activities. Our typology focuses on both the intellectual property rights in the output of a project and the intellectual property rights in individual contributions (i.e. the form of user contribution). While the existence of intellectual property rights may depend upon the nature and form of the contribution made to the project, the ownership of intellectual property rights turns upon factors such as legal presumptions, employment status, institutional norms, or contractual agreements. Intellectual property rights in the products of research may be claimed in whole or in part by researchers managing citizen science projects, funding agencies, private sector research partners, the institution or other employers of the researchers, and, in the case of published works, by academic journals or book publishers.

Citizen science project coordinators should be concerned about the management of intellectual property rights because of their potential to lead to unanticipated consequences that may hinder the dissemination or use of the research output. For example, when citizen scientists are invited to contribute content in which they have copyrights, such as photographs or written accounts, it would be difficult for a researcher to disseminate the datasets containing these contents or to reproduce the copyright-protected contributions without authorization. If these issues were not addressed at the outset, research dissemination would be inhibited or, at the very least, made more complicated by the need to seek rights clearance after the fact. Similarly, a citizen science project that engages participants in activities that lead to a major scientific breakthrough and to a patentable invention may also prove problematic for researchers if the potential for participant co-inventorship is not anticipated

Citizen science project coordinators should be concerned about the management of intellectual property rights because of their potential to lead to unanticipated consequences. For example, when citizen scientists contribute content in which they own copyrights, such as photographs or written accounts, it would be difficult for a researcher to disseminate the datasets containing this content without authorization.

and addressed at the outset. From a participant perspective, transparency around issues of intellectual property ownership can help in understanding their relationship to the project and its output.

The proposed typology is intended to reduce potential barriers to dissemination or development of the research, its results and the accumulated research data, by assisting researchers and participants to understand the potential intellectual property issues related both to the nature of the particular project and to the type of participation it requires. For researchers who design and develop citizen science projects, this typology may be useful in identifying the issues that they may wish to address in their "Terms of Use" and in thinking about their own needs and obligations as they relate to dissemination, publication, follow-up research, and, where relevant, patenting. Understanding these issues is important to research scientists because their careers may depend upon effective dissemination of research results. This typology may also assist participants in understanding the nature of their contribution and its relationship to the research output of the project – at least in legal terms. From the perspective of public participants, it may be useful to understand how their contributions fit within research outputs that are the subject of intellectual property rights. This paper is not intended to offer legal advice of any kind, particularly as individual situations will turn on their own unique facts. Rather, our goal is to raise awareness of the importance of addressing intellectual property rights in citizen science to avoid potential misunderstandings or disputes.

This short paper begins with a discussion of the definition of citizen science. It then provides an overview of some of the intellectual property and other related legal issues that may be raised by citizen science projects. Part III of this paper provides a typology of citizen science framed in terms of intellectual property rights. This typology considers the nature of participant involvement and the intellectual property implications that may flow from this involvement.

DEFINING OF CITIZEN SCIENCE

The term "citizen science" embodies a very broad range of activities in support of scientific research. Bowser and Shanley have defined it as "a form of collaboration where members of the public participate in scientific research to meet real world goals."[2] They further observe, "Citizen science is also considered a paradigm where the needs and activities of an engaged public are intertwined with professional scientific research."[3] It is interesting to note that other definitions also share both the emphasis on collaboration[4] and the fact that the activities are meant to be mutually beneficial to both researchers and participants.[5] The definition put forward by Bowser and Shanley is quite open-ended in terms of the nature of the participation. They also place citizen science within the broader category of "open innovation".[6] In doing so, Bowser and Shanley draw parallels with an evolving type of activity that is present

In terms of patents in the citizen science context, a key issue might be whether the contribution of any individual participant amounts to inventive activity such that they should be included as a co-inventor in a research project that leads to a patentable invention.

in fields other than the pure sciences. They further note other terminology used to describe similar or related activities, including "public participation in scientific research, volunteer monitoring, crowdsourced science, democratized [sic] science, and participatory action research."[7]

Shirk *et al.* note the inconsistency in meaning attributed to "citizen science," ranging from "large scale data-collection initiatives" to the engagement of "public perspectives and knowledge in science discourse and policy making."[8] They also note that additional terms have been adopted to describe citizen science activities, including community-based monitoring, participatory monitoring, and volunteer biological monitoring.[9] As a consequence, Shirk *et al.* abandon the term "citizen science" in favour of "public participation in scientific research," thus emphasizing the participatory nature of citizen science and distinguishing it from other forms of crowd-sourcing activity.[10] Although it still encompasses a broad range of scientific inquiry, this definition is more narrowly focused than that proposed by Bowser and Shanley. While various types of open innovation activities may raise similar issues to those raised by a more narrow conception of citizen science, the context in which they take place may introduce other variables that render an analysis of intellectual property issues more complex. In this paper, therefore, we adopt the definition proposed by Shirk *et al*, that citizen science involves "intentional collaborations in which members of the public engage in the process of research to generate new science-based knowledge."[11] Projects that fall within the boundaries of this definition may have different goals and different methodologies. The common element is the explicit objective to "contribute to scientific research and/or monitoring."[12]

INTELLECTUAL PROPERTY AND PARTICIPANT CONTRIBUTIONS TO CITIZEN SCIENCE

"Intellectual property" refers to a bundle of rights in intangible property that arise as a result of some exercise of human intellect. In the citizen science context, patents and copyrights are most important, although other rights, such as trade secret protection, may also be relevant. Some of the essential elements of these rights are outlined in Table I below. Note that database rights (available only in European Union member states) are included as well.

Patent and copyright law both provide a temporary monopoly protection for intellectual property. A patent provides a 20-year monopoly over the exploitation of an "invention," which is defined in the *U.S. Patent Act* as "any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof."[13] A patent must be applied for by the inventor(s).[14] In the citizen science context, a key issue might be whether the contribution of any individual participant amounts to inventive activity such that they should be included as a co-inventor in a research project that leads to a patentable invention. As

Copyright considerations arise where participants contribute 'works' (original expression fixed in a tangible medium such as photographs, drawings, or text-based submissions). A contributor who provides only raw data to a project has no intellectual property rights in that data.

the threshold for inventive activity is quite high, this will occur only in rare circumstances and in those projects that call upon a high degree of intellectual involvement from participants.

The patent monopoly is only available for inventions that are "new" within the meaning of the *U.S. Patent Act*. Patentable subject matter will not be considered "new" if it has been disclosed to the public prior to the application for the patent (although there is a short grace period in cases where the patentee is the source of the disclosure).[15] The degree to which details of the research project are disclosed may be of some concern in the context of citizen science, which has a very public dimension. At the planning stage of a citizen science project that may lead to one or more inventions, researchers should consider whether patenting is a necessary or desired outcome (as opposed to the dedication of the results to the public domain). If there is a plan to focus on patents, the manner in which the project is implemented might have to limit the extent of participant access to sharing "just enough" research data to enable collaboration without jeopardizing patentability.

In contrast to patents, copyright law provides a much longer monopoly (typically based upon the life of the author plus 70 years),[16] which gives exclusive rights to the copyright owner over the exploitation of the protected "work."[17] Copyright arises automatically and without formalities and is available for "works" described in very broad terms. Many outputs of citizen science projects will be "works" that are protected by copyright law. This would include journal articles, research notes, conference papers, audio/visual presentations, and so on. Further, while copyright does not protect facts, it will protect the original expression of facts. As a result, there may be copyright in the collection of research data as a compilation. In cases where a compilation of facts is protected under copyright law, what is protected is any original selection or arrangement of the facts and not the facts themselves (which remain in the public domain).

Participants in citizen science projects may also have copyright in their contributions (i.e. research inputs) to these projects in certain circumstances. Copyright considerations arise where participants contribute "works" (original expression fixed in a tangible medium, such as photographs, drawings, or text-based submissions as demonstrated in Figure1). A contributor who provides only raw data to a project has no intellectual property rights in that data; by contrast, observations expressed in detailed prose or in a photograph may qualify as original expressions. Attention to intellectual property issues in contributions by the public to citizen science projects is important, since researchers may seek to use contributed materials (such as photographs) in their research dissemination.

While facts in and of themselves cannot be protected by copyright law, in appropriate circumstances they may be eligible for protection as trade secrets or confidential information. To qualify for this form of protection, the

information must not be generally known and must be subject to efforts taken to maintain its secrecy. Protection is available for as long as secrecy is maintained – thus, in theory, it may be perpetual. This type of protection may be appropriate in some circumstances; it is, of course, not consistent with the publication or dissemination of data. Trade secret protection, for example, will not be available to researchers who decide to make their citizen science research data publicly available.

Researchers in member states of the European Union (EU) may also benefit from database rights, which are protected as a separate form of intellectual property in EU jurisdictions.[18] The *EU Database Directive* uses a lower threshold for database protection than that in U.S. copyright law. According to article 7, database protection is available where a substantial investment is made to create the database. Therefore, the *EU Database Directive* may provide protection even when a database does not qualify for protection under copyright law. Database protection can also apply in addition to the domestic copyright protection for compilations. Protection is available for a 15-year term, but a new 15-year term is available each time the database is substantially revised. The protection available for a database extends to some degree to the contents of the database, since the database right will be infringed by the extraction of a significant part of the data, to be assessed either qualitatively or quantitatively.

FIGURE 1: This photograph was taken by a volunteer, and shared with a citizen science project researching plant phenology.

PHOTO CREDIT: Anne Bowser. The volunteer holds the right to this photo.

TABLE I – OVERVIEW OF INTELLECTUAL PROPERTY SUBJECT MATTER

Intellectual Property Right	Protected Subject Matter	Duration of Protection	Ownership[19]	Formalities
Copyright (*Copyright Act*, 17 U.S.C.)	"Works," which includes literary works (journal articles, blog entries, computer software) as well as works such as photographs, graphs, charts, plans, and drawings. Compilations are also protected as works, including compilations of data.	Life of the author plus 70 years (in United States and European Union).	The "author" of a work is typically the first owner of copyright. With a "work made for hire," the employer is considered to be the "author" by default. Ownership can be transferred by contract.	None. Copyright arises automatically on creation of the work; however, registration is possible and confers some benefits.
Patent (*Patent Act*, 35 U.S.C.)	"Inventions," which includes "any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof."	20 years from the date of filing of the patent application.	The "inventor" of an invention is the first owner of a patent. Ownership of a patent may be assigned by contract.	A patent must be applied for and applications are subject to rigorous review procedures.
Trade Secrets (*Uniform Trade Secrets Act* enacted into law in most U.S. states, jurisdictions, or common law)	Information (which can include a compilation of data, a formula, etc.) that has independent economic value from not being generally known and is the subject of efforts taken to maintain its secrecy.	As long as secrecy is maintained.	Owner is the person in whom the rightful title to the trade secret resides.	None, other than the requirement to ensure that the information remains secret.
Database rights	A database is defined in the EU database directive as "a collection of independent works, data or other materials arranged in a systematic or methodical way and individually accessible by electronic or other means." Protection extends to databases where there has been "qualitatively and/or quantitatively a substantial investment in either the obtaining, verification or presentation of the contents." **Note**: In the United States, a database is a compilation of data that is protected under copyright law by reason of the original selection or arrangement of the data (see above). There is no separate database right and the facts within the compilation are not protected. For the protection of databases in the US, see "copyright" above.	15 years from the date of completion of the database, though any substantial revisions to the database may give rise to a "new" database entitled to its own 15 year term of protection.	Owner is the person or persons who created the database. Database right may be assigned by contract.	No formalities required.

AN INTELLECTUAL PROPERTY RIGHTS-BASED TYPOLOGY FOR CITIZEN SCIENCE PROJECTS

Typologies of activities such as citizen science are useful analytical tools. They allow for analysis that is based on common features. Bonney *et al.* have proposed a typology for citizen science that focuses on the degree of public participation in citizen science projects. They identify three broad categories. The first involves projects designed by scientists with the public contributing data (contributory projects). The second category is also largely defined by scientists, but in addition to contributing data, the public may play some role in refining the design of the project, analysing its data, or disseminating its results (collaborative projects as demonstrated in Figure 2). The third category is called "co-created projects," which involves collaboration between scientists and members of the public at all stages of the project.[20] Wiggins & Crowston take a different approach with the typology they propose. They focus on the goals of citizen science projects and the manner in which technology is used to facilitate the projects. Thus, they categorize citizen science projects into those focused on action, conservation, investigation, virtual, and education.[21]

Because our interest is in the intellectual property implications of citizen science activities, our own typology focuses on those elements that give rise to intellectual property rights for participants. In the areas of both patent and copyright law (the two most important areas of intellectual property law in this context), rights accrue, in the first place, to inventors[22] or to authors.[23] In either case there is a qualitative element in assessing inventorship or authorship – not all activities in relation to a work or invention will qualify a contributor as an inventor or author. It should also be noted that in the case of copyright law, there is a separate issue: While it is legitimate to ask whether a contribution amounts to authorship (joint or otherwise) in a work that is the output of a citizen science project, there will be instances where the contributions elicited from the public will themselves qualify as "works" in which the contributors (or some other third party) are the authors. As a result, our typology, as set out in Table II, considers the nature of contributions to citizen science. This includes not just contributions to the output of the project, but also contributions that may themselves be "works."

Contributions to citizen science projects may range from a more mechanical contribution of labor to the contribution of ideas or expertise. They may also take various forms, from checking boxes or filling out online forms to submitting photographs or written observations. In some cases, contributions may be of personal health information or even human tissue samples and DNA. Our typology is therefore structured around the type of activity in which participants are invited to engage, the type of contribution they are asked to make, and the extent to which these contributions raise intellectual property issues. It is clear that not all contributions will involve either authorship or inventiveness; some are more clearly outside those qualitative measures than others.

Our typology is divided into four main categories of activities. Because there is such a wide diversity of project types, activities can vary widely both in terms of nature and substance. In the first category, the participants do not play a role in the collection of the raw research data. Rather, their role is to **classify or transcribe** data that is made available to them. Activities in the second category involve participants in actual **data gathering**. While there may be no copyright in data itself, the manner in which the data is submitted to the project may have some significance in the intellectual property context. The third category requires participants to provide data about themselves. Thus, in this category the participant is both **contributor and research subject**. A fourth category demands more intellectual engagement from participants. They are asked to **solve problems, share ideas, or manipulate data**.

FIGURE 2: Scientist demonstrates to community members how to enter observations into a mobile data collection system. The community members helped design the survey in response to the monitoring needs of their coffee plantations in Chiapas, Mexico (e.g. coffee plant health and endangered species.)

PHOTO CREDIT: Elizabeth Tyson

TABLE II: AN INTELLECTUAL PROPERTY TYPOLOGY OF CITIZEN SCIENCE

Type of Participant Activity	Type of Participant Input
1. Classification/Transcription	
Observation of recorded materials provided by project organizers (images, video, etc.)	Using structured data submission forms; clicking boxes; highlighting parts of text or image
	Providing own comments and/or annotations
Classification of images or sounds	Using structured data submission forms; clicking boxes
Transcribing information	Typing old handwritten logs or records
2. Data gathering	
Observation of natural phenomena (wildlife, plants, insects)	Using structured data submission form
	Submitting photographs
	Providing written observations in participant's own words
Monitoring environmental conditions (air or water quality, etc.)	Using specialized equipment provided by project leaders to record and submit data
	Submitting air/water quality samples for testing
3. Research subject	
Providing personal and/or medical information	Using structured data submission form
	Providing written descriptions or other accounts in participant's own words
	Providing DNA or other bodily fluid or tissue samples
4. Problem-solving, Data manipulation	
Game-playing to generate human behaviour data	Generation of data through game-playing
Problem-solving and manipulation of data	Participating in online games
	Hackathons
Sharing ideas and collaborating on innovation	Open innovation models

Potential IP Issues Related to Participant Input	Examples of Projects
Unlikely	What's the Score: Bodleian Library at Oxford
If written contributions amount to more than a few words, the contribution may be protected by copyright	What's the Score: Bodleian Library at Oxford (blog portion)
Unlikely	Moon Zoo Bat Detective WhaleFM Cell Slider
Unlikely	Notes from Nature Old Weather Citizen Archivist
Unlikely	The Great Sunflower Project Condor Watch eBird
Author of photo has copyright in the photograph (author may be the participant or a third party)	Lost Ladybug Project
Author of written observations may have copyright in the written text	
Unlikely	Community Collaborative Rain, Hail and Snow Network
Unlikely	Volunteer Monitoring at the EPA Louisiana Bucket Brigade San Francisco Baykeeper
Unlikely (note: there may be significant privacy issues)	
Author of written observations may have copyright in the written text	Patients Like Me (blog or forum postings)
Clear ethical issues Depending on project design and methodology, and on ultimate use of genetic materials, IP or IP-related issues may arise	Human Genome Project
Unlikely	Citizen Sort
Potential patent issues if involvement amounts to inventive activity	FoldIt Eterna
Potential patent and copyright issues relating to any software solutions developed	NASA Space Apps Challenge
Potential patent issues with respect to any inventions Potential copyright issues with respect to designs, ideas, comments, or feedback submitted in some material form	Quirky

Intellectual property considerations are important at the planning stage of a project, and in the drafting of appropriate terms of participation because addressing potential intellectual property issues can increase the value of the research output and ensure the researcher's ability to disseminate the results.

Table II offers a graphic representation of our typology. From this table it is clear that intellectual property issues tend to be relatively minimal (though still possible) in the first two categories, which involve mostly mechanical tasks. Where intellectual property issues arise in these categories, it is mostly as a result of the *form* in which contributions are made. Observational data entered into an online form may not turn the observer into an author; however, a journal or log entry by the participant that expresses those same observations in their own words may well qualify as a "literary work" that is protected by copyright law.[24] A contribution in the form of a photograph will almost certainly be a work in which copyright subsists. The third category is more complex. As with the previous two categories, intellectual property issues arise predominantly in this third category as a result of the *form* of the contribution. However, the form of contribution may be notably different. For example, it may include human tissue, DNA, or personal health information. In both cases, while the issues around the subsistence of intellectual property rights in contributions may not be notably different from the other categories discussed,[25] there will be an added layer of ethical concerns that will warrant particular attention.[26] In the fourth category, intellectual property issues arise as a result of the nature and intensity of the contribution. In this category the participant, by reason of their contribution, may actually engage in inventive activity that may give rise to patent rights. It is also possible that a participant might generate original copyright protected works when they provide creative inputs such as a new design or 3D shape. Thus, researchers should pay attention to both copyright and patent issues when they design citizen science projects that look for intellectual, innovative, or creative contributions from participants.

CONCLUSIONS AND FUTURE DIRECTIONS

Scientists who design and implement citizen science projects should consider two important intellectual property considerations:

1) Whether participants might have intellectual property rights in their contributions

2) Whether the nature of the participation is such that some participants might have claims to intellectual property rights in the output (such as a patentable invetion)

The typology we have developed outlines four broad categories of participation in citizen science projects. In the first three categories, whether contributors have intellectual property rights in the material contributed will depend largely upon the form in which contributions are made. Photographs, videos, and written observations may all be works in which copyright subsists. On the other hand, transcription, or entering data into fillable forms is unlikely to give rise to any intellectual property rights. In cases where the participant is also a research subject, the intellectual property analysis does not change materially, although there may be additional

ethical and privacy considerations. It is in the fourth category – where participants engage in problem-solving and data manipulation – that it is possible that the contributions of particular participants may rise to the level of inventorship or authorship in terms of the research outputs.

The typology we have developed provides a means of understanding the potential intellectual property implications that may arise from citizen science activities. Intellectual property issues may arise not only from the degree or quality of the participants' involvement in the project, but also from the form in which their contributions to the project are made. These considerations are important at the planning stage of a project and when drafting the terms of participation; addressing potential intellectual property issues can increase the value of the research output and ensure the researcher's ability to disseminate the results.

This typology addresses only a subset of the intellectual property issues raised by citizen science projects. Issues of ownership of intellectual property rights are complicated by the web of additional relationships that exist around science-based research. These include the relationships between researchers, their institutions, their funders, the technological platform used to carry out the project, and the journals that publish the research results. Other issues may include the effectiveness of terms of participation in managing intellectual property rights as between participants and researchers and the implications of involving participants located in multiple countries (and multiple legal jurisdictions). Another consideration relates to the management of intellectual property rights in the output of citizen science research projects. This treads the line between ethical obligations (for example, to provide full access to research results to participants in the research and to other research scientists) and the intellectual property tools that permit both open and restricted licensing of intellectual property-protected works. These issues will be the subject of future work in this area.

DISCLAIMER

This is a working paper to be submitted for peer review. This report should not be construed as legal advice. Groups should consult with counsel prior to adopting any of the strategies identified in this report.

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ENDNOTES

1. See, e.g.: R. Bonney, H. Ballard, R. Jordan, E. McCallie, T. Phillips, J. Shirk, and C. Wilderman, "Public Participation in Scientific Research: Defining the Field and Assessing its Potential for Informal Science Education. A CAISE Inquiry Group Report", Center for Advancement of Informal Science Education (CAISE), Washington DC, Tech. Rep., 2009, http://files.eric.ed.gov/fulltext/ED519688.pdf; Andrea Wiggins and K. Crowston. 2011. "From Conservation to Crowd Sourcing: A Typology of Citizen Science". Proceedings of the 44th Hawaii International Conference on System Sciences – 2011.http://crowston.syr.edu/content/conservation-crowdsourcing-typology-citizen-science.
2. Anne Bowser and Lea Shanley. 2013. *New Visions in Citizen Science*. Wilson Center, Commons Lab, Case Study Series, Vol. 3 at 45.
3. *Ibid*.
4. See, e.g.: Anne Bowser, Andrea Wiggins, and Robert D. Stevenson, "Data Policies for Public Participation in Scientific Research: A Primer", http://www.birds.cornell.edu/citscitoolkit/toolkit/policy/Bowser%20et%20al%202013%20Data%20Policy%20Guide.pdf, August 2013, online: at 1. "Open innovation" or "o(feel free to use any of it) g body or university or research lab?t (Cambridge, MA:duce new or improve existing knowledge and tpen development" may be described as the intellectual production between multiple contributors who share and coordinate their own resources to produce new or to improve existing knowledge or technology. This mode of knowledge production has been used in academic

science, peer-production projects like open source software and wikis. It is also used by the private sector, and in traditional knowledge communities. See Rochelle Cooper DreyFuss, "Does IP Need IP? Accommodating Intellectual Production outside the Intellectual Property Paradigm" (2010) 31:5 Cardozo L Rev 1437 at 1443-1447 and Matthew L. Smith & Katherine M. A. Reilly, eds, *Open Development: Networked Innovations in International Development* (Cambridge, MA: The MIT Press, 2013).

5. For example, Raddick et al state: "Citizen science is driven by a scientific need, but it simultaneously meets an identified need for authentic science experiences in both formal and informal education." M. Jordan Raddick, Georgia Bracey, Karen Carney, GezaGyuk, Kirk Borne, John Wallin, Suzanne Jacoby, "Citizen Science: Status and Research Directions for the Coming Decade", Proceedings of the Fifth International Conference on Weblogs and Social Media, Barcelona, Catalonia, Spain, July 17-21, 2011, https://www.researchgate.net/publication/237744375_Citizen_Science_Status_and_Research_Directions_for_the_Coming_Decade. Silvertown notes that a citizen science project may be for the benefit of either the participant or the research, but states that "The best examples benefit both." (Jonathan Silvertown, "A new dawn for citizen science", Trends in Ecology and Evolution 2009, 24:9, 467-471, at 467.)
6. Bowser & Shanley, *supra* note ii at 4.
7. *Ibid*. at 45.
8. Jennifer L. Shirk, H. L. Ballard, C. C. Wilderman, T. Phillips, A. Wiggins, R. Jordan, E. McCallie, M. Minarchek, B. V. Lewenstein, M. E. Krasny, and R. Bonney. 2012. Public participation in scientific research: a framework for deliberate design. *Ecology and Society*17(2): 29.http://dx.doi.org/10.5751/ES-04705-170229.
9. *Ibid*.
10. *Ibid*.
11. *Ibid*.
12. *Ibid*.
13. *Patent Act*, 35 U.S.C. §101.
14. According to the Patent Act, 25 U.S.C. §199(f) an 'inventor' is "the individual or, if a joint invention, the individuals collectively who invented or discovered the subject matter of the invention".
15. There is a one-year grace-period, before patentability is lost, for subject matter disclosed by the inventor or joint inventor, or someone who obtained their information from either the inventor or joint inventor: *Patent Act*, 35 U.S.C. §102(b)(1).
16. 17 U.S.C. § 302(a).
17. The U.S. *Copyright Act* provides that "Works of authorship include the following categories: (1) literary works; (2) musical works, including any accompanying words; (3) dramatic works, including any accompanying music; (4) pantomimes and choreographic works; (5) pictorial, graphic, and sculptural works; (6) motion pictures and other audiovisual works; (7) sound recordings; and (8) architectural works." 17 U.S.C. §102.
18. Directive 96/9/EC of the European Parliament and of the Council of 11 March 1996 on the legal protection of databases, OJ L 77, 27.03.1996, p. 20–28.
19. It should be noted that the use of contracts – end user licence agreements or terms of use in the online context – can change default expectations regarding the ownership of IP rights. Thus, this typology identifies IP issues arising in the context of citizen science projects in the abstract, the existence of a contract between participant and researchers may be determinative. For example, Terms of Participation might require users to assign all intellectual property rights in their contributions to the researchers. Indeed, contracts are a crucial tool in managing both IP rights and participant/researcher expectations in this context.
20. R. Bonney, H. Ballard, R. Jordan, E. McCallie, T. Phillips, J. Shirk, and C. Wilderman, "Public Participation in Scientific Research: Defining the Field and Assessing its Potential for Informal Science Education. A CAISE Inquiry Group Report", Center for Advancement of Informal Science Education (CAISE), Washington DC, Tech. Rep., 2009, http://files.eric.ed.gov/fulltext/ED519688.pdf.
21. Andrea Wiggins and K. Crowston. 2011. "From Conservation to Crowd Sourcing: A Typology of Citizen Science". Proceedings of the 44th Hawaii International Conference on System Sciences – 2011.http://crowston.syr.edu/content/conservation-crowdsourcing-typology-citizen-science.
22. According to the Patent Act, 35 U.S.C. §100(f), "The term "inventor" means the individual or, if a joint invention, the individuals collectively who invented or discovered the subject matter of the invention."
23. See the definitions of "author" for the purposes of copyright law, in Table I, above.
24. Note that a use of this material that simply extracted the factual data from the contributor's account would not necessarily infringe upon the contributor's copyright in their account. Problems might arise, however, if the research sought to publish significant verbatim extracts from these accounts.
25. Human tissue, DNA, and bodily fluid are all naturally occurring substances, and as such, are not patentable as inventions. Where research is carried out using these contributed substances, it may lead to patentable inventions, but the contributor will not be in a position to claim intellectual property rights, as they will not have participated in the inventive step that results in the patent.
26. These ethical concerns, which may involve research ethics and privacy considerations, are beyond the scope of this paper.

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