

Biodiversity Citizen Science Data Production Through iNaturalist: An Anthropological Exploration

by
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A thesis
presented to the University of Waterloo
in fulfillment of the
thesis requirement for the degree of
Master of Arts
in
Public Issues Anthropology
Waterloo, Ontario, Canada, 2023

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners. I understand that my thesis may be made electronically available to the public.

Abstract

iNaturalist is a common mobile application used in biodiversity citizen science projects and education. The application lets laypeople of all levels of expertise submit species ‘observations’ that can include correlating photo and audio data. All iNaturalist observations are publicly available and can be utilized by professionals in environmental organizations, researchers, academics, and park rangers. By drawing on participant observation at citizen science events hosted by the environmental charity EcoSpark, interviews with academics as well as professionals working for federal and provincial government institutions, it appears that the movement of data from the laypeople to the researchers and professionals can involve acts of giving and taking as well as an abundance of activities that spurn hope and trust for biodiversity citizen science involvement. As explicit anthropological engagement with biodiversity citizen science remains an area for ripe exploration, this thesis thus aims to embark on an anthropological exploration of a sample of iNaturalist users in Ontario, their perspectives, and the data production activities that engage them in biodiversity citizen science efforts.

Acknowledgements

I would like to thank my advisor, Dr. Götz Hoeppe, for his patience and guidance throughout this journey. I also want to thank my committee for their immensely insightful feedback. To the Faculty of Arts, the Department of Anthropology faculty and staff, and the Iris Yuzdepski family, I thank you all for your support. To my cohort, your time, support, and kind words throughout it all, no matter how small or fleeting, were never lost on me. Thank you.

To EcoSpark, members of the iNaturalist steering committee of Canada, and all the participants who I met along the way, thank you – for I would never have learned as much about citizen science without your willingness to share your knowledge and perspectives.

Lastly, I would like to thank my dear friend J. Lin who has supported me so much and is truly the donut of my life – I could technically go on without you, but what a misery it would be.

Table of Contents

Author's Declaration	ii
Abstract	iii
Acknowledgements	iv
Chapter 1: Citizen Science's Contribution to Public Issues Anthropology	1
1.1 Introduction to Citizen Science	1
1.2 Citizen Science and Digital Technology	2
1.3 Relevance to Public Issues Anthropology	3
1.4 Conclusion	4
1.5 Proposed Publication Venue	5
Chapter 2: Biodiversity Citizen Science Data Production Through iNaturalist: An Anthropological Exploration	6
2.1 Introduction	6
2.2 Background	8
2.2.1 Engagements with Citizen Science by Social Scientists	11
2.3 The Context of Observed Acts of Data Collection and Data Production	12
2.3.1 Methodology	12
2.3.2 Observations of Event Staff and Event Participants	13
2.3.3 Introducing Marcel Mauss and Exploring Gift Exchange	16
2.3.4 The Nature of iNaturalist Data, Hope, and Trust	18
2.4 Data Users, Their Uses, and Their Perspectives on Biodiversity Citizen Science Data	24
2.5 Discussion and Explorations	28
2.5.1 Circling Back to Mauss	30
2.5.2 In Consideration of Mauss and Hope	31
2.6 Conclusion	33
References	36
Appendices	40
Appendix A: iNaturalist References	40
Appendix B: Details on Methods	42

Chapter 1

Citizen Science's Contribution to Public Issues Anthropology

1.1 Introduction to Citizen Science

Citizen science can be broadly understood as the involvement of people in the scientific process (Pocock et al. 2019, 275). People are generally understood to be able to participate regardless of their degree of expertise or knowledge on a topic. Citizen science's history can be traced as recently to the 1990s when the term was allegedly coined by Richard Bonney and Alan Irwin (Strasser et al. 2018, 53) or from a conceptual front, as far back as ancient China (Irwin 2018, 481). The nature of citizen science encourages greater intimacy within the relationship between everyday people with interests in science and under some circumstances, accredited scientists that can benefit from the data collection processes undergone by citizen science participants. Citizen science thus aspires for an elevated public understanding of, and support for, science and environmental conservation (Dickenson et al. 2012, 292). Citizen science has been touted for decades for its potential to advance informal science education and contribute diverse perspectives to a more robust science (Dickenson et al. 2012; Adler et al. 2020). It also yields immense potential in terms of the scope of different kinds of publics it may interact with and has demonstrated its versatility through projects such as Phylo, eBird, Galaxy Zoo, and iNaturalist, each attending to citizen science engagement in genomic sequencing, ornithology, astronomy, and biodiversity respectively. Biodiversity citizen science is so much about and reliant on everyday people engaging with their natural surroundings motivated by the logic of helping further scientific efforts and expanding their individual scientific knowledge.

1.2 Citizen Science and Digital Technology

While citizen science efforts have existed prior to the rise of accessible internet devices, participation rates have since increased with its adoption. With the computer being the first to arrive, many sites have since been used to promote and corral public volunteers to assist with data collection to the benefit of scientists and researchers around the world. With the developments in technology, new ways of delivering media such as audio clips and photos would become more prevalent and sought out as part of citizen science work (Dickenson et al. 2012, 296), eliciting a sense of newness. The newness of media technology can be further applied to the various apps that have emerged to assist with citizen science projects. They each occupy a unique way to communicate data about the natural world, all of which challenge a predeceasing strategy for coordinating social interactions involving the exchange of information and its public (everyday people) and private (scientists) communications. Ilana Gershon writes that “people experience a communicative channel as new when it enables people to circulate knowledge in new ways, to call forth new publics, to occupy new communicative roles, to engage in new forms of politics and control—in short, new social practices” (Gershon 2017, 15). This leads us then to explore what exactly such new social practices look like and if they are, indeed, new. Citizen science technology such as iNaturalist is positioned as this exciting doorway and invites exploration to better understand what kind of approaches are utilized to engage with the prospect and excitement of the field of citizen science.

Citizen science and its interaction with digital technology can pique the interest of anthropologists due to the way it involves matters of trust, hope, promise, acts of giving and taking, the establishment and maintenance of social relationships, and the statuses of such relationships. Anthropologists are familiar with these subjects, yet direct engagements with

citizen science by anthropologists have been limited (Chari et al. 2017; Jeevendrampillai and Conquest, 2021), which can optimistically be translated as a ripe area for anthropological exploration. This invites an investigation to determine why anthropology has yet to invest greatly in the subject.

1.3 Relevance to Public Issues Anthropology

Rather than trying to explain why this topic is relevant *to* public issues anthropology as it could be easily argued that it is because of its ambitious desire to engage as wide of a public as possible, I want to spend some time thinking about why this is important *for* public issues anthropology. Public issues anthropologists have struggled with the desire to communicate themselves more conveniently to everyday people in a way that comprehensively attends to the nuances of anthropological thought while simultaneously safeguarding ideas from being co-opted or appropriated for unsavoury purposes which displace the original researcher's intentions and ideas entirely (Kansa et al. 2005, 286).

Another issue public issues anthropology faces is that it is prone to be converged upon by other synonymous culprits such as applied or engaged anthropology. The public issues anthropology that I wish to consider and frame this research around is national and hinted at by authors like James Waldram (2010) and Regna Darnell (2015). A tradition of Canadian anthropology appears to have always resided in the realms of what public, engaged, or applied anthropology writes itself to be, which is one maybe most simplistically defined as engaging with people and helping where possible. That being said, Waldram (2010) described Canadian anthropologists to act on this "legally, respectfully, often quietly, almost apologetically" (225), whereas Darnell (2015) understood that "to engage the world inevitably has consequence, whether good or ill." (4). Here I depart from Waldram and walk behind Darnell in charging forward with my regional

investigation of citizen science. Like Darnell I hope to illustrate that with the lack of explicit literature in socio-cultural anthropology about citizen science my preliminary engagements can only help the next to better establish how to approach discussions of citizen science within public issues anthropology and ultimately anthropology as well. Many Canadian examples of public issues anthropology conventionally include discussions of advocacy, policy making, and collaboration with Indigenous peoples (Silverman 1991; Graburn 2006; Waldram 2010). Biodiversity citizen science can follow in this vein because of the closeness some of its projects are to nature conservancy and related policy. The importance of nature conservation is fundamental to many ways of life and livelihoods of Indigenous communities across Canada and has seen increasingly visible advocacy in the political sphere as well.

1.4 Conclusion

Research on Citizen Science is thus relevant for public issues anthropology in that it directly involves the words, actions, and perspectives of the public that find interest in participating in citizen science projects. It brings attention to a broader concern regarding the relationship academic institutions have with the public. This concern has plagued public issues anthropology and is echoed in citizen science by Maria Aristeidou et al. (2021) who have claimed that “there is a lack of agreement as to what [citizen science] is or means, which has resulted in considerable heterogeneity amongst [citizen science] projects, difficulties in assessing the quality of the projects and their outcomes, and a risk in establishing trust between citizens and scientists” (1). To be able to describe the present circumstances unto which citizen science in Ontario looks like is important to public issues anthropology, partly because of how it establishes a public that encompasses everyone dependent on natural resources (an ambitiously sized public), and partly because of how it resembles similar struggles that public issues anthropology itself encounters.

Issues of public outreach and engagement, defining the relationship between researchers and the lay users, as well as the data that sits between the two. Understanding how these issues are of concern to citizen science may then be useful, not just as a topic of interest to public issues anthropology, but for public issues anthropology.

1.5 Proposed Publication Venue

I propose to publish my research in Science Technology and Human Values, published by Sage Journals. The journal is a double-blind peer-reviewed interdisciplinary journal devoted to science and technology and their relationships to politics, society, and culture. A handful of citizen science publications have emerged from this journal (Ottinger 2009; Kuchinskaya 2019; Benyei et al. 2020) and this research which attends to hope, trust, the managing of social relations, and more that are important to daily life, provides a unique addition to the journal's existing citizen science contributions.

Chapter 2

Biodiversity Citizen Science Data Production Through iNaturalist: An Anthropological Exploration

2.1 Introduction

Citizen science is a term that encapsulates many goals and practices that are aimed to increase public engagement and education with the sciences. Citizen science efforts can be grassroots efforts made and run by laypeople to better serve local communities to long-term and large-scale monitoring projects involving various parties and expertise. One view of citizen science draws upon the premise of a shortage of scientists and scientists' resources to collect data for research projects, in conjunction with the idea that any amateur layperson has the potential to assist in data collection thereby assisting in the production of scientific knowledge (Strasser et al. 2018, 54). All that is needed is a research project or setting to bring these scientists and laypeople together (Dickinson et al. 2012, 291). Since the emergence of iNaturalist in 2011, it has been one of the go-to applications in Ontario citizen science projects, potentially in part by iNaturalist's own efforts (Di Cecco et al. 2021, 1181-2), for recording species observations (with some niche exceptions such as with eBird, a dedicated birding app). BioBlitzes engage public audiences in a "race against time to find, identify, and record as many different species as possible in a given timeframe" (Postles and Bartlett 2018, 365) and have garnered public attention as they are typically hosted at publicly accessible locations such as public parks or conservation areas.

Prior to the widespread use of mobile cellular devices with cameras which enabled the creation of iNaturalist, many BioBlitzes and other biodiversity species surveying activities in Ontario were conducted with a field guide, paper, and pencil (Anderson 2018, 24). iNaturalist's mobile

application has since replaced the attendance of pen and paper at many BioBlitzes and survey activities due to its sophistication and streamlined ability to store species observations and receive community feedback on species identifications. Over the past decade, biodiversity citizen science in Ontario has been popularized through many BioBlitzes utilizing iNaturalist and have been hosted by institutions as large as the Royal Ontario Museum, to local county nature clubs such as in Prince Edward County. Due to the pandemic, large public events were restricted and with the departure of key members who helped lead BioBlitz engagement in Ontario, such activities were forced to take pause. Yet that did not mean the end of biodiversity citizen science in Ontario.

To learn more about biodiversity citizen science and how iNaturalist was being employed as a citizen science tool to produce data, I attended four citizen science events hosted by EcoSpark, an environmental charity based in Toronto. I also interviewed academics and professionals who had encountered iNaturalist in their work setting; this ranged from students and professors to provincial park rangers, as well as members of organizations that made up the iNaturalist steering committee of Canada such as the ROM, Parks Canada, and Canadian Wildlife Federation (CWF). While there was some overlap, I also observed a variety of biodiversity citizen science activities and usages; students using iNaturalist data as research material, park rangers utilizing the app and its data as tools for public engagement and local knowledge generation, professors collaborating on research projects and teaching with the app, and institutional uses of the data in conservation and community involvement.

What this diversity of experiences showed me was that, firstly, people were still engaging in biodiversity citizen science projects in Ontario, and secondly, biodiversity citizen science as I had come to learn about it, spoke to a multitude of anthropological interests. Matters pertaining

to public outreach and community involvement, education, hope, trust, and most starkly acts of giving and taking that were being established by ways of citizen science projects engaging laypeople and data users through specific kinds of activities. For clarification, while there are certainly occasions where a layperson could also be a data user (and vice-versa), for this paper, I shall distinguish these two groups separately in which the use of laypeople will serve as a reference to the participant volunteers engaged in activities of data collection, whereas the interviewees I encountered such as researchers, students, park rangers, and other professionals, will be written about and referred to as data users as they were the specific kinds of people I encountered who mentioned explicit data usage practices.

2.2 Background

Before delving further, it is important to understand the way biodiversity and citizen science have been written about in academic literature. The term ‘biodiversity’ is often synonymized with ‘biological diversity’ which refers to the “variability among living organisms from all sources” (Harper and Hawksworth 1994, 6). Yet the term ‘biodiversity’ has been debated for the past two decades. Some of the key concerns regarding ‘biodiversity’ which have yet to achieve a consensus include concerns regarding evaluating biodiversity using quantitative metrics, how to evaluate the significance of a given species to its ecosystem (Harper and Hawksworth 1994; Fieseler 2021), and the term’s implication toward Western knowledge and science practices that can disregard the contextual aspects of the subjects of study (Mazzocchi 2006, 464).

These concerns regarding biodiversity emerged in response to questions about whether some species produced more benefits to an ecosystem than others and how to answer such a question. The implication for Western knowledge lies in the practices which ‘biodiversity’ encourages, such as total surveying and minimizing the human impact on protected lands. Such practices

have left limited space for other ways of knowing and doing, such as those provided by Indigenous knowledge keepers to help inform and assess the abundance of biodiversity in an ecosystem as well as ways to mitigate biodiversity decline (Fieseler 2021). In this way, Clare Fieseler (2021) argues that many critiques of the term biodiversity derive from implicit human values and whose knowledge matters. While such critiques are insightful, iNaturalist appears to present itself in a way which resonates more so with the surface-level sentiment of ‘biodiversity’ that refers to the variety of life forms in an environment because of how it defines itself as a “generator of high quality biodiversity data” (Loarie 2022). However, as the design of the app encourages the inclusion of photo (or audio) evidence for species observations, it is implied that the biodiversity iNaturalist favours are the varieties of life which are visibly (or audibly) accessible.

Citizen science, as a term, has many sister terminologies that evoke similar but slightly nuanced variations in their definitions. Terms include that such as community science, or inclusive citizen science (Cooper et al. 2021). A broad definition has been provided by Michael Pocock et al. (2019) who define it as “the involvement of lay persons in the scientific process” (275). While its history may be traceable to ancient China (Irwin 2018, 481), citizen science has seen increasing presence, speculated to be attributed to “an increase in public knowledge and concern about anthropogenic impacts on natural ecosystems” (Conrad & Hilchey 2011, 274). Ultimately, after all this effort, citizen science writers and enthusiasts believe such engagements with the public will achieve three promises. These promises were specifically outlined by Strasser et al. (2018) as “a greater democratization of science; better scientific literacy; and new scientific breakthroughs” (62). In the process of achieving such promises, building social capital has been

suggested by citizen science writers to increase public support for citizen science (Conrad and Hilchey 2011, 280) and thus provide more awareness and participation in such projects.

According to some biodiversity citizen science writers (Conrad & Hilchey 2011; Dickenson et al. 2012; Strasser et al. 2018), beginning with the recruitment of volunteers, two kinds of exchange-like events are believed to occur. The first is that the volunteer, by way of simply attending the event, can increase their scientific literacy (Dickinson et al. 2012, 292; Strasser et al. 2018, 54). What seems to be implicated is an act of reciprocation or repayment for the increased scientific literacy that is realized by retained attendance or continuation of citizen science involvements. I interpret this exchange as a strategy that citizen science looks toward to address concerns regarding volunteer engagement (Strasser et al. 2018; Adler et al. 2020), by fostering this kind of relationship as a way of enabling both egocentric and altruistic motivators that participants use to grow their personal knowledge, while simultaneously contributing to some larger project or goal. The second exchange has to do with fostering a relationship between the volunteer who produces data and the scientists who use such data (Conrad and Hilchey 2011; Dickenson et al. 2012; Strasser et al. 2018). The exchange of data points for education and better Earth stewardship practices are highlighted as aspects of a relationship between volunteers and scientists that could help to constitute what Trizenberg et al. 2012 (quoted in Dickinson et al. 2012, 292) calls “a fully shareable public good”.

Citizen science thus holds a unique and promising position for some researchers because it can “assist in answering scientific questions that would otherwise be difficult or impossible to determine without the presence of such vast resources” (Conrad & Hilchey 2011, 277). Conrad and Hilchey go on to confirm that in one case regarding ornithological data collection through citizen science, “there [was] no conceivable way that paid professionals alone could gather the

amount of data annually undertaken by volunteers of the British Trust for Ornithology (Bibby 2003)” (2011, 277). While such data collection practices appear quite beneficial for scientists, critical challenges that Conrad and Hilchey highlight regarding the sufficiency in which scientists can give back to laypeople, continue to echo into more recent writings. Frederick Adler et al. (2020) writes deliberately about the concerns which remain unresolved with citizen science projects, such as evaluating success as well as enhancing participation and acknowledgement of participant efforts (58-9).

2.2.1 Engagements with Citizen Science by Social Scientists

Social scientists have also begun to participate in citizen science discussions. Publications have appeared to increase after a 2017 call by Raffael Heiss and Jörg Matthes, but whether this call led to the increased engagement is not entirely clear. Regardless, there is a growing body of literature that speaks to specific biodiversity citizen science efforts within countries in Europe, Africa as well as the United States (Aristeidou et al. 2021, Pocock et al. 2019, Chari et al. 2017, Irwin 2018), typically looking at the efficacy of the discipline in education and in impacting policy change.

While much of the existing work by ways of surveying (Aristeidou et al. 2021), utilizing statistical analyses (Kullenberg and Kasperowski 2016), as well as some participant observation (Altrudi 2021) has come to help contextualize and understand participant behaviours during biodiversity citizen science events. While Soledad Altrudi’s (2021) argument was centered around the problematizing of the Western lens in which iNaturalist encourages users to “connect with nature” (125), Altrudi also hinted at how user engagement with iNaturalist sometimes involved two parties, laypeople and data users, and these parties were somehow connected to each other through acts of giving and taking, knowledge production, promises, community, and

at the center, a mobile and web application called iNaturalist. Excluding iNaturalist, the rest of these subjects have all been of anthropological interest and thus invite further exploration in this new context. I aim to do this by outlining some of my fieldwork experiences, followed by an example of the kinds of giving and taking I had observed, and then introducing and utilizing the theories of gift exchange such as that pioneered by Marcel Mauss, to see how the kinds of giving and taking fit into such frameworks.

I will also adopt Hirokazu Miyazaki's (2004) thoughts on hope which he derives great inspiration from philosopher Ernst Bloch (1986), to better understand the kinds of perspectives some laypeople had in context to creating observational data through iNaturalist. Miyazaki's understanding of hope will help to make visible some of the moral elements of biodiversity citizen science data and the unique temporal disposition of research-grade data on iNaturalist. I will then turn to some of the perspectives on the data produced through iNaturalist that were shared by the data users as well as some of their examples of data usage. From here I will return to Mauss, Bloch, and Miyazaki to recognize the multifaceted nature of the data being produced, and what this nature can reveal about biodiversity citizen science. In doing so, I hope to shed light on some of the kinds of anthropological engagements that are made possible by biodiversity citizen science data production through iNaturalist.

2.3 The Context of Observed Acts of Data Collection and Data Production

2.3.1 Methodology

I collected data for this study using purposive sampling, which H. Russel Bernard (2018) describes as somewhat similar to quota sampling, which is a stratified sampling technique without random selection and often includes a sampling design (146). The two sampling

techniques are similar in that they do not rely on random selection, however, a key difference Bernard (2018) identifies that differentiates purposive sampling from quota sampling is the absence of a sampling design (147). Bernard (2018) writes that instead, purposive sampling adopts a “take what you can get” (147) approach that requires the researcher to decide the purpose informants will serve and to subsequently go looking for them. Bernard (2018) draws upon his own experience during initial interviews that resulted in an exploratory and emergent discovery of a group of men who he would not have considered meeting otherwise (147). For my research purposes, I took interest in seeking participants who were iNaturalist users that had used the app in a professional setting or as a tool in their citizen science participation. Whilst the population of interest would not typically be as challenging to find in a pre-pandemic climate, purposive sampling was appropriate for the research given the timing and uncertainty of public event organizations after the easing of public health restrictions.

With a purposive sampling approach, I was able to conduct 13 virtual interviews; 3 informational and 10 semi-structured to learn more about professional uses of iNaturalist and to discover possible sites for participant observation. However, it became apparent that it would be challenging to organize follow-up visits with interviewees due to participants’ geographic unavailability or hesitancy relating to public health safety. It was only about two months into the research stage that I had the opportunity to begin collecting data utilizing participant observation after reaching out to EcoSpark, a local environmental charity.

2.3.2 Observations of Event Staff and Event Participants

On June 25, 2022, I attended the first of four public events hosted by EcoSpark in partnership with Project Swallowtail, a newsletter that provides information about upcoming nature and conservation events in Toronto. I was informed that while EcoSpark did host occasional public

and private events for corporate groups, most of their efforts were focused on school groups and developing educational materials. I would later attend two more public events and one private event, but one of the two public events would end up being cancelled as there were no members of the public who showed up. Due to the cancellation, I was able to instead spend some time with the EcoSpark staff to learn more about their non-public-facing work. Between the other two public events which I attended; participant attendance averaged between seven to eight. The private event, which was hosted for a corporate group, had 18 people in attendance.

The events all had similar itineraries, beginning with some general information about the day and the importance of the work to citizen science in general. After introductions, the host for the public events would take the group to a ‘circle of trees’ (i.e., a group of trees that had been previously tagged by volunteers working on the project – typically 3 to 6 trees were tagged per circle) to teach participants about the Caterpillars Count citizen science project that EcoSpark was working on in partnership with Project Swallowtail. Volunteers watched and optionally participated in the use of beat sheet surveying on the circle of trees to determine the diversity and the abundance of arthropods, otherwise known as members of the phylum Arthropoda (e.g., invertebrates distinguished by their segmented body and jointed limbs such as insects, spiders, and centipedes), in the area. In one public and one private event, this was also coupled with an exercise of bird surveying using eBird. While the app demoed to record data was a designated and custom app for the Caterpillars Count citizen science project, it was noted that data entries were also hosted to iNaturalist and could be found on the iNaturalist app by searching for the Caterpillars Count project. After a demo of the surveying process, the participant group would either continue to be led through the park to see other circles and continue to conduct beat sheet surveys, or it would transition to a butterfly net activity where participants were educated on the

use of iNaturalist and its sister app Seek, which utilizes the same computer vision model (Shepard 2018), as well as some of the tools used to take photos of insect species such as clear containers and ice packs. I observed the iNaturalist and butterfly net activities across all public and corporate events that I attended.

The public event participants showed varied amounts of interest. Public volunteers with backgrounds in education and members of the corporate group showed the most engagement with the activity. Aside from a general fondness for nature and conservation, a variety of more specific motivations for attending the events were also apparent. Two participants who identified themselves as teachers expressed interest in attending the event to learn about what kind of activities or knowledge, they might be able to introduce to their classroom. Three other participants I spoke with expressed their interest in learning more about conservation science and closely followed specific scientists and their research, one jokingly self-describing themselves as a “groupie”. What was perhaps the most striking was that of all the event participants I spoke to only one person explicitly mentioned an altruistic interest in helping scientists. At the end of two of the three events I participated in, the EcoSpark staff gave participants a parting appreciation gift. During the public event, it was a small packet of wildflower seeds native to the area, and at the corporate event, it was wooden pencils designed by EcoSpark.

In general, EcoSpark structured events in a way where there was always one section of the event where the event facilitators would teach the participant group about the apps iNaturalist and Seek, and then it would be shortly followed by a demonstration of how to use butterfly nets. This would transition into the participants utilizing the butterfly nets to try and capture some insects of their own and then bringing them back to the event facilitators to put into clear containers so that photos of the specimens could be taken and uploaded to iNaturalist. As mentioned

previously, at the end of two events I attended, participants received a small thank-you gift from the event hosts. These aspects of the events with EcoSpark make visible some of the acts of giving and taking that were also involved and crucial to the procurement of iNaturalist observations.

2.3.3 Introducing Marcel Mauss and Exploring Gift Exchange

It is here that I want to introduce a popular framework for thinking about gift giving by Marcel Mauss (1872-1950). Mauss proposed in his seminal essay *The Gift* (1954 [1925]), that there are three obligations to gift giving; the giving, the receiving, and the reciprocating (10-11). Though appearing simplistic, each obligation can be extremely important as each can implicate tension, gratitude, peace, alliance, and so much more between parties. In his work, Mauss exemplified this through a variety of references to practices between Polynesian clans he had collected second-hand. Mauss would go on to utilize a variety of other cultural rituals to investigate the moral and economic codes that structured the descriptions of exchange he had come across. The contribution Mauss has made to the understanding of gifts and exchange has been monumental to anthropologists for decades after its original publication and has since inspired further adaption, response, and critique.

For instance, Marion Fourcade and Daniel Kluttz (2020) have suggested an evolution of the Maussian gift to the Maussian bargain, which speaks to the absence of the solidaristic “moral economy” that sustains the gift, and in its place an “economic morality” of bargaining, ultimately construed as a set of moral relations deliberate for the constant replenishing of the data pipeline at the cheapest cost through incentivizing free labour via free reciprocation. Fourcade and Kluttz attempt to make moral relations visible through a diagram articulating the relationships and obligations between the parties involved.

Another sharp contributor to the subject of gifts is Pierre Bourdieu (2010 [1977]), who writes that the gift economy, “in contrast to the economy in which equivalent values are exchanged, is based on a denial of the economic, on a refusal of the logic of the maximization of economic profit, that is to say, of the spirit of calculation and the exclusive pursuit of material (as opposed to symbolic) interest, a refusal that is inscribed in the objectivity of institutions and in dispositions.” (195). In the realms of a gift economy, it might be that such inequality is not of concern because the spirit of calculation is not particularly of interest or priority to any of the laypeople, at least in the handful of those that I encountered. Altrudi (2021) for instance writes that upon her investigation, it appeared that many of the iNaturalist users she encountered had already seen themselves as ‘connected to nature’, and had a vested interest in knowing more about it, implying that rather than the app’s place in the mind of these users being one that occupied a relational position which connected different agents, instead it served as a way in which to enhance their personal practices with the natural world that they were already engaged in.

Mauss is often read as a foundational text to anthropologists and as shown there have since been adaptations and extensions to his original work. For instance, Jonathan Parry and Maurice Bloch (1989) define gifts in relation to money, in which they determine gifts “impose an identity on both the donor and the recipient, and reveals ‘the idea which the recipient evokes the imagination of the giver’” (8-9). Money, for Bloch and Parry (1989), thus differs from gifts in that money could not impose an identity in the same way, and rather money “signifies a sphere of ‘economic’ relationships which are inherently impersonal, transitory, amoral, and calculating.” (9). In separating the two, Bloch and Parry suggest there is an inherent moral feature within the giving and receiving of gifts.

While the literature on gifts and exchange in anthropology continuously expands, as Mauss and many other anthropologists have understood, the obligations of gift-giving do not just exist in a neat bounded vacuumed space. Rather, they serve a larger purpose of establishing and maintaining a social relationship between parties. Anthropologists' understanding of gift giving thus lends to the understanding that it is not only a practice used to (re)affirm the relationship between two parties but can establish a temporally binding relationship as well in further acts of gift giving.

I want to now take Mauss' three obligations and transport them back to the example I shared earlier. The structure of the events made visible three interactions of giving and taking interactions happening; the give and take of knowledge, the give and take of data collection, and then finally the give and take of a parting gift. To be able to adopt Mauss firstly requires thinking about all the things that were being given and taken as gifts. This means considering knowledge and data collection as gifts, a temporary relationship becomes established between the event facilitators and the participants, in which they go through the motions of giving, receiving, and reciprocating, and ultimately adjourn the relationship with a final thank you gift from the facilitators to the participants. While this is an interesting way of understanding the activities on the ground which contribute to the data collection processes through iNaturalist, it is only a surface-level approach to understanding gift giving in biodiversity citizen science because this is only one-half of the citizen science endeavour with iNaturalist, and ultimately begets the question of how we can make sense of the scientists and other data users through this theory of gift exchange.

2.3.4 The Nature of iNaturalist Data, Hope, and Trust

Before shifting to the data users, it is important to first understand the movement of the data that was made by efforts from lay citizen science participants and then funnelled indirectly into the hands of scientists and researchers via the export data feature on iNaturalist or through the export data feature on a variety of other databases which has merged iNaturalist data into their own. Understanding this movement of data from lay to professional people requires a bit of context regarding hope and trust in biodiversity citizen science and iNaturalist. This is to prepare for a later discussion of gift exchange, and in doing so also recognizes that gifts contain and transmit the moral qualities of those who are giving said gifts (Bloch and Parry 1989, 8). Furthermore, while it may sound lucrative that just about anyone can produce data, the quality of the data is also a prevalent concern. Steven Shapin (1995) emphasized the importance of trust relations in the making of scientific knowledge. Data in citizen science is the raw materials from which scientific knowledge is produced, thus if a sense of trust can not be established with the data, the entire endeavour of citizen science could begin to break down.

The tutelage of iNaturalist in biodiversity citizen science data production requires some context to fully appreciate its position and the attitudes surrounding it. Stuart Anderson (2018) writes that the preliminary technologies used to document biodiversity were paper and pencil (12). This was echoed by two interviewees who noted that before the existence of iNaturalist, the medium in which they used to record citizen science data for species surveys and checklists was via pen, paper, a field guide, and optionally a camera if that happened to be around. Verifying the accuracy of photos and species identification was also noted as a time-consuming task. One of the interviewees, Data Manager A, who had previously worked on data management for Ontario BioBlitzes, explained to me that her experience included the repetition of exporting and importing data multiple times through multiple software programs to store and share information

about the species that were discovered at events. This was work that was facilitated through this individual, amongst others who assisted them in auditing the data for duplicate entries and ensuring data accuracy. This changed once iNaturalist was adopted, in which the work of being the intermediary was no longer the sole responsibility of an individual and was thus partially delegated to each participant's mobile device. Ilana Gershon (2017) explains that "every new communicative channel alters the available participant structures that have previously been established for already existing channels" (16). Thus, understanding the shift in media helps to provide an understanding as to why so many use iNaturalist now, and how data production practices have changed temporally and socially because of the perceived newness of the app and the alterations to communication channels that were not as readily available before it.

Most of the interviewees that used iNaturalist data in a research context, noted they only drew upon research-grade data. Upon a personal exploration of the iNaturalist app, I observed that the data could be categorized into two grades on iNaturalist: "casual" and "research" grade (Appendix A). The differential between the two grades is significant because it is what separates entries from being uploaded to various government and non-profit research databases, such as the Global Biodiversity Information Facility (GBIF) which can be utilized by researchers around the world. The qualification for an observation on iNaturalist to meet research-grade is simply to have a majority of users agree that the species is indeed what the observer states it is. This could be done in the app by simply tapping the comments icon below the image of the observation and then pressing the "agree" button on the bottom right of a species suggestion.

Users could also utilize the "Data Quality Assessment" checklist by tapping anywhere in the Data Quality section, which at the end, would ask "Based on the evidence provided, can the specimen's ID still be confirmed or improved?" to which users have the option of selecting

“Yes” or “No, it’s as good as it can be” (Appendix A). This wording is interesting because of how iNaturalist asks their users to confirm their opinion of an observation’s data quality and that doing so requires encountering this empathetic prompt. For some special observations, users may discuss in the comment section their species identification suggestions before coming to an agreement. For example, under one Acadian Flycatcher observation in Toronto (Appendix A), the user who made the observation inquires how a second user came to offer a species suggestion. The second user writes “it could be a eastern wood-pewee but I think Acadian because of the wing color, belly color, and the bill. I could be wrong though.”, to which the user who made the observation replies “I agree. I wish I could have taken the photo in better light.” This interaction shows how a user offers an alternative identification but rationalizes their offered suggestion based on specific attributes available in the image. The original observer confirmed their agreement with an added comment on how they wished they had better photography conditions. Irrespective of the desire to have better photography conditions, the observation by ways of both users coming to an agreement based on what is available for interpretation from the observation, becomes a research-grade entry.

This implies that to agree with a species suggestion or the data quality of the assessment is to also suggest a certain threshold or degree of sufficiency that is acknowledged and determined by an individual user or users, and them alone, thus demonstrating how a practice on iNaturalist may also be a practice of trust of one’s own knowledge while also tapping into a moral pathos of sufficiency. As such, all iNaturalist observations rely on these exercises of rationalizing trust that individual users partake in, to provide feedback on the quality of the assessment and to certify entries as worthy of research attention.

To better understand the temporal orientation of data produced through iNaturalist, I want to briefly shift tangentially to consider Hirokazu Miyazaki's conceptualization of hope as a method. Miyazaki introduces this idea in his 2004 book *The Method of Hope: Anthropology, Philosophy, and Fijian Knowledge* which was a reflection on his fieldwork with the people of Souvavou, Fiji, and their aspirations for local knowledge to be accepted by a government body that had repeatedly rejected their requests in the past. This idea of hope as a method thus developed in part through inspiration from philosopher Ernst Bloch's (1986) discussion of a "not-yet" consciousness that is located at the moment in which hope is fulfilled. Miyazaki (2004) utilizes Bloch's discussion to realize the temporal orientation that hope enables and itself hopes to replicate, further explaining that "hope is inherited from the past, and the pull of hope in the present derives from anticipation of fulfillment contained in that past hope" (139).

By nature of the design of the grading system, any given observation on iNaturalist is not taken for granted or assumed as research-grade. What Miyazaki's explanation of hope thus makes visible, is an understanding of the temporal orientation of research-grade data, in that those observations that presently aspire for research-grade attribution, are held in a future-oriented state that is dependent on the hope that the majority of iNaturalist users that encounter the observation will come to an agreement on the observation's species identification. Furthermore, what Miyazaki brings me to consider is that the source of this hope is drawn upon from a previous moment, which for the observations that presently aspire for research-grade attribution, is the past hope of observations that have already achieved research-grade, thus revealing a replication of hope from past to present.

Some event staff and participants also made passing remarks about their belief that even if you identify something incorrectly yourself, the community within iNaturalist could help you figure

out the correct identification. For instance, I had noted to myself after using the Caterpillars Count app, that specific species identifications for the recorded arthropods were not necessary for their data entries. As such many records from the Caterpillars Count app that were also visible on iNaturalist did not have specific species names associated with the observation records and would simply show “ant” or “spider”. This was striking to me because of the impression I had of the iNaturalist app and what made it so powerful as a data collection and data production tool was the specificity of its species observation records. When I inquired with EcoSpark Staff Member D regarding a variance of an ant observation recorded from a previous event they responded, “eh, it’s fine. Someone in the [iNaturalist] community will figure it out.”

A noteworthy aspect of the iNaturalist app is its machine learning computer vision model implemented through the species suggestion feature which as it suggests, provides suggestions on what possible species may be visible in an observation photo uploaded to iNaturalist. This computer vision model has also been adapted for use in Seek. A couple of interviewees shared the perspective that the suggestion feature was not very reliable in its early years, but has since become quite accurate and much more reliable in recent years for certain families of species. This perspective was also noted in Soledad Altrudi’s (2021) work with iNaturalist users. The increased reliability, while not entirely replacing the field guidebook for some such as Conservation Site Staff A and Park Ranger A whom I interviewed, had become a useful tool for many iNaturalist users. While demoing iNaturalist’s sister application in the first public event, EcoSpark Staff A noted, “Seek really struggles with fungi”, to which an event participant replied, “Everybody struggles with fungi”, to which EcoSpark Staff A replied, “Yeah, we can give it that grace...”. What these perspectives and interactions revealed was that at least some of the people who were using iNaturalist were not too worried about their own ability to accurately

produce accurate observation data because they held this underlying assumption that the community, or the app itself, could come to your aid if needed.

I interpret these assumptions as remarks of various kinds of trust. Political scientist Eric Ulsaner arrives upon moralistic trust as a way of understanding why members of a community involve themselves in collective action such as with community engagement or volunteering efforts. Ulsaner (2001) writes that unlike strategic trust, which presumes that trust depends on information and experience (2) and thus explains when persons choose to trust, moralistic trust is a presumption that people *should* be trusted because moralistic trust rests on the premise that “others will not let us down” (11). While some users demonstrated a kind of strategic trust of the app based on their understanding of the limitations of the app and its features, others such as EcoSpark Staff Member D hinted at a more moralistic trust of the community members of iNaturalist as their remark rested on the assumption that there was ‘someone’ who could help, alluding to Ulsaner’s premise of “others not letting us down”. The observation data that is being produced by event participants and facilitators as well as these passing remarks and even the data quality assessment feature itself, thus provide a peek into where trust can emerge from the perspective of those who are producing or collecting the data and begins to shed light on the kinds of hopes and trusts that are a part of the social constitution of the data production process itself.

2.4 Data Users, Their Uses, and Their Perspectives on Biodiversity Citizen Science Data

Now having an idea of some of the ways biodiversity citizen science efforts come to be trusted by its lay participants, it is a good time to cross the bridge to look at some of the ways trust is established by the data users.

In the interview with Student C, I learned that their use of iNaturalist derived from a course they had taken which allowed them to work on a group project that helped develop mapping materials for a class of Indigenous students. Her group's project showed the value of utilizing iNaturalist data points to help map sightings of specific species that were of significance to the high schoolers and a seasonal Thanksgiving event. While the data was directly usable in this educational context, the student noted they faced significant challenges comparing and validating data points with data found in published journal articles due to differences in methodology. This was interesting because it revealed how the newness of citizen science had come into contention with formal understandings of data collection and usage.

Continuing within the realms of academia, I had learned through interviews with a graduate student, Student B, that they had been working on some data validation exercises with a bird species whose northern geographic migration boundary resided in southern Ontario. Student B explained her process of working with eBird and iNaturalist as follows:

“I did a concordance analysis to see, well, are they telling me the same stories? Am I actually getting the same results, even though it kind of looks like they're saying the same things, is this statistically significant? So it actually was, which was really cool to see, like, you know, [because] eBird and iNaturalist are arguably very different platforms. You know, eBird's only specific to birds. It's kind of like the bird community [and] the whole observation vetting process is very different, [be]cause you don't need pictures. It's kind of like the observations are vetted by the eBird entity, which is like the eBird experts going through the observations and going through and approving or rejecting all of the observations. Whereas iNaturalist is more like, I guess citizen run, but you do need photo evidence of all your observations in order to have it be research-grade. And then in order for it to be like approved, two thirds of like people who look at your observations need to agree. So it's kind of like, yeah, that's also an Acadian fly catcher- I agree on that. So very different ways of handling observations and very different ways that the observations are concentrated yet they told us the same story.”

Student B emphasized the significance of this finding for their research because, “one could probably argue that there’s bias associated with each platform, which there probably is to some degree, but it’s not bias that can’t be overcome.” I later followed up with this student to learn that because the datasets proved to tell the same stories, they had moved on to expand the scope of their project by looking at the data sets to see what kind of temporal trends could be made visible when data from earlier years were included in their investigation. The work involved many more analyses to verify the data. Student B noted, “We redid our analysis so many times and we were getting answers, but we didn't know whether or not to trust our answers. [Be]cause we did not really have a good understanding about what our data looked like.” They shared that eventually, it appeared that once expanding the temporal scope of the dataset, various forms of bias could no longer be overcome and instead hindered their ability to determine if the stories being told were true to real ongoing patterns of the bird’s migratory behaviour. While this was a disappointing finding to Student B, they went on to describe their perspective on similar analyses being done in the future:

“As time goes on, we're overcoming those taxonomic biases that, you know, are still in the data but are being accounted for and being noticed more than they used to be. [Be]cause people like to go through like the charismatic megafauna generally when they're making observations and we saw a total under sampling of plants and insects and like things that are less interesting, but now you have whole groups of people who, you know, are super interested in these things and care about these things and want to sample them and want to observe them.”

For this student, trust in these citizen science datasets, including iNaturalist, was an ongoing process of a variety of analyses and comparative analyses to determine the scope of the data that could be trusted. It also revealed to me that the kinds of interests and questions this student sought to explore and the ability to approach certain data points (from the past), were predicated

on the ability to systematically validate and establish a degree of trust with smaller sets of data first.

However, for a professor teaching at a large university in Ontario, there was no argument about whether the biodiversity citizen science data could be trusted, as they had already begun to utilize the materials as a training ground. Their explanation came in two parts, the first being the reference to a successful example of a citizen science project concerning genomics, which provided evidence that citizen science was feasible and could be practically useful to researchers. Secondly, the data found through platforms such as iNaturalist was seen as a place to challenge students to ask and explore the capacities and limitations of the data, recognizing that while the truth of the data was not necessarily what was at stake, but simply the fostering of curiosity, wonder and fascination as its main value.

For others, trust was also not a point of contention with the data. Park Ranger B noted that the issue of validating trust with an observation entry could simply be resolved by going to the area to verify the species observation for themselves. This proved valuable in an instance they recalled when an iNaturalist user submitted a rare fungus observation which they had taken to a park campsite. From the information available from the image posted to iNaturalist, the park rangers were able to identify the campsite and inform the user about park policies against collecting rare species as part of their conservation efforts. They also noted that one of the things they felt was significant about the observation data was that regardless of whether any given record was utilized in a scientific or research context, the data also simultaneously served a second purpose as a natural history record. Similar sentiments were shared by several other interviewees regarding citizen science more generally, in that there was a general attitude that just by the data existing, meant there was the potential for someone to find a use for it.

Another interviewee, Steering Committee Member C, expressed their trust in citizen science and iNaturalist by sharing examples of local conservation efforts their organization was able to develop based on observational data trends that were produced from iNaturalist and other citizen science platforms. This spanned from more local efforts such as constructing a tunnel-like structure beneath a road that allowed small amphibians like frogs to pass from one side to the other without the risk of vehicle contact, to larger projects such as endangered species inventorying efforts that the federal government shares status reports on through the assistance of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), in which iNaturalist data entries have been utilized to help provide evidence for such statuses.

2.5 Discussion and Explorations

My interviews with Student B showed how the differences between the data production and data validation processes between iNaturalist and eBird illuminate where iNaturalist is situated in the broader citizen science landscape, which through its dataset, embodies one of many possible storytellers. I also interpret the incremental approach from Student B as a way not just to establish trust as they sought, but momentary productions of hope, which illicit possibilities for future moments of hope, such as with the conducting of their initial analysis between eBird and iNaturalist data. While in the second instance, her analyses appeared challenged by biases, this disappointment harkens to Bloch's "not-yet" consciousness that Miyazaki referenced and thus continues to allow hope to be the driver which may have prevented disappointment from becoming defeat.

Yet it is here in these conversations with the university professor, Park Ranger B, and Steering Committee Member C that my capacities to adopt Miyazaki's notions of hope as a method begins to break down. In Miyazaki's work, it is the retrospective perspective that is brought forth

that reproduces hope. While aspects of such a hope were made visible through interactions with the laypeople and the features of the mobile app, rather than hope, it appeared for these data users that I encountered, trust was already at the forefront of their perspectives on data from iNaturalist. The ways trust was established between the data and many of the data users differed depending on the scope of data that they used. This difference appears to align with current understandings of data in that it highlights its multiplicity and particularity that relocate it in diverse local worlds (Douglas Jones et al. 2021, 10). Due to the smaller geographic scope, the ways observational data records were interacted with by Park Ranger B were more intimate. They could encounter and confront observations if needed, and the way in which data could and had been used directly responded to their land stewardship responsibilities. This was a grace that did not appear to apply as easily when working with larger bounds of areas as Student B had, which led her to cross reference and utilize multiple different types of analyses to develop a method of assurance.

Unsurprisingly, what I learned collectively from my interviews with a variety of professionals and academics was that their usages and applications of data from iNaturalist also widely varied. Yet it was because their usages and applications widely varied, that the timelines for completion of utilizing the datasets were also different. For instance, the time it could take a researcher to analyze, write, and publish a paper or report that utilized some data points created by lay users of iNaturalist, could vastly differ from those who need to develop a conservation response after identifying a rare species on iNaturalist was inappropriately handled on park grounds, or a student working on a collaborative term project. What then became clear to me was that across these interviews, the timing of the reciprocation on the part of these data users is never

concretely established or directly communicated to those laypeople who helped collect the data that they used.

2.5.1 Circling Back to Mauss

Returning now to Mauss, and the three obligations of gift giving he outlined; if we apply these obligations to the broader structure and the relationship that is being established between the volunteer citizen scientists like those I had witnessed at the EcoSpark event, and the scientists and professionals who were using some of the data that was being produced, as well as return to the configuration of data as a gift, it is made clear that there are sorts of giving and receiving of data happening between the laypeople who had helped to collect data hosted on iNaturalist and the data users, alongside a variety of hopes and trust seeking actions by both parties.

While in some instances there may be an argument that some of these academics and professionals are engaging in acts of reciprocation, be it through acknowledgements in publications, increased conservation efforts, or production of educational materials, the reciprocation itself is never guaranteed to return directly to the laypeople who made their work possible. I connect this uncertainty to the writing of Soledad Altrudi, in which she explains:

The premise that underpins the practices around iNaturalist estimates that verified photographs – not incidentally always referred to as ‘observations’ – will become data points that will make themselves useful for some undefined research project conducted by certain undefined scientists, which in turn casts those practices as contributions toward an undefined greater good. (Altrudi 2021, 133)

As mentioned, in thinking of data as a gift, it is important to note that the way the gift is received, is not through a direct handoff from data collectors to data users but has been facilitated by the iNaturalist platform and those like it. While there are ways in which the counter-gift can be reciprocated, none of the counter-gifts then transverse through the same

medium in which the first gift was received (i.e., iNaturalist). This asymmetry points to a potential area in which the mobile application's current state exemplifies the premise Altrudi writes about, in the sense that as a medium between data collectors and data users, the apprehension and extractive qualities of biodiversity citizen science engagement are made more visible in the absence of ways in which data users can counter-gift to those whose contributions provided useful biodiversity information.

2.5.2 In Consideration of Mauss and Hope

I had briefed earlier some of the ways in which Mauss had been read and adapted by other writers interested in gifts and exchange in hopes to utilize some of their ideas in a way that could help make sense of the acts of giving and taking that were visible in my observations and interviews. While this approach was unable to completely encapsulate the entire relationship being created between laypeople and data users as the timing of the reciprocation appeared uncertain. Despite this, it was through such an approach of examining the observable acts of giving and taking that made visible multiple other kinds of social values and dynamics citizen science transports between laypeople and data users. Matters pertaining to science education, community development, and a variety of hopes and trust that pertained to biodiversity citizen science data on iNaturalist and the citizen science community as a whole.

I want to return to Miyazaki and Ernst Bloch for a moment. Miyazaki (2004) invokes Bloch's "not-yet" consciousness to locate hope in the production of knowledge (9). Miyazaki's invocation harkens to Bloch's second and third presentation of the "not-yet" consciousness, which are described by Keller and O'Hara (1976) as the struggle to throw off old forms of life and productivity respectively (24). The authors use the analogy of an artist who begins with a dim conception that becomes clearer as the creative process goes on to explain this third

presentation (Keller and O'Hara 1976, 24). These acts of data collection, public education, and data processing circulating the iNaturalist app can be interpreted as representations of Bloch's "not-yet" consciousness which Miyazaki embeds in his configuration of hope, in so far as how they attempt to produce ways of engaging people with biodiversity and that these ways also have yet to find a finality to its form.

Submitting observational data on iNaturalist does not cost users monetarily, nor does it cost professionals to access the data, whether it be through iNaturalist directly, or through other open-access databases that research-grade iNaturalist observations are uploaded to, such as GBIF. Mauss (1954) writes in the conclusion of *The Gift* that "it is a good fortune that all is not yet couched in terms of purchase and sale. Things have values which are emotional as well as material; indeed in some cases the values are entirely emotional. Our morality is not solely commercial" (63). I connect the accessibility of iNaturalist to this quote by Mauss to consider then the value of biodiversity citizen science data produced through the app, as it suggests a morality and a valuation of the user-contributed data in not just a transactional sense of being made to be used but to recall that the value of the data is multifaceted. Multifaceted in the way in which the data associates with aspirations for education and curiosity as mentioned by Professor A, it's potential to contribute to conservation efforts, its value as records of natural history and a teller of stories, as well as the way the production of the data itself is entangled with hopes, trusts, and community building.

In a bid to return to a group morality, Mauss (1954) suggests we should "come out of ourselves and regard the duty of giving as a liberty, for in it there lies no risk" (69). Mauss tells us the obligation of giving is a good one that benefits the group and individual alike. Altrudi argues that iNaturalist engages its users in practices that are rooted in a Western science perspective, that are

associated with extraction, impersonality and depleted of contextual details. Yet if we consider the representations of the “not-yet” consciousness as well as iNaturalist data’s multifaceted nature and the acts of giving surrounding its production, an implication for morality and the personal, become recognizable through biodiversity citizen science’s simultaneous desires to engage and educate the public, conserve local biodiversity, and build community with the help of mobile technology.

2.6 Conclusion

My experiences learning about biodiversity citizen science data produced from iNaturalist proves there are a variety of use cases in many settings in Ontario, ranging from academic, conservation, government, and public engagement. From an ‘anthropological’ perspective, one of the aspects that spark an interest in the data production through iNaturalist and the subsequent data usage is that many of the activities involved some acts of giving and taking, be it from a surface-level approach to broader ideas that covet biodiversity citizen science efforts. Yet, it is not just that there are acts of giving and taking that make this realm interesting to anthropologists and social scientists alike, but that there are many other social and morally significant features that may be generally known to exist but are often overlooked. For all the publications assessing data quality of specific species in specific geographic areas, and all the promissory discourse citizen science leads its readers, participants and perhaps its writers onto, details on the exact ways of how people who attend and participate in citizen science projects think about citizen science can be missing.

Discussions of the dynamics of the giving and taking as well as the perspectives on biodiversity citizen science data are filled with a variety of hopes and trusts from both data collectors and data users. What I hope to have revealed is that when the voices of such data collectors and data

users are not amiss, discussions about their relationship become possible. Such discussions are useful to better understanding a portion of the landscape of citizen science in a way that could uniquely be offered by embarking on such an anthropological exploration. I have utilized some theoretical frameworks and perspectives to think about the data I collected about biodiversity citizen science activities in Ontario, such as through the attempt to adopt a Maussian Gift Exchange framework and considering Miyazaki's conceptualization of hope that was inspired in part by Ernst Bloch's discussion of the "not-yet" consciousness to understand the nature of iNaturalist data as well as the perspectives of some of the laypeople involved in data collection processes. I lastly drew upon both authors to make recognizable the implications for morality that may appear amiss from iNaturalist due to the way, as Altrudi had argued, it encourages a traditionally Westernized lens of viewing and learning about nature.

While the tail end of this analysis may suggest that the ways gift exchange and the variety of ways to think about it could help more comprehensively describe the acts of giving and taking I witnessed, I hope to have also conveyed that alongside these acts of giving and taking, there are also multiple other kinds of social values and dynamics in transit, such as those pertaining to community building and maintenance, public science education, as well as a variety of hopes and trusts. These are all enveloped in the processes and activities of producing biodiversity citizen science through iNaturalist as well as the social relationship between laypeople and science professionals that is being fostered here in Ontario.

I hope that the results of this exploration and the interpretations that came from it are seen as branches for starting points because, with fewer public health restrictions in sight, one may expect citizen science efforts in Ontario will only become more abundant in the next and coming years with the return of more BioBlitzes and other events like those hosted by EcoSpark. The

iNaturalist community itself aims to increase their user base to the scale of a hundred million (Loarie 2022), which will also likely introduce new or exacerbate existing characteristics of biodiversity citizen science efforts that impact the activities in which data collectors and data users engage in. Secondly, by thinking of this exploration as a starting point, my hope for this work is that it may encourage more anthropological engagement with citizen science as a dual method of providing a space in which to test the possibilities of anthropological exploration, while simultaneously contributing to social scientist's understanding of citizen science more broadly.

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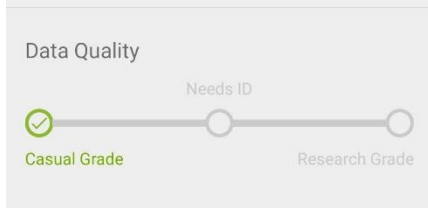
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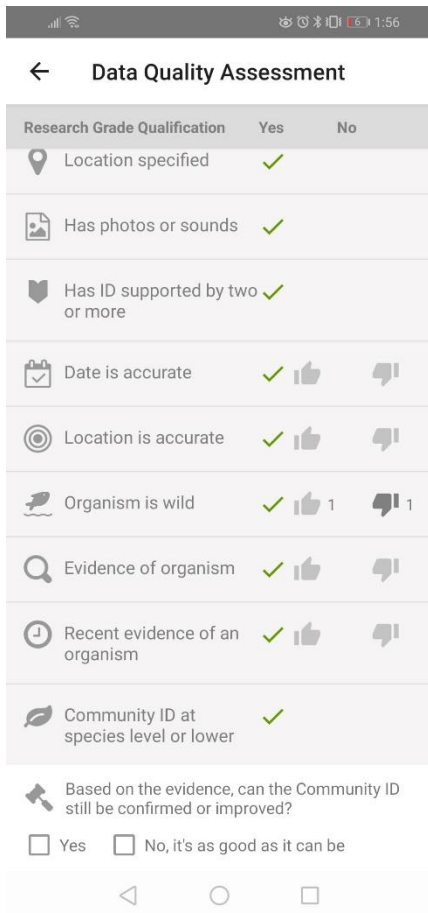
Appendix

Appendix A: iNaturalist References

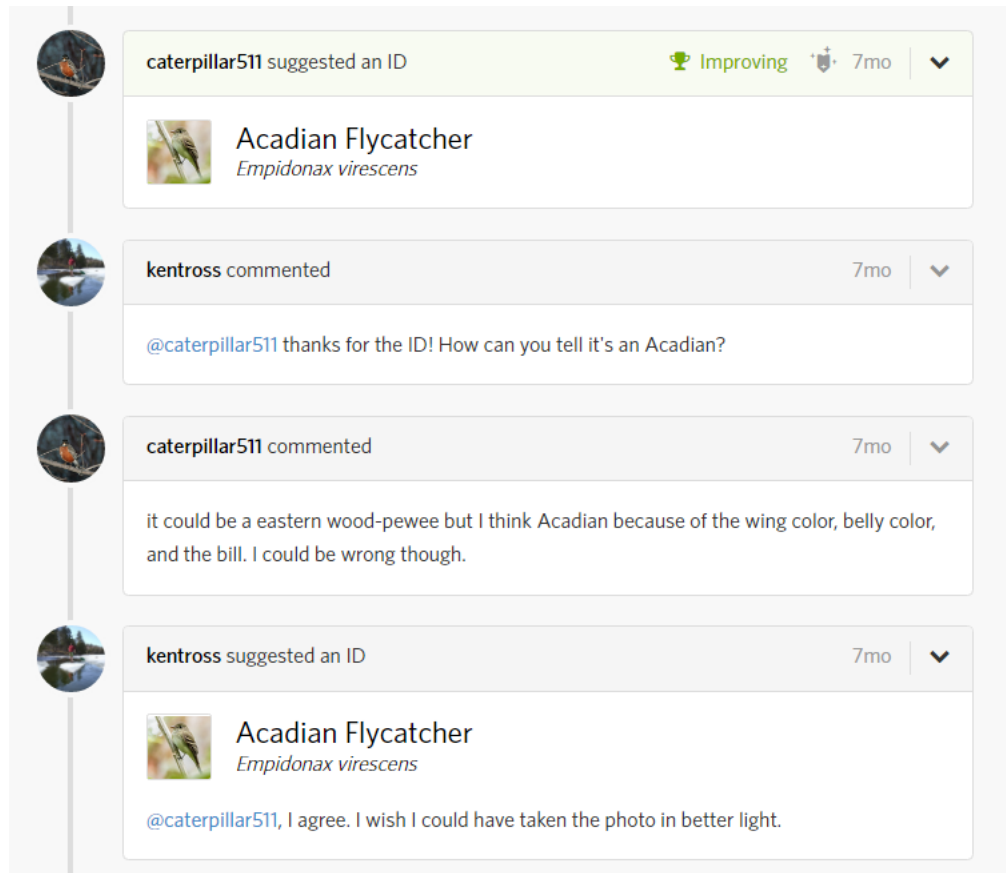
Screenshot of casual versus research grading which appears underneath an observation entry on the mobile android version of the iNaturalist app.



Screenshot of a Data Quality Assessment




Screenshot of the comments below iNaturalist Observation No. 118861155 (provided by user kentross)



The screenshot shows a vertical list of four comment blocks on a light gray background. Each block is preceded by a circular profile picture of the user. The first block is highlighted in light green and shows a suggestion by user 'caterpillar511' for the species 'Acadian Flycatcher' (*Empidonax virescens*), with a small image of the bird. The second block shows a comment by 'kentross' asking how to identify the bird as Acadian. The third block shows a response by 'caterpillar511' suggesting an alternative species, 'eastern wood-pewee', but leaning towards 'Acadian' based on wing, belly, and bill color. The fourth block shows 'kentross' agreeing with the identification and wishing for better lighting in the photo.

caterpillar511 suggested an ID Improving 7mo

 **Acadian Flycatcher**
Empidonax virescens


kentross commented 7mo

@caterpillar511 thanks for the ID! How can you tell it's an Acadian?

caterpillar511 commented 7mo

it could be a eastern wood-pewee but I think Acadian because of the wing color, belly color, and the bill. I could be wrong though.

kentross suggested an ID 7mo

 **Acadian Flycatcher**
Empidonax virescens

@caterpillar511, I agree. I wish I could have taken the photo in better light.

Appendix B: Details on Methods

Information Interviews

Park Ranger A	March 24, 2022
Park Ranger B	March 30, 2022
Conservation Site Staff A	April 20, 2022

Semi-Structured Interviews

Professor A	May 25, 2022
Student A	May 25, 2022
Student B	June 7, 2022, August 15, 2022
Student C	June 16, 2022
INaturalist Steering Committee Member A	May 26, 2022
INaturalist Steering Committee Member B	June 16, 2022
INaturalist Steering Committee Member C	June 23, 2022
Ex-Data Manager A	May 31, 2022
EcoSpark Staff C	July 18, 2022

EcoSpark Events

June 25, 2022 10 am – 12 pm
Hosted by EcoSpark Staff A, B

July 23, 2022 10 am – 12 pm
Hosted by EcoSpark Staff A, D

August 13, 2022 10 am – 12 pm
Hosted by EcoSpark Staff D, E

September 13, 2022 1:30 pm – 4 pm
Hosted by EcoSpark A, B

Appendix C: Semi-Structured Interview Questions

Q1: When and where did you first hear about iNaturalist?

Q1.a: Was there someone who introduced it to you?

Q1.b: What about it made you interested in using it?

Q2: What goals were in mind when iNaturalist was introduced to assist your work?

Q2.a: What opportunities did iNaturalist enable?

Q2.b: How did it become important to your work?

Q2.c: Has there been a time/times where it has been more hindering than helpful?

Q3: Have you used the suggestion feature?

Q3.a: Has it been helpful to you or your work?

Q3.b: Is there anything you wish it could improve upon?

Q4: What are your thoughts on the user generated data?

Q4.a: Has the accumulation of such data benefitted your work or research? How so?