Climate change science communication:
Exploring environmental scientists' views and engagement on social media

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A thesis submitted to the University of Ottawa in partial fulfilment of the requirements for the Master of Arts degree in Education

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Preface to the Thesis

This thesis is original, unpublished, and independent work by the author, Alysha Wenghofer, for the MA in Education, and supervised by Dr. Giuliano Reis and Dr. Adam Brown. All methods were approved by the University of Ottawa's Institutional Review Board [certificate #S-10-25-12126].

To protect the anonymity of all participants, random pseudonyms were used, and the faces, names, and handles appearing on the participants' social media content were redacted so that the participants could not be identified, thus meeting the ethics requirements for human subjects' research at our university.

Disclosure Statement

There are no conflicts of interest to be reported.

Abstract

Social media is becoming a necessary tool for modern science communication about climate change. When done responsibly, social media science communication can not only inform the public but also help to advocate for climate activism and evidence-based environmental policy change. However, little is known about the engagement of Canadian climate change experts, such as environmental scientists, on social media. This research explores a small sample of Canadian environmental scientists' views and engagement on social media as a tool for climate change communication. Focusing on participants affiliated with an environmentally oriented faculty at a university in Eastern Canada, this study employs a thematic analysis of in-depth interviews and social media content to examine how professional engagement on social media (or lack thereof) for climate science communication is shaped by the affordances of the platforms. The study further explores the platforms employed, motivations, challenges, and what institutional support may be necessary to promote social media science communication. It was found that the participants of the study do engage on social media to communicate their research, but at varying capacities. The number of challenges that they face when engaging on social media outweighs the number of motivations. However, there is still motivation to utilize the affordances of social media to communicate science and encouragement for other environmental scientists to do the same. According to the participants, support from scientists' institutions through resources and tools, social media etiquette and skill training, or simply a positive institutional culture toward social media, may provide the skills and confidence needed for this evolving form of public outreach. These findings provide a preliminary snapshot of eastern Canadian environmental scientists' contribution to climate change communication using social media platforms, and it may serve as a jumping point for further investigation.

Keywords: Climate change, Public science communication, Social media, Climate scientists, Environmental scientists, Motivations, Deterrents, Institutional support

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1.0 Introduction

1.1 Context and importance of social media climate change science communication

Climate change is a time-sensitive, anthropogenic, irreversible, and existential threat to modern civilization and the planet's biodiversity (Freebairn, 2007; McBean, 2011; Wiens & Zelinka, 2024). It is a global issue that requires collective and interdisciplinary intervention to be addressed (McBean, 2011). One such intervention is public education and outreach (i.e., science communication). However, due to the multidimensional nature of climate change (i.e., spanning scientific, environmental, political, economic, and ethical domains), it presents a distinct challenge for public outreach.

Social media is becoming increasingly relevant for accessing climate news and information, especially among young adults (Ejaz et al., 2024; Newman et al., 2020), likely because it can quickly facilitate the exchange of scientific information (Hunter, 2020). Free and easily downloaded social media platforms, such as Instagram, Facebook, TikTok, etc., are more accessible to the public and scientists than traditional media channels (Brossard & Scheufele, 2024; Coletti et al., 2022). The affordances allowed by particular platforms differ, but in general, social media has the potential to engage the public with science, including climate change (Anderson, 2017; López-Goñi & Sánchez-Angulo, 2018; Pavelle & Wilkinson, 2020).

When done responsibly, public engagement helps advocate for climate activism, evidence-based environmental policy change, and it can foster public trust in science (León et al., 2023; McNeall, 2023; OECD, 2023; M. Schäfer, 2024). However, climate science and its complex systems can be challenging to convey in a way that caters to the variety of knowledge backgrounds and beliefs found on social media, especially when combating the spread of misinformation, disinformation, and echo chambers, which grow with the expansion of social media algorithms and AI (Cover, 2022; Lee et al., 2024). This research explores whether Canadian environmental scientists use social media to communicate about climate change, their methods and motivations in doing so, or their reasons for not doing so.

1.2 Rationale of the proposed study

Despite the encouragement by other science communicators for social media to be used for climate change science communication, little is known about the engagement and views of Canadian environmental scientists on social media ("How Social Media Helps Scientists Get the Message Across," 2018; McNeall, 2023; M. S. Schäfer, 2025). Previous research has found that general science communicators, both on and off social media, are motivated by a desire to inform, counter misinformation, and educate the public (Ho et al., 2020; Velho & Barata, 2020; Wilkinson et al., 2023). Conversely, they are potentially deterred due to a lack of time and resources (Andrews et al., 2005; Ho et al., 2020; Wilkinson et al., 2023) or online harassment and abuse (Global Witness, 2023; Jaigris Hodson et al., 2024). However, it remains unclear whether these dynamics extend to environmental scientists on social media, where the complexity of climate change as a time-sensitive, anthropogenic, and politically charged problem may shape communication differently than other scientific topics (Ahmed et al., 2022; Benavides & Delčios, 2024; Conradie, 2020; Incropera, 2015; FitzGibbon & Mensah, 2012; Prowle, 2024; Surminski et al., 2018b). In any case, the dissemination of climate change research is crucial for promoting pro-environmental behaviour and a scientifically literate democracy (Davies, 2022; Davies & Horst, 2016), and social media affords that dissemination (Nawaz et al., 2025; Safianu & Van Belle, 2023). Yet little is known about researchers' engagement on or views of social media climate science communicators.

1.3 Aim of the study and research question

With a focus on researchers affiliated with an environmentally oriented faculty at an Eastern Canadian university, how is professional engagement on social media (or lack thereof) for climate science communication shaped by the affordances of the platforms?

1. What social media platforms do participants employ?
2. What motivates the participants to engage (or not) with social media for climate science communication?
3. What challenges do they face that limit or prevent their engagement?
4. According to the participants, what institutional support (if any) is necessary to promote social media science communication?

These findings provide a preliminary understanding of the landscape of Canadian environmental scientists' public outreach via social media for climate science communication. The following chapters will broadly explore existing literature on social media climate science communication, the theory of affordances, the methodology of this study, its findings, and a discussion comparing these findings to the existing literature to inform suggestions for future professional social media climate science dissemination.

2.0 Literature Review

2.1 Climate change as more than just a hot topic

Climate change remains one of the most prominent and complex scientific issues currently engaging both academic and public discourse (Rodrigues & Shepherd, 2022). It is described as the biggest challenge facing humanity in history (Bouman et al., 2020; Parums, 2024; Prowle, 2024, p. 29), yet it is an anthropogenically caused phenomenon that has been progressing since the Industrial Revolution due to greenhouse gas emissions (Ahmed et al., 2022; Benavides & Delčios, 2024; Hormio, 2023; Prowle, 2024, p. 35). While other scientific developments, such as the rapid advancement of artificial intelligence (AI), genetically modified organisms (GMOs), and ongoing debates surrounding vaccination, have also garnered public attention and present their own complexities, climate change is distinct in its far-reaching scope and the intricacy of addressing a deeply systemic and interconnected challenge (Garett & Young, 2021; Li et al., 2021; Neubauer, 2021; Wnuk & Kozak, 2011). It is a multifaceted and controversial social-scientific issue (SSI) that spans scientific, environmental, political, economic, and ethical domains (Chan & Tam, 2023; Dinda, 2015a, 2015b; Freebairn, 2007; Incropera, 2015; Prowle, 2024; Surminski et al., 2018b, 2018a; Widiyawati, 2020), and is also widely regarded as a "wicked problem" due to its lack of straightforward solutions (Conradie, 2020; FitzGibbon & Mensah, 2012; Mitchell, 2019). It has disastrous global impacts that are felt locally and in real time (Rodrigues & Shepherd, 2022), and it requires global and interdisciplinary integration and cooperation to be addressed (Hormio, 2023; McBean, 2011).

Despite quantitative and empirical evidence of rising atmospheric temperatures and the associated negative effects (e.g., severe storms, species loss, global rise in hunger, poverty, and displacement), societal and political responses have often been inadequate or delayed (Dinda,

2015a; Leichenko & Silva, 2014; Michener et al., 1997; Prowle, 2024, pp. 48, 68; Surminski et al., 2018a; Wiens & Zelinka, 2024). Hormio (2023) argued that many factors affect the public's apathy toward climate change, including its inconspicuousness (despite overwhelming evidence of its existence), the inconvenience of acting against it (through household adjustments like reducing single-use plastics or driving less, or wider policy changes), and the convenience of blaming it on others. Further, many people remain unconvinced that climate change presents a risk or is in part caused by fossil fuel consumption (Lewandowsky, 2021), often due to misinformation, which undermines people's understanding and acceptance of the issue. These issues need immediate action, especially if we are to meet the goals set by the Paris Agreement at the UN Climate Conference (COP21) to limit the temperature increase by 1.5 degrees Celsius above pre-industrial levels by 2030 (UNFCCC, 2016).

While climate change discussions can cause worry among people, and intense eco-anxiety can be harmful to personal well-being, an understanding and concern of the threat that climate change poses can evoke action to reduce the problem (Bouman et al., 2020; Brosch, 2021). The disconnect between the urgency of climate change and the actions taken to address it underscores the critical role of environmental scientists in translating complex, data-driven realities into meaningful public understanding and response. However, the urgency and multidimensional nature of climate change make its communication uniquely complex, underscoring the distinct challenges environmental scientists may face in public outreach.

2.2 Climate Change Science Communication

To date, the definition of science communication is still under debate. Nerghes et. al. (2022) analyzed 584 definitions of 'science communication' to reveal the main dimensions of the field. Their findings suggest that science communication is a "one-way transmission and translation of scientific results and their impacts towards a lay audience, with the goals of making science more accessible, of educating audiences, and of raising awareness about science." (Nerghes et al., 2022). This may involve the communication of science outside of traditional science classrooms, scientific conferences, or academic papers (Kobylarek, 2017; Oliveira et al., 2021), and instead communicating through media such as the news, podcasts, and increasingly social media (Depoux et al., 2017; Ittefaq, 2024; McNeall, 2023). Science can be communicated to varied audiences, including other scientists and experts, policy makers, and non-scientists (Oliveira et al., 2021). The

'general public' or 'lay audience' encompasses all non-experts, including scientists outside a particular field (Burns et al., 2003; Lévy-Leblond, 1992).

Effective science communication has the power to increase public trust in science, reduce communication and comprehension barriers, and encourage multidimensional communication necessary for change, such as communication between scientists and policymakers (Oliveira et al., 2023). For instance, misinterpreted, inaccurate, or ineffective science communication regarding climate change information creates confusion, distorts public perception, and delays action toward a more sustainable world (Communicating on Climate Change, n.d.; National Academic of Science Engineering and Medicine, 2017).

To some people, social media is just a form of entertainment, and they may wonder why there has been a shift for scientists to communicate with the public through social media (Anderson, 2017; Brossard & Scheufele, 2024; Coletti et al., 2022). These platforms allow scientists to engage the public in climate change discourse (Anderson, 2017; López-Goñi & Sánchez-Angulo, 2018; Pavelle & Wilkinson, 2020). When done responsibly, this helps to foster public trust in science and promotes evidence-based policymaking (OECD, 2023) and increases the impact of research and access to funding (Vainieri et al., 2023) - all of which can contribute toward tackling the important environmental issues.

2.3 How have people's consumption of information and news changed?

How people absorb information, including scientific information, is changing. In an average among eight countries (Brazil, France, Germany, India, Japan, Pakistan, UK, and USA), 19% of the online adult population access climate news and information from social media, with a small majority still accessing it from television news channels (31%) or other internet applications (24%) (Ejaz et al., 2024). It remains unclear how much information specifically relating to climate change is being disseminated through social media platforms, let alone by reputable experts, such as environmental scientists, in Canada.

However, Statistics Canada found that while just 24% of the Canadian population receives general news and information (i.e., local news and current events) from social media. Among young Canadians (aged 15 to 34), the percentage is significantly greater at 48% (Statistics Canada, 2023). Further, another study found that young adults are three times more likely to access climate change-specific news on social media compared to adults over 55 (Newman et al., 2020). These

statistics suggest that over time, social media will not only gain popularity as a source of general news and information for Canadians, but also as a source of scientific information.

Notably, in 2023 the Government of Canada enacted the *Online News* Act (Bill C-18), which sought to support the fair compensation of news and journalism outlets to counter the rise of misinformation and support informed democracy (The Government of Canada, 2024). The result was Meta restricting Canadians' access to news on their social media applications (Mundie, 2023). But this has not stopped science communication or word-of-mouth "news" sharing on these platforms. How important scientific issues are communicated to the public must adapt to how society chooses to access information, underscoring the need for social media science communicators.

2.4 Social media affordances for science communication

Social media is defined as an "internet-based channel allowing users to interact and selectively self-present, either in real-time or asynchronously, to broad or narrow audiences who derive value from user-generated content and the perception of interaction" (Carr & Hayes, 2015, p. 50). While these platforms offer unique affordances for communication, they are not neutral spaces. Many operate on profit-driven algorithms that personalize content delivery based on user interactions. For instance, Instagram's Creators page notes that its algorithm relies on "signals" derived from how users engage with the app and how others engage with them (Instagram, n.d.). This algorithm-driven content organization necessitates that researchers possess *social media literacy*, which is defined by Cho et al. (2024) as a critical understanding of the technical affordances and architectures of social media platforms (Cho et al., 2024). The platform-specific characteristics among applications that affect the structure and transmission of information are often described as media logic (Altheide, 1979; Baram-Tsabari & Lewenstein, 2017; Jonsson et al., 2022; Peters, 2012). More specifically, *social media logic* refers to how social platforms organize content, facilitate communication, and direct user attention (van Dijck & Poell, 2013). Adapting to media logic can be important for communicators to establish credibility in digital spaces (Luik et al., 2025) because it directly influences the visibility and impact of their content (Mishra & Upadhyay, 2024; van Dijck & Poell, 2013).

As of January 2025, Facebook and Instagram remain the most-used platforms in Canada, followed by TikTok and X (formerly Twitter) (*Social Media Statistics in Canada*, 2025). Each

platform varies in function, structure, and audience, and thus the types of science communication that are effective among them will differ too. Facebook fosters communities and profile-based interactions (Hall, n.d.), Instagram emphasizes visual content (*About Instagram*, n.d.), TikTok prioritizes short-form entertainment (*TikTok*, n.d.), and X centres on text-based updates and link sharing (X, n.d.). Thus, social media literacy may direct science communicators to use Facebook for in-depth discussion with their community, Instagram for visually appealing informational graphics or reels, TikTok for entertainment-driven content that could direct the public to other resources, or X for more detail-oriented written content.

An understanding of media logic helps scientists to distinguish their scientific content among the masses of opinions on these platforms (Jonsson et al., 2022). However, it is notably a balance when communicating science on these constantly updating platforms to accommodate their media logic. Jonsson et al. (2022) argued that the adjustment of science communication to media logic may even harm the legitimacy of 'being an expert' as they are pushed to simplify concepts for the understanding of the general public (Jonsson et al., 2022; Weingart & Guenther, 2016). As a result, the public may also not have a comprehensive understanding of what they are being taught.

Nonetheless, there has been a push for scientists and science communicators to utilize new media technology to reach audiences more directly and interactively (Brossard & Scheufele, 2024; Coletti et al., 2022). This strategy not only broadens the reach of scientific research but also provides users with access to credible and trustworthy sources. As trusted science communicators, the content that scientists share has the potential to influence public understanding and decision-making—whether related to policy, health, or environmental behaviour (Bertemes et al., 2024; Intemann, 2023).

2.5 What motivates and discourages public science communication?

Although numerous studies have explored why scientists may engage in public communication, the influencing factors have neither been examined collectively nor consistently, within the context of climate change, social media, or among environmental scientists specifically (Ho et al., 2020; van Eck, 2023; Wilkinson et al., 2023). As such, our understanding of what drives science communication in these intersecting domains remains incomplete, and so it is not known how to support this action, or if it requires support at all.

In general, science communication is frequently viewed by scientists as volunteer work that is auxiliary to their other responsibilities (Andrews et al., 2005). Despite this, researchers are motivated to communicate science by factors such as a desire to inform the public, raise awareness, enhance visibility, attract funding, and contribute to broader societal change (Ho et al., 2020; van Eck, 2023; Wilkinson et al., 2023). Some climate scientists feel that it is not only fun and important to share their research with the public, but also their duty to restore public trust in science and warn people of the dangerous impacts of climate change (van Eck, 2023).

In recent years, social media has emerged as a powerful tool for informal science education and public engagement (Belova et al., 2022; Majcen & Spitzer, 2024). The research literature is increasingly acknowledging its affordance for accessible climate change communication, dialogue, and mobilization (M. S. Schäfer, 2025; Wilkinson et al., 2023). These platforms allow anyone to quickly and easily create science content, regardless of its accuracy (Belova et al., 2022). As such, the spread of misinformation and the growth of echo chambers may be increased by the expansion of social media algorithms and AI (Cover, 2022). One key motivation for researchers to engage with social media is the need to counter misinformation (Wilkinson et al., 2023). These communication outlets offer scientists an opportunity to engage with the incorrect content and correct it (Freiling & Matthes, 2023). The topic of misinformation and social media's affordance for it will be examined further in the theoretical framework (see section 3.0).

Despite the motivating factors, in general, it has been found that social media science communication also presents researchers with personal and professional deterrents. They are often deterred from science communication, on social media or in general, because of a lack of time, knowledge, or resources (Collins et al., 2016; Wilkinson et al., 2023). Additionally, scientists do not always inherently have the necessary skills to communicate effectively with the public. As students, scientists are taught the language of science and how to apply it in formal academic settings to communicate effectively with other members of the scientific community (Lemke, 1990). However, this "language barrier" can affect the public's ability to understand scientific research and the researcher's ability to effectively communicate their findings to the public. This may perpetuate a certain "mystique of science" (Lemke, 1990), where scientific knowledge seems unattainable to lay people. In such cases, public discourse may rely more on opinion or misinformation than on scientific evidence (Bertemes et al., 2024) perhaps because it is more easily

presented. This highlights the importance of science communication training, both on and off social media, to bridge the comprehension gap between expert and lay person.

The public's lack of understanding of science has been described as the *Knowledge Deficit Model of Science Communication*. This dated model assumes that ignorance, or a lack of scientific literacy, is the basis of society's lack of support for issues of science (Simis et al., 2016). However, evidence shows that simply providing facts does not necessarily change beliefs or behaviours, especially in the context of climate change (Hayhoe, 2019). Over the past few decades, the concept of science literacy and the deficit model have been reconsidered, and scientists are being called on to better engage and communicate with public audiences (Cicerone, 2006; Simis et al., 2016). Climate scientist Katherine Hayhoe (2020), for example, is a proponent of connecting climate change to people's personal values and engaging in non-judgmental conversations to influence their feelings and actions related to climate change (Hayhoe, 2020). According to Hayhoe, applications such as Facebook and Instagram are useful for providing information, starting constructive conversations, and sharing scientific images (Hayhoe, 2019). Hayhoe's suggestions for using social media to engage in open and perhaps less-intimidating climate conversations may engage more people with scientific concepts and improve their scientific literacy, decreasing the knowledge disparity between scientists and the public and policymakers (Lieberknecht et al., 2024; Ryan & Bustos, 2019).

Nonetheless, some scientists may be naturally adept at translating scientific research findings into a more understandable language, while others lack training or confidence in their science communication skills (Hundey et al., 2016). A handful of Canadian universities now offer courses in science communication and social media-specific engagement (Mojarad, 2017), but they are few and far between (Zhang & Lu, 2023).

In addition to structural and skill-based barriers, social media presents the challenge of "internet trolls". Online trolling is the practice of engaging in deceptive, destructive, or disruptive behaviour in online social settings (Buckels et al., 2014). Social media also exposes researchers to criticism and pointed attacks in comment sections, particularly when discussing topics that the public deems controversial (Gewin, 2018; Gierth & Bromme, 2020). Kumar & Haneef (2025) used the "gestalt switch" to describe how social media affords a decentralized and favourable space for science communication, while simultaneously affording disinformation and polarization. Hayhoe's experience as a climate communicator on social media is a prime example of this switch in

affordance. While she advocates for how social media can be used for climate science communication, she has also publicly discussed her experience with online harassment. In an interview for the Nature Careers Podcast, Hayhoe said: "But now the deluge of hundreds of hateful comments in a single day that the internet facilitates, whether it is on Twitter, or LinkedIn, or Facebook, or even Instagram, the volume is just 100 times more than it would be without the Internet." (Levy, 2023). In the same interview, Hayhoe discusses how not speaking 'face-to-face' with people can result in being dehumanized, and when coupled with communicating about climate change, a very politicized and polarizing topic, she is flooded with online hate (Levy, 2023). Online trolling, harassment, and attacks affect the well-being and work of climate scientists, manifesting as anxiety, sleeping problems, and loss of productivity, especially among women who may be additionally attacked for their gender (Vidal Valero, 2023).

3.0 Theoretical Framework

3.1 Affordance Theory

This study is grounded in the Theory of Affordance (1979), also called "Affordance Theory", developed by James J. Gibson, which highlights the qualities of an object or environment that afford the performance of an action. The term *affordances*, as described by Gibson, refers to the opportunities provided by the environment or object to the animal; our perception of what it can be used for (Gibson, 2014). This theory offers critical insight into how objects and environments can have more than one affordance or provide more than one use. This extends to actions outside their perceived use, meaning an object or environment can be utilized for something it perhaps wasn't intended for, such as social media applications being used as a science education tool. With social media's growing presence, the application of the Theory of Affordances has grown in relation, being used as a theoretical lens for the effects of new media on society (Bimber & Gil de Zúñiga, 2020; da Silva et al., 2024; Ellison et al., 2015; Majchrzak et al., 2013; Ronzhyn et al., 2023; Treem & Leonardi, 2013; Vaast et al., 2017).

Affordances, in the context of social media, are defined as perceived, actual, or imagined properties (or qualities) of social media, emerging through the relation of technological, social, and contextual factors that enable and constrain specific uses of the platforms (Ronzhyn et al., 2023).

Studies focused on modern communication expanded the original application of affordance theory to encompass technical communication advancements, including social media's affordance for political campaigning (Kannasto & Pöyry, 2025), climate change reporting (Nawaz et al., 2025; Safianu & Van Belle, 2023), informal learning (Stephanidis, 2024), knowledge sharing (da Silva et al., 2024; Haider, 2016) and digital activism (Ahuja et al., 2018; Haider, 2016). These affordances are accessible through technological features such as share, comment, and hashtag (Kumar & Haneef, 2025).

Nagy et al. (2015) employed the term *imagined affordance* as a more nuanced definition of "affordance" that can be applied to socio-technical systems, like social media, rather than simply a physical object or environment (material). They argue that people shape their media environments and their perception of them because of imagined affordances (Nagy & Neff, 2015). This is an important concept when considering how an environmental scientist may shape social media into a science communication tool based on the qualities that they imagine can afford this action[1]. The imagined affordances of that same media environment may differ among environmental scientists depending on their individual experiences or perceptions. The imagined affordances could serve as motivations for engaging with social media if they promote effective science communication, or they may be considered challenges or deterrents if they expose the environmental scientists to qualities that they deem unfavourable (ex., misinformation, harassment, trolling).

Chen & Peng (2023) further advanced the Affordance Theory model to explain that the motives for social media use influence platform selection. As such, certain platforms would attract certain users because of their affordances (Chen & Peng, 2023). This suggests that certain platforms may be more attractive to environmental scientists seeking to educate the public about climate change through the affordance of social media. The affordances offered among social media platforms differ, and social media users can exploit these differences to satisfy their motives (Chen & Peng, 2023).

However, the fast-changing nature of social media through the emergence, synthesis, and acquisition of features across and between the different platforms means that user motives within and among the apps available change with time (Biever, 2025). For example, Facebook and Instagram were once image-sharing focused but can now be found to have features such as Stories and Reels adopted and rebranded from Snapchat and TikTok, respectively. Similarly, platforms such as Bluesky are gaining popularity among scientists for their X (formerly Twitter) adjacent

features, including the sharing of short texts and images, but are reportedly ‘better’ and ‘less antagonistic to science’ because it hosts fewer fascists and racists, and that it is not influenced by Elon Musk (Biever, 2025).

Previous studies have demonstrated environmentally conscious discourse presented on social media through the Theory of Affordances. Haider (2016) used the concept to explain how material and technological affordances work to engender individual responsibility for environmentally friendly living. They explain that social media, in particular blogs, Facebook, Instagram, and X (formerly Twitter), have become important tools for individualization and self-administration of greener living. An example of social media providing an affordance for the encouragement of greener living is seen in online challenges, such as *Earth Hour*, *Meatfree Monday*, or *Buy-Nothing Day* (Haider, 2016).

Notably, Affordance Theory not only acknowledges the advantages of communicating via social media but also the shortcomings (ex., misinformation and harassment). Nawaz et al. (2025) employed Affordance Theory to explore the transformation of climate change news from traditional outlets to social media, arguing that news organizations omit significant details due to the limited affordance of social media for news delivery (Nawaz et al., 2025). Additionally, Wu et al. (2025) sought to understand why people choose to share misinformation on social media. Their study shed light on the affordance of social media to access information, voice opinions, and effectively associate with others; however, when participating in a heightened emotional state (perhaps experiencing climate anxiety or denialism), these affordances may lead to misinformation sharing. The affordances of social media for scientific misinformation sharing have also been studied in recent years regarding COVID-19 (Apuke & Omar, 2021; Islam et al., 2020). These studies provide useful insight into how false information relating to public and environmental health, such as climate change, can spread due to the affordances of social networking sites (Norman, 2013).

With the Theory of Affordances as a lens, this study assumes that, despite certain differences among social media platforms, in general, social media affords environmental scientists the opportunity to publicly communicate climate change science by acting as an environment or tool that facilitates this action. As such, the participants in this study were interviewed with questions formulated under the assumption that social media inherently has the potential to be a successful outlet for public science communication. The subsequent data were analyzed under the

same assumption, meaning that the participant's engagement and views of social media as a climate science communication tool will be interpreted with the insight that it *can* successfully provide the affordance for science communication. Thus, findings will not determine *if* social media can be used as a tool for science communication, because this is known. Instead, it will be used as a lens to explore how the affordances of these platforms shape the participants' engagement for climate science communication, what platforms they may employ, what motivates or challenges their engagement, and what institutional support (if any) is needed to support this unconventional method of science communication.

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[1] This author acknowledges the variety of literature surrounding different conceptualizations of affordances in relation to The Theory of Affordances. This includes 'perceived affordance' which differs from Gibson's (1979) original definition by shifting the attention from the materiality to the perceptions of a platform's features and it how it determines use of those features (Dvir-Gvirsman et al., 2024). However, given this study's focus on the views and engagement of the participants, and less so on their behaviour in relation to the structural design of social media, the term "Imaged affordances" is applied instead. The concept of 'Imagined affordances' redirects the focus to the participants imagination of what the platform affords and how it influences their engagement (Nagy & Neff, 2015). Further, the scope of this study does not involve an analysis of how platform features are used or enacted, but it does briefly explore what platforms and post-types the participants are engaged with.

4.0 Methodology

This research contains a two-part design, namely interviews and social media content collection, to investigate the engagement, methods, motivations, challenges, and perspectives relating to social media climate science communication among the sample of participants. With the Theory of Affordances, it is assumed that many social media platforms possess the logic that allows for science communication, and environmental scientists' engagement is shaped by their views of what the platforms afford. Through this lens, the research questions were developed, and then subsequently it influenced the development of the interview questions, and how the data was interpreted." Here you should focus on describing your methodology.

4.1 Participants and Setting

The research focuses on professional insights that can only be understood through first-hand knowledge and experience, which were aimed to be collected through interviews. As such, the first part of this research followed the qualitative methodological guide of several previous studies that have involved environmental scientists and their experience in environmental or climate change communication (Armstrong & Krasny, 2020; Johns & Pontes, 2019; Steinhorst & Beyerl, 2021). More specifically, this research closely followed the methodology of Hafenscher & Jankó (2022), where they used thematic analyses to investigate environmental scientists' motivations, thoughts, attitudes, and beliefs in relation to environmental communication. The second part of the research involved a qualitative content analysis of science communication content, as seen in Martin & MacDonald (2020), to enrich the data collected from the interviews and better illustrate the findings.

Twenty-two candidates from an environmentally oriented faculty of an Eastern Canadian university (henceforth "The University"), self-identifying as having a career focus on environmental issues, were contacted to participate in the study. This environmentally oriented faculty, which seeks to research environmental issues and develop solutions, was sampled because it represented a pool of environmental scientists at The University. The candidates were defined as researchers and educators who have studied and/or worked in environmental fields for 5 or more years. No previous experience or engagement on social media for science communication purposes was required to participate. Of the 22 candidates who were contacted, just 8 agreed to participate.

Follow-up messages were sent to encourage greater participation; however, some of those who were contacted stated that they were too busy.

The participants work in departments across campus relating to the natural sciences, social sciences, society and policy. Additionally, the sample group was made up of a mix of part-time and full-time, early-career and established career professors and researchers. All participants gave their informed and signed consent before their participation in the study, and the research did not require any personal details. As such, any identifying information provided by the participants was removed or redacted in the analysis.

4.2 Data Collection

Individual in-depth qualitative interviews were conducted over video call to understand the professional engagement (or lack thereof) of the participants with social media for climate science communication, and how their engagement is shaped by the imagined affordances of the platforms. The individual interviews were each about 30 minutes in duration, and consisted of open-ended questions, following a semi-structured interview guide as seen in Steinhorst & Beyerl (2021) (see Appendix B).

The 30-minute interview time allowed each interview question to be thoroughly explored without taking up a large amount of time out of the participants' workday. The interview questions were formulated to improve our understanding the participants' social media engagement, the platforms that they may use, their views on the platform affordances for science communication, how the affordances may motivate or challenge them as climate science communicators, and what they feel is needed (if anything) institutionally to encourage this form of outreach. This approach enabled us to address the research questions without restricting new insights (Gerrath et al., 2024).

Additionally, the interview questions were attempted to be phrased in a very colloquial way. Any mention of the theoretical framework and terms such as "affordance" was avoided to (1) not confuse the participants who may not be familiar with this terminology, (2) to allow for rephrasing and flexible prompts to collect the data, and (3) to get nearer the reality of the participants' experiences without forcing unnatural language usage (Swain & King, 2022).

The participants were additionally asked to share one or more pieces of science communication content that they have published on social media to be thematically analyzed (Kędra, 2013; Martin & MacDonald, 2020; Shanahan et al., 2019). It was specified to the

participants that the piece(s) of content should be those that they feel exemplify their professional social media activity and experience. In the case of the participants who reported having experience engaging with social media to communicate science, this additional step served to enrich and illustrate the interview data, and act as a supplementary data source

4.3 Data Analysis

Each participant was assigned a random pseudonym to help ensure anonymity. This was especially important given the small sample size of the study. The interviews were recorded and automatically transcribed over MS Teams, saved as MS Word documents, and then manually reviewed while rewatching the interview recordings to the ensure accuracy of the automatic transcription (Gerrath et al., 2024).

The interviews were then analyzed using an inductive thematic analysis outlined by Braun and Clark (2006). Following the *Phases of thematic analysis* (Braun & Clarke, 2006), the transcripts were first individually reviewed to improve familiarity with the data. Still working from the MS Word documents, the transcripts were divided (chunked) into sections and assigned codes using the "Comment" feature. These codes were based explicitly on the participants' experiences and opinions, and they were all re-reviewed to identify any possible mislabelling. Next, the codes were transposed to a spreadsheet where they were manually collated into patterns and potential themes. The initial themes were compared against the original interview transcripts to ensure they still accurately represented the data. Then, they were refined to those that provided the greatest insight into the research questions. As seen in Gerrath et al. (2024) and Lou et al. (2023), findings that are recurring and/or similar were re-coded into broader themes and sub-themes. The thematic analysis was entirely data-driven, and there was no interpretation involved. Throughout the analysis process, the data were re-checked and reviewed by the supervisors of the study to confirm the findings and ensure rigour.

Following the interview analysis, the thematic content of the social media posts was also analyzed. The analysis was based on the framework seen in Shanahan et al. (2019), originally adapted from Kędra (2013), where sampled images from social media sites were thematically analyzed through qualities that were broken into categories. The categories used in Shanahan et al. (2019) were adapted to suit this study. The qualities of the posts that were explored using categories

in this study included the platform, post-type, caption/photo/video content and messaging, and the intended audience.

The analysis took place in MS PowerPoint using screenshots of the provided posts. Again, using the "Comment" feature, codes were applied to the thematic content using each of the outlined categories in the posts. Following a similar rigorous revision process as used to analyze the interview data, the codes and themes were reviewed to ensure they were accurately applied. The analysis of the social media posts generated unique codes that were able to be fit into the existing themes that were developed in the thematic analysis of the interviews. As such, this analysis enriched the interview data and provided an illustrative example of a section of the themes that emerged in the interviews.

5.0 Findings and Discussion

Despite the small sample size of this investigation (n=8), 6 broad themes were identified from the interview data to provide context for each part of the research question. The uncovered themes include Engagement, Platform Affordances, Motivations, Challenges, Support, and Contrasts and contradictions.

The theme of *Engagement* encompasses sub-themes relating to if, how, and how much the participants engage on social media, including an overview of which platforms were discussed. This theme aligns closely with the primary research question and sets a foundation to understand the professional engagement (or lack thereof) of the participants on social media for climate science communication. The *Platform Affordances* theme further develops this investigation, while more deeply exploring the participants' use of different social media platforms in relation to their views of the platforms' affordances (imagined affordances). It also aligns closely with the first sub-question, which specifically asks what social media platforms the participants employ for their engagement. The theme of *Motivations,* which aligns with the second sub-question*,* explores what encourages the participants to use social media for science communication. Conversely, the theme of *Challenges*, aligning with the third sub-question, explores the challenges faced by active social media science communicators and the deterrents for those who have not engaged with it. The theme of *Support*, aligning with the fourth sub-question, discusses the suggestions made by the participants to encourage social media science communication. Finally, the theme of *Contrasts and*

Contradictions appeared outside of the scope of the primary research questions as a result of the inductive nature of the analysis. This theme explores the differences found among the reach and experience of communicating science on social media versus other forms of communication, contrasts and contradictions in the participants' views, and discussions on the duality of social media as a communication environment.

The first three themes from the interview data (Engagement, Platform Affordance, and Motivations) were able to be enriched through screenshots and linked examples of the participants' social media science communication. The remaining 3 themes were not enriched with social media content because the interview findings did not apply to the data shown in the social media posts.

Based on the available literature, no other studies have explored the engagement and views of Canadian environmental scientists on social media for climate science communication. Although exploratory and provisional to a small subset of environmental scientists at just one Eastern Canadian university, this study attempted to do just that. The themes are explored in the sections below.

5.1 Theme 1 – Engagement

5.1.1 Participants are engaging with social media for science communication

There is existing discourse surrounding social media's affordance as a tool for both general and climate science communication (Brossard & Scheufele, 2024; Coletti et al., 2022; López-Goñi & Sánchez-Angulo, 2018; Pavelle & Wilkinson, 2020), especially owing to its growing popularity among younger generations as a source of information (Newman et al., 2020; Statistics Canada, 2023). While further research is needed to understand the relationship between social media use and climate change knowledge in the general population, there is evidence supporting social media as a place for knowledge-building communities (Anderson, 2017), and its affordance for science communication (Brossard & Scheufele, 2024; Coletti et al., 2022; Haider, 2016). With this existing literature and the Theory of Affordances as our theoretical lens, it is understood that social media can act as a tool to afford science communication - whether the participants seek to engage in it or not. That being said, the data collected in this study find that environmental scientists at The University report that they *are* engaging with social media to communicate science. No specific criteria for science communication were outlined to the participants, and so their report was based

on their own understanding of what social media science communication is. Seven out of eight of the participants in this study have directly (5/8) or indirectly (2/8) contributed to social media science communication in varying relation to climate change.

Additionally, the social media platforms and post types vary among participants. They claim to use X, Instagram, Bluesky, Facebook, YouTube, and LinkedIn for professional social media science communication. Further, the illustrative social media content examples provided by a subset of the participants included a mix of original and reposted text, image, and video posts across the different platforms (see Appendix C for examples).

Table 1. **Participant social media science communication engagement details.**

These details help to conceptualize the participants' self-assessed level of engagement on social media, the platforms they mentioned using, whether they engage with it directly (through their own accounts) or indirectly (contributing to the accounts of others), and what phase of their career they are in at The University. "*" signifies that the participant engaged with social media on behalf of an environmental organization outside of The University.

Participant	***Direct/indirect***	***Self-assessed engagement (scale of 1-10)***	***Professional Standing within The University***	***Platforms mentioned***
*Jason **	*Direct*	*8*	*Part-time*	*Bluesky* *Facebook* *Instagram* *LinkedIn* *Twitter/X* *(Stopped using Twitter when it became X)*
Calvin	*Indirect*	*0*	*Early career*	*Instagram* *YouTube*
Ryan	*Indirect*	*0*	*Established career*	*Not mentioned*
Chris	*Direct*	*3*	*Established career*	*Facebook*

				Twitter/X (Stopped using Twitter when it became X)
Martha	*Direct*	*2*	*Established career*	*Bluesky Instagram Twitter/X (Stopped using Twitter when it became X)*
Sue	*NA*	*0*	*Established career*	*NA*
Mary	*Direct*	*6*	*Established career*	*Instagram LinkedIn Twitter/X*
*Kevin **	*Direct*	*1*	*Established career*	*Twitter/X*

Participants Jason, Chris, Martha, Mary and Kevin reported that they directly use social media for science communication. Their participation is considered direct because they are directly posting on social media themselves, rather than simply contributing to the social media science communication of others. On a scale of 1 to 10, with 1 being very low engagement and 10 being very high engagement, participants Chris, Martha, and Kevin report a relatively low level of engagement on social media for professional science communication. Their engagement was self-reported at 3, 2, and 1, respectively. Alternatively, Mary reported their engagement level to be higher at 6. While Jason reported their engagement level as an 8 out of 10, claiming that they did not rate themselves higher because there is always room for improvement. Notably, Participants Chris, Martha, Mary and Kevin are established professors, whereas Jason is a part-time professor who also directs an environmental NGO, where they place significant importance on public outreach (see Figure 1). Kevin also mentioned previously being a part of an environmental organisation where they participated in social media science communication; however, they are no longer doing so, and their engagement on social media reflects that.

These findings suggest that despite the participants' widespread engagement on social media for science communication, most felt that they were not very active in doing so, or that they could be doing more. As such, they may view the affordances for science communication that social media possesses but face enough challenges or deterrents to limit their engagement. The potential challenges and deterrents will be discussed further in Section 5.4. Additionally, without knowing how the participants adjust their social media engagement to take advantage of the media logic (and knowing that most participants ranked their level of engagement on social media quite low), their social media science communication may not be effective or significant (van Dijck & Poell, 2013). However, this is beyond the scope of this study.

Only one participant, Sue, was completely removed and had never participated in social media science communication at any capacity. They claimed to engage with social media solely as a viewer. Sue reported that they "don't really engage in social media communication in general" and that it is "not really specific to science." They say that it is simply not their "preferred way to interact or disseminate information."

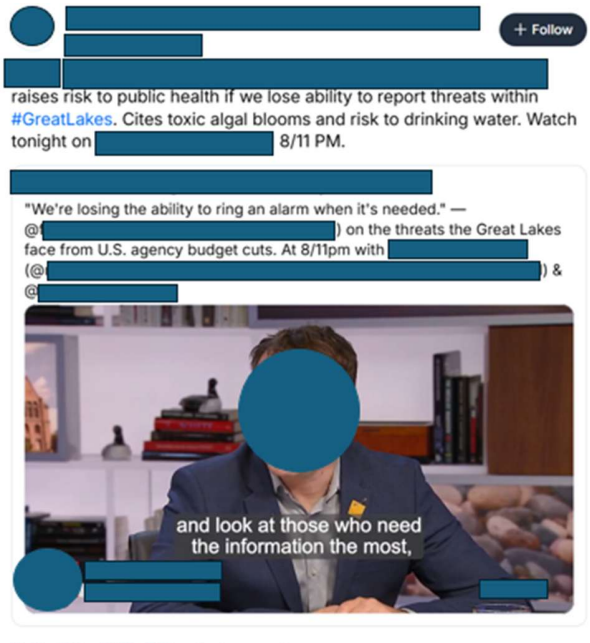

Figure 1 **. Example of Jason's engagement on social media for science communication on behalf of the environmental organisation to which they belong outside of The University.** Jason rated their engagement on social media the highest out of all of the participants (rating of 8 out of 10). In this example of their engagement, they reposted a video interview clip on BlueSky

of themselves that was originally posted by a journalism outlet. This post is an example of one of the social media applications and communication methods that Jason employs. The post warns the public of the threats to [Jason's environmental area of research] due to U.S. environmental budget cuts. Viewers are able to tune into the full interview advertised on the original post.

Some of the social media science communication examples that were shared in this study did not align with Nerghes et al.'s (2022) definition of science communication, aka the one-way transmission and translation of scientific results and their impacts towards a lay audience. Instead, some of the posts seemed focused on sharing project status updates, rather than education around the topic of their research or science in general. This could have been because the example of their content that they selected to share with the study was not a complete representation of their social media science communication. Alternatively, the participants may have had a different definition of science communication. Whatever the case, the participants have demonstrated that environmental scientists at The University are engaging with social media to share some level of scientific information, even if it does not always fit neatly within other definitions of science communication.

5.1.2 The focus of the participants' science communication

Once it was understood that the participants do, or have, engaged with social media for science communication, the focus of their engagement was investigated. Particularly, whether it was climate change focused or not. Participants Jason, Martha, Mary and Kevin reported their social media communication as being related to climate change because of the environmental focus of their profession, but they did not report that they principally communicate climate change science. For example, rather than breaking down the key concepts of climate change to increase their audience's general understanding of the topic, the focus of their social media communication is to share their research process, status, or findings, which just so happens to be affected by climate change. This is demonstrated in the social media screenshot examples in *Figure 2,* where the participants share updates on their research using lake sediments and monarch butterflies to investigate the impacts of climate change. These are considered examples of science communication related to climate change. Yet, they are not directly communicating the mechanism or causes of climate change.

A basic understanding of climate change may be needed among the lay audience to understand the context of the research that is being communicated. For example, if the audience does not understand that climate change affects the occurrence of a species in a particular environment, they may not understand why studying changes in a species' habitat is related to climate change. Further background knowledge may be needed by some audiences before researchers can successfully communicate more specific details about their research. Alternatively, this may mark a greater need for effective social media science communication training among environmental scientists to bridge this gap between them and the general public.

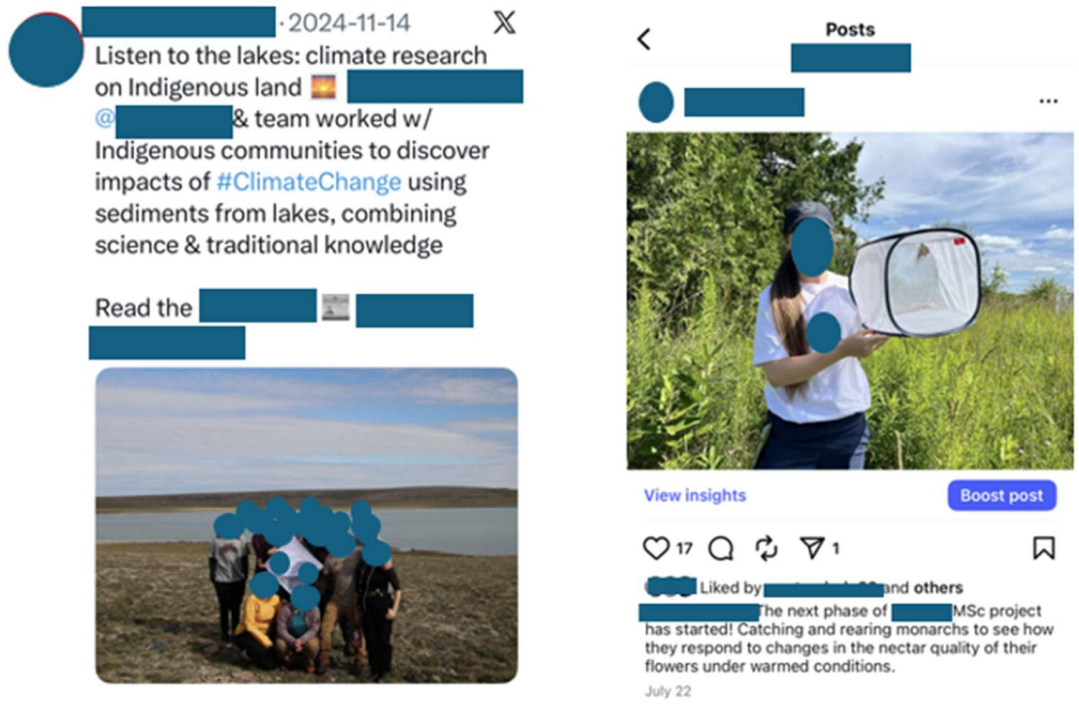

Figure 2. **Examples of environmental science communication on social media that are related but not necessarily focused on climate change.** The left screenshot from Kevin is an example of science communication on the platform X. This particular post was originally made by a multi/interdisciplinary journal and reposted by Kevin. The post highlighted the participant's research and redirected viewers to an article on The University's website for more information. The right screenshot from Martha is an example of science communication on Instagram. Martha

is highlighting the research of their student. Both posts summarize the research in their lab with mentions of the impacts of climate change.

Participants Calvin and Ryan do not directly engage with social media to communicate any form of science. That being said, they have both indirectly participated in social media science communication that, similarly to participants Jason, Martha, Mary and Kevin, is climate change-related due to the nature of their profession. These participants, while deterred from using social media directly, both support the initiatives of other scientists to publicly disseminate science (see example in *Figure 4*). Calvin said, "If people have projects, I can talk on a camera; I'm happy to do this. I can provide material; I can provide idea expertise. I'm happy to help other people's endeavours and efforts at mobilizing climate information on these platforms, but I don't want to be interacting directly with the platforms themselves." More succinctly, Ryan said, "I did see the value in contributing to the stuff that the labs and the groups were doing on social media, just not me personally."

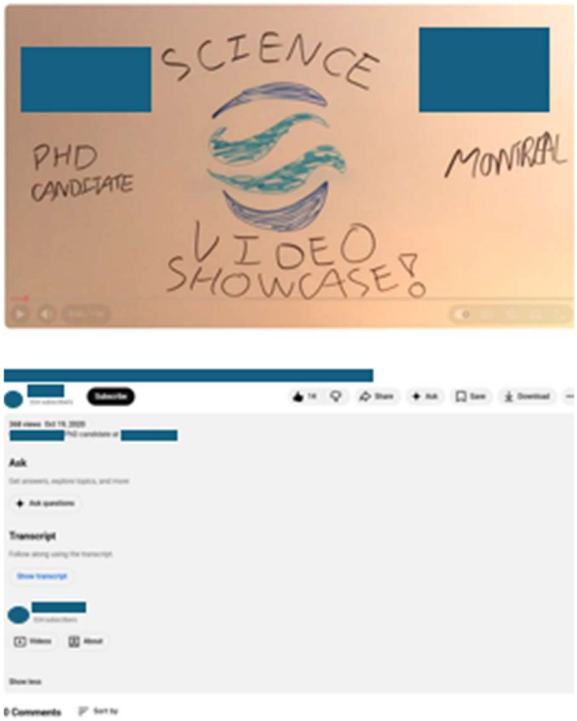

Figure 3. **An example of how Calvin has indirectly contributed to social media science communication related to climate change in the past.** Calvin provided a 2-minute video

showcase of their research for the YouTube channel of a national network of researchers. The participant's research is intertwined with climate change and the Arctic.

5.1.3 Professional engagement on social media for science communication

The participants additionally discussed what led them to engage with social media for science communication and how they would define their engagement on social media (professional or casual). Jason and Kevin explained that, because they belong(ed) to a public environmental organization, social media is important for their role in that organization. Jason said, "We are mostly [communicating climate science] because our members have asked us to be more active. Our members were asking us to promote the science and climate science about [Jason's professional focus]." Similarly, Kevin stated that as the "president of a society," they were "using social media", beginning "around 2012". Kevin provided more detail, stating, "It wasn't focused on that [climate change]. It was focused on the society, which broadly includes climate and environmental quality".

Martha reports that initially, their engagement on social media was focused inwardly on communicating their research with other scientists and recruiting students to their lab. However, now they report that they are less concerned with communicating within the academic community, and that if they were to continue to engage with social media for science communication, they would like to reach the public. Martha stated, "I haven't been - probably - very effective at like reaching the public, which is probably what I really want to do. But in the end, I really reach other researchers and students in labs."

Mary reports that their current social media engagement is strictly for science communication: "I'm definitely engaged in science communication. I really steer away from advocacy, so I don't engage in advocacy at all through social media. But I do engage in social media to share science findings, facts, information about what's going on."

Chris, however, primarily viewed social media as a tool for marketing their research and to stay in touch with professional friends and connections, less so to communicate science, let alone climate science specifically (see *Figure 3*). Chris stated, "- especially as our research group was starting, I thought it was kind of a useful way to build a kind of brand." "I found it was kind of good that way because we were quite a multidisciplinary, quite a large group doing projects all in

different parts of the world, you know what I mean? So, I did find it useful, right? That was my purpose for it originally. It was really kind of a marketing thing, really."

Figure 4. **An example of how Chris' engagement on social media is considered marketing while communicating topics related to their research.** Chris posts on Facebook in a private group for the purposes of community outreach and communication, not specific to climate change. The platform is used to advertise their research, accomplishments, and upcoming activities/events.

Participants Jason and Mary, who have the most experience among the participants in communicating climate science on social media, feel that there needs to be advocacy for climate change understanding and action on social media, intending to inform but not lobby, and that it may indirectly benefit future climate research and action. Based on their interviews, they may view social media as possessing the affordance to inform the public and advocate for climate action.

> There's a paper coming out in the next issue of [scientific journal], for example, where we're talking about the impact of what's happening in the US on Canadian researchers. So, these

> are things that I feel are very important to do. And when that paper in [scientific journal] will be out, well, we're going to put it on social media because we want to amplify this. And when you're a non-profit organization, it's really important to have a clear mandate and to understand what we are for. And we are, we're not lobbyists, for example, we're not lobbying for particular things to be passed in terms of budget or things. But we are saying, 'this works', 'this doesn't work'. We are providing the ingredients for recipes, basically. And I think by doing so, we hope to be helpful for everyone. We want the people making the decisions to have all the information they need to make the decisions, but the decisions are still with them. (Jason)

> I follow ministers, for example, even though I don't advocate, I try to create change. And you have to do that at different levels. … I will not use social media to share a petition or anything like that. I may support it, I may sign it, but I will not share that. But I will use social media to share a fact that might encourage people to see things in a factual way. But I'm very particular about this, and there are a lot of other environmental scientists who are not there. They see their role actually as a scientist and as an advocate. For me, it's black and white. But it's not like I'm advocating, I am not doing it in a way that an NGO would do it. Or I feel like, for me as a scientist, my credibility comes from my ability to be neutral and to be fact-based. So I'll share facts which could be viewed as advocating, but I will not use them for personal opinions. (Mary)

These participant accounts demonstrate the range of professional outcomes social media science communication is viewed to possess, and they give a peek into the qualities that affect their engagement on the platforms for climate science communication specifically (these qualities as motivations and challenges will be discussed further in sections 3 and 4). Through the theoretical lens, this professional engagement (no matter the motivations) suggests that the participants view social media as possessing the qualities that allow for the action of professional science communication. Further, multiple social media platforms were reported to be used for it (e.g. X, Instagram, Bluesky, Facebook, YouTube, and LinkedIn), which may suggest that these participants view a quality, or qualities, among these platforms that enable the action of science communication.

5.2 Theme 2 – Platform Affordances

Not all social media applications are created equally when it comes to science communication. Looking again through the lens of Affordance Theory, which states that it is the qualities of an object or environment that afford an action, it is understood that certain platforms or features may be more attractive to environmental scientists because of their qualities that afford climate science communication. In addition to *what* platforms they use (see Section 5.1.1), the participants discussed their *preferences*, the qualities of those applications that lend themselves to science communication, the applications that they are actively deterred from, and why.

5.2.1 Participant perceptions of individual platform affordances

Statistics Canada claims the most popular social media applications in Canada, to date, are Facebook and Instagram, followed closely by TikTok and X (formerly Twitter) (Social Media Statistics in Canada, 2025). The popularity of Facebook, Instagram, and Twitter/X is reflected in the findings, as the most popular applications used by the participants for their social media science communication (see *Figure 5*). Further, the qualities examined from the provided social media content demonstrated the affordances provided by the platforms for science communication. All of the platforms seem to afford the ability to share text, photos, and videos. Across all examples, the post captions and videos were relatively concise – typically 2-3 sentences or 1-2 minutes long, respectively – demonstrating social media's affordance for concise yet informative communication. The attached photos seemed mainly for aesthetic purposes and didn't provide any scientific information. Other caption qualities, like hashtags or tags, were often used and provided the affordance for discoverability and community connection on the platform. Based on the findings above, the participants may choose specific social media platforms based on their ability (affordance) to reach their intended audience.

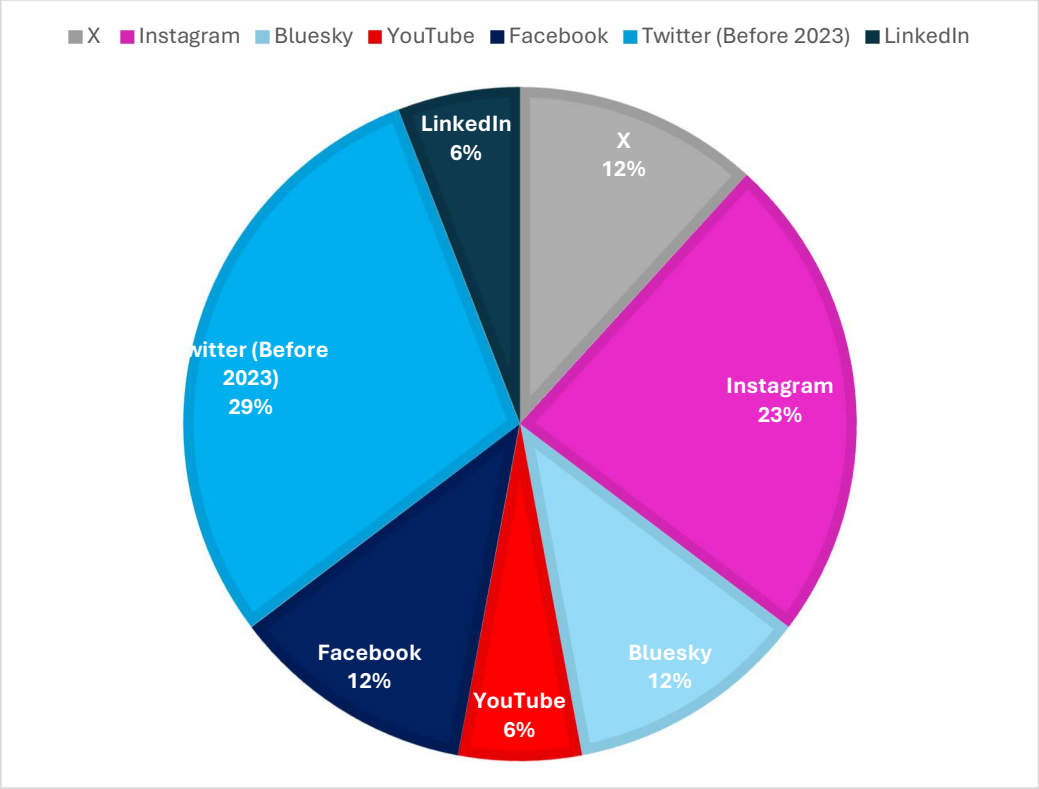

Figure 5. **The popularity of each social media application mentioned by the participants (n=8) for professional science communication.** The participants discussed the social media applications that they use, or have used, to communicate science, either directly (using their own accounts) or through the accounts of others. Each participant (n=8) mentioned using between 0 and 7 different applications. These applications included X, Instagram, Bluesky, YouTube, Facebook, Twitter, and LinkedIn. Twitter is considered separate from X in this figure despite originally being the same application.

Instagram

Instagram was found to be the most popular social media application, currently, among the participants. The general view of Instagram among the participants is that it has the most potential for public outreach due to its popularity, and it is seen as a valuable application for reaching students and the younger generations (demographic data is not publicly shared by Instagram). Given that young adults are more likely to go to social media for information than older generations, and that Instagram is among the most popular social media platforms in Canada

(Newman et al., 2020; *Social Media Statistics in Canada*, 2025; Statistics Canada, 2023) it aligns with the participants' views that Instagram affords a reach to younger generations for science communication.

At large, participants did not discuss Instagram as a primarily visual platform, nor how they take advantage of this quality. However, the example provided by Martha depicts them using this feature for sharing images of their research in progress. That being said, users are not limited to photo sharing. It is also possible to share infographics and educational Reels. Despite the variety of visual communication methods on Instagram, one participant felt that due to its primary visual focus, it has a lesser affordance for science communication, not allowing for the explanation of complex topics. Meta's recent news-sharing policies in Canada were also noted by the participants to majorly impede simplistic information sharing (Meta, n.d.) (See section 5.4, "Unfavourable media policies" for more).

Twitter and Bluesky

Once, Twitter would have been considered the most popular platform among this sample of participants. Five participants reported using Twitter for science communication, while only four participants reported using Instagram. Twitter/X was acknowledged among the sample for its affordance and ease of article/link sharing, communication among professional connections, and the public at large (Collins et al., 2016; X, n.d.). Chris found that Twitter "was quite useful" for its "different audience." Martha said, "It seemed like Twitter was the sort of best of both in a way," when talking about reaching academic connections and a wider audience. Mary stated that "before it switched to X," they "did use Twitter the most for science communication." Consequently, three of the five participants who used Twitter ceased use of the platform following its change of ownership and title in 2023, becoming 'X'.

Conversely, the view among participants is that Bluesky mainly connects them with members of the scientific community and loyal followers of their research or career, less so with the general public. Jason mentioned using a variety of applications, including Bluesky. "We use Facebook, Instagram, we use LinkedIn, and we also use BlueSky, which is that new platform that a lot of scientific organizations have been using." They felt that "Blue Sky is now the best fit" for the "more hardcore science communications." Similarly, Martha said, "Blue Sky seems way more sort of academic. But again, it's partly how I have come into it and when I first originally saw it

like that, and then I've sort of left because it seemed to be going towards more of the academic side."

Facebook

A couple of participants, Chris and Martha, noted Facebook's affordance for community-based interactions and personal communication (Collins et al., 2016; Hall, n.d.), but less so for public outreach. However, it seems to be losing popularity. Martha said that they think they have a lab profile on Facebook, "But we never use it either". Mary mentioned specifically having many other social media platforms for their lab's science communication endeavours, but not Facebook, "So, we don't have a lab Facebook, but we've got a lab Instagram, a lab X, a lab like everything." Notably, participants did not formally discuss their privacy settings which could affect Facebook's affordance for public outreach given its specific logic that is seemingly geared toward community pages.

YouTube and LinkedIn

Finally, YouTube and LinkedIn were much less popular among the participants. LinkedIn was mentioned by Jason and Mary. However, they disagreed on its affordances of for science communication. LinkedIn was viewed as being in a transition stage, somewhere between a social media application and a job search application. Jason mentioned using it for science communication, specifically sharing scientific articles and research findings, implying that it offered this affordance. Though, Mary felt that it affords the opportunity for sharing with colleagues and students more than science communication (See Appendix C, Jason versus Mary). They discussed LinkedIn, saying, "it's still this awkward place where, like it was meant for job hunting, but then people are starting to use it to share stuff. I tend to only share opportunities on LinkedIn, whereas I would share, say, a paper or facts on X and Instagram". Given the application's professional focus, this transition toward sharing may lend LinkedIn as a social media application for science communication geared toward non-expert professionals, such as policymakers and government officials.

Just one participant mentioned using YouTube to indirectly disseminate their research. Calvin felt that YouTube is valuable for storing educational videos, but it was not noted as effective for public outreach.

TikTok

Notably, TikTok was excluded from the list of popular applications among the participants. TikTok is a video-based app that tailors recommended content to viewers based on their behaviour within the app (Rein, 2023; TikTok, n.d.). This is possibly due to the security of information, or the potential dissolution of the application following the Canadian government's order in November of 2024 to dissolve TikTok's Canadian arm following a national security review of its Chinese parent company, ByteDance Ltd (Tunney, 2024). Alternatively, it may not be popular among the participants because they do not know how to use it as a science communication tool (Rein, 2023). Although age was not a consideration in this study, perhaps the age of the participants could be related to the applications that were popular among them (this demographic data is also not publicly shared by TikTok). Whatever the reason, TikTok, uniquely, provides a dedicated STEM feed in Canada aimed to "empower continued discovery on TikTok and connect a dynamic community of individuals over their shared passion for learning" ("TikTok Launches STEM Feed in Canada," 2024), and this feature is not being utilized by the participants of this study.

5.3 Theme 3 – Motivations

5.3.1 Societal responsibility and professional benefit drive participants' social media engagement

Nagy & Neff's (2015) conceptualization of an "imagined" affordance, in relation to Affordance Theory, tells us that people shape their media environments, perceive them, and have agency within them. If affordances are in large part imagined by users, then social media's technological features (e.g. share, comment, hashtag) can inherently be used for science communication, should it be imagined to be used that way. Participant motivations for science communication may impact the imagined affordances of social media – allowing social media to be a tool for this purpose. However, that same media environment can simultaneously pose hurdles depending upon how the participant or those interacting with the participant choose to shape the media environment. With the imagined affordance of social media as a science communication platform, scientists' communication objectives may be achieved. Therefore, those objectives, or

motivations, were sought to be understood. The following perspectives were collected from the interviews of the participants who have previously or currently, and directly or indirectly, engaged with social media to communicate science.

Professional connections

To a couple of the participants, social media is viewed as being important for maintaining professional connections, such as journalists and coworkers (see Appendix C, Jason and Chris). Jason stated that "over the years, the network that we have is made of that mix of professional and personal connections." While Chris stated, "I use Facebook primarily just to stay in touch. Like everyone that I work with [at research location], they're on Facebook."

Similarly, despite professional connections not being their primary intention for engaging with social media, Mary stated, "I don't have like a specific strategy, which means that I haven't been probably very effective at like reaching the public, which is probably what I really want to do. But in the end, I really reach other researchers and students in labs."

These connections are described as being between "professionals", but they are not necessarily between other climate change experts or environmental scientists. As such, they may still fall within the definition of science communication, which is meant to educate the "lay" or general public (Nerghes et al., 2022). Therefore, social media's affordance for science communication among other professionals is seemingly appreciated, motivating the participants' engagement on these platforms.

Quick communications

Some of the participants felt that social media is useful for quickly communicating science (see Appendix C, Jason). Their interviews suggested that a motivation for using social media for science communication was its affordance for these quick communications.

Jason said:

> Going to social media has also been very effective for sharing things very quickly since the beginning of this year (2025). We are monitoring a number of things because of the US situation, and again, we are a US-based organization, but the research environment in the

> US has been very impacted, and getting information out on social media has been quite effective to a large number of people very quickly.

Mary stated:

> I think my motivation is the same [among social media and other science communication outlets], but it just takes less time to do social media, even though it takes a lot of time to do social media. Like I can write something and chuck it out there. Whereas if I'm doing a presentation at a thing, it's like it's, you know, it's an hour.

Professional responsibility

Participants, Jason and Kevin, who also mentioned communicating science for environmental organizations outside of The University, said that one of their motivations for engaging with social media is simply because it is 'part of the job' (see Appendix C, Jason). Jason said that their organization has a communication team and that they are a part of that team. "The communication we do is linked to the mandate of our organization, that is to promote all sciences related to [environmental focus]. And of course it has a very strong climate change dimension." Similarly, Kevin stated, "I actually got involved with social media when I was the president of our Society at the time. "That was kind of the motivation because the society was using social media. So, I got involved."

This sub-theme is less so focused on the qualities of social media that motivate their engagement on it for science communication, and more so external motivations that resulted in their use of social media's qualities that afford their professional responsibility.

Engaging the public with science

Social media is seemingly viewed by the participants as being useful for engaging the public with academic discourse (see Appendix C, Martha). Jason said that their motivation on social media is "to be helpful, to share," to encourage "the transfer of science to policy". Martha admitted that they are still trying to figure out how to best engage the public, stating, "I'm still curious to figure out, like, you know, how do I- how can I generate more attention or more public attention to the work that we do." Mary stated that one of their motivations for using social media "is just to make

change". They said, "I believe in the science that we're doing," and "I think you need to be sharing your work, but I also like to share other people's work." As social media becomes increasingly popular for accessing information and news (Newman et al., 2020; Statistics Canada, 2023), it may also increasingly afford public engagement with science. This data suggests that these participants are motivated to engage with social media because of its affordance to engage the public with science."

Attract funding

Finally, participants discussed how forms of public outreach, including social media science communication, can increase access to funding. Mary stated, "the more you communicate, the more like attention and funding you can get and the more you can support the next generation of scientists". Similarly, Chris called social media science communication "a marketing thing" in the early days of their career. Attracting funding is also discussed in the literature as one of the benefits of going to social media for science outreach in general (Ho et al., 2020; Wilkinson et al., 2023). These participants seemingly view social media's qualities as useful for attracting funding for their research; alternatively, providing the affordance to advertise their research.

5.3.2 Missing motivations

No participants claimed to be motivated to engage in social media science communication for purely personal fascination or fun, as in van Eck (2023). Instead, social media science communication among the participants is seen purely as a professional duty to increase the impact of their research and attract funding (Vainieri et al., 2023). Often, scientists' success and productivity are judged by their peer-reviewed publications and their access to grant funding. As such, public engagement may not be considered a high priority for the participants who are not seeking further recognition for their topic of research in order to gain greater access to funding; they may not seek to take advantage of the affordances for climate communication offered on social media. Alternatively, social media science communication may be more often engaged in purely professionally because the challenges afforded by social media facing the participating science communicators may outweigh the more frivolous motivations.

Therefore, the participants are seemingly motivated to engage with social media to communicate science because they afford them the ability to foster professional connections, quickly communicate scientific information, engage the public in academic discourse, attract funding, and because it is necessary for their career. These findings are all consistent with the literature concerning the explored motivations for science communication in general (Ho et al., 2020; van Eck, 2023; Wilkinson et al., 2023), and more specifically, social media science communication and climate communication (Belova et al., 2022; Freiling & Matthes, 2023).

5.4 Theme 4 – Challenges

Despite the imagined affordances of social media that may enable the participants to foster professional connections, engage the public in academic discourse, and quickly disseminate science (i.e. motivations), many sub-themes also emerged relating to the challenges and deterrents of engaging with social media, in general, and specifically for climate science. Under the theoretical lens, if social media's imagined affordances can motivate the participants' engagement on social media for science communication, then they can dually challenge or deter their engagement as well. Alternatively, the qualities of social media may not directly challenge or deter the participants, but they may not serve as a strong enough motivating quality.

The list of challenges and deterrents was notably built from the experiences of the participants who do and do not engage with social media. Therefore, these sub-themes serve as examples of both deterrents from engaging with social media (from participants not directly engaging with social media) and of the challenges experienced (from participants actively on social media as science communicators). Like the motivating themes, many of the sub-themes found in this study are consistent with the challenges found in the literature for other forms of science communication.

No professional advancement

Firstly, social media is seen as providing no professional advancement for the participants, or its affordance for professional science communication was not made obvious until recently, and thus it was not engaged in. Chris stated, "There's no, like, professional advancement or there's nothing in it for me, I would say." In that same vein, Ryan stated, "I had already gotten tenure and

promotion and stuff, so I didn't really feel like I needed it. My work's always been pretty well cited, so I didn't feel like I needed it."

Ryan and Chris' sentiment echoed Andrews et al. (2005) who discussed that science communication is frequently viewed by scientists as volunteer work that is auxiliary to their other responsibilities (Andrews et al., 2005). Notably, some participants discussed motivations such as increasing professional connections and marketing their research to increase funding opportunities. However, if these things are not needed, or not viewed as afforded by social media, then the extra work that is needed for this form of outreach may seem unnecessary.

Mental fatigue

The participants also discussed feeling or experiencing cognitive overload. Social media is seen as too much work and causing too much mental fatigue. It is not worth the effort for Chris, who said, "It's probably the stage in my career - like, I'm, you know, I'm at 5-6 years away from being done - Like, my grants are already done - I don't need networks. I don't want networks." Whereas Calvin is mainly deterred by "mental fatigue", stating:

> I was on social media before. I had a Facebook account [a personal one], which I suspended in 2020, around the pandemic time, right? … But it was part of this mental fatigue, and I haven't looked back since, right? So, I was not incentivized either to reopen such an account, whether that was Facebook or Instagram. And I did not have the incentive to reopen that for professional reasons either.

For these participants, the mental fatigue and effort experienced when engaging with social media is seemingly a strong enough deterrent. The action of engaging with social media to take advantage of its affordances for science communication may simply be too demanding. Alternatively, the mental fatigue may not directly be afforded by social media, but its qualities may afford interactions that lead to this feeling.

Lack of time and rising expectations

A few of the participants reported that they are challenged to engage with social media due to a lack of time and the rising social media production expectations, requiring greater resources

than the participants have. Social media science communication was also commonly described as time-consuming, and thus, participants either did not want the obligation of engaging with it or they simply could not find the time. Ryan stated:

> To be totally honest, I didn't want to have that obligation. I didn't want to be constantly updating things. I didn't want to be checking things all the time. I kind of saw my life offline as being more valuable than my life online. So, the time I was at work, I was at work. The time I was at home, I was at home. And so by the time I started to notice that people were promoting themselves through social media and that it wasn't just for like updating high school friends and stuff, I kind of already made that decision that that I didn't want this encroachment on my life, and I wasn't, myself, going to like kind of push my career stuff that way.

Martha said, “Instagram seemed to me like it had the most potential to be more public outreach, but I haven't again had the time to do it.” Likewise, Calvin said that social media “does take a lot of time and effort”, and that it's “committed work to create this content, so you want to make it count.” Mary stated, “We've had aspirations to do a bit more than that [existing social media engagement], but also at the same time, like, we're slammed. Like, we're barely able to get done what we need to get done, so it's it feels overwhelming and like an extra sometimes.”

Martha additionally noted that rising production expectations for social media are a challenge to keep up to date with; relating back to a ‘lack of time’. As an active social media engager, they were not completely deterred by this factor, but it was seen as a large enough hurdle that it is limiting their engagement. Martha said:

> It seems like there's a higher bar for how fancy the media that you're putting out is. I mean, obviously, there are now tools to sort of meet the moment, but I haven't invested in the tools to then do that. So, I'm sort of like lagging behind 'cause it now seems like I have to do more, but I haven't spent the time to figure it out.

Social media may be seen by some participants as affording the quick dissemination of science content, but when lacking the resources or know-how to effectively take advantage of this

affordance, it becomes a deterrent for the participants. These findings echo Wilkinson et al. (2023) and Collins et al. (2016), who explored scientists' perceptions about science communication in general and on Twitter, respectively, and found they are deterred due to a lack of resources and time. A lack of time from members of the faculty may also be a contributing factor to the modest sample of participants who volunteered for this study, further aligning with this sub-theme. Moreover, Wilkinson et al. (2023) found that scientists may be deterred due to a lack of knowledge or understanding of social media applications.

Unsuited to productive discussion

A few participants felt that social media is unsuited to productive discussion. Through the theoretical lens, it simply may not have the affordance for effective climate science communication due to the structure (or logic) of the platform. Alternatively, it may afford interactions that deter the scientists from engaging with it for that purpose. As such, Sue stated, "I just think those platforms tend not to be conducive to thoughtful interaction," and Jason reported:

> I haven't had an interview that went necessarily wrong, or we haven't seen attacks on our social media posts, maybe because we're in a niche. And again, if people want to attack our scientific discoveries, we can prove to people very quickly that this is actually true. But we are definitely careful on things we post.

The participants often referred to social media as fostering a negative or toxic environment due to the facility for users to leave negative comments or share toxic opinions, especially when communicating a scientific topic that has become politicized, like climate change. Ryan said, "Now, what's always been a disincentive for me to jump in on that, you know, like setting aside questions of time and personal preference, is this kind of toxic soup that surrounds these discussions, right?". Sue agreed, saying "seeing the kinds of pointless and often negative interactions that do happen on social media - I just don't want to be part of it." At a few points, Calvin discussed this negativity, saying:

> There are many issues about these platforms being toxic to those discussions, and yeah, having issues about the dissemination of information. … Yeah, I would think that you get

> more negative comments - my perception is that you would get more negative comments when you're behind a keyboard, right? … Yeah, I think it's the general question, like, is it worth your time, right? Is it worth your time engaging with people, with climate deniers, who will easily attack you online? For my own mental health and well-being, I'm like, I'm not doing this.

The participants' perception that social media is inconducive to productive conversation and fosters a toxic environment aligns with previous literature as reported by Gewin (2018). This sub-theme does not necessarily contradict social media's previously discussed affordance for communication but highlights its additional affordance for harassment and misinformation (Apuke & Omar, 2021; Islam et al., 2020; Levy, 2023; Vidal Valero, 2023), possibly leading to these reported perceptions of toxicity and unproductiveness. The participants also reported that the experience of engaging with social media was, at times, overwhelming and strenuous for scientists who are already extremely busy, possibly further contributing to mental fatigue or cognitive overload. These same challenges were not acknowledged as deterrents in their preferred in-person or traditional science communication events.

Misinformation

The topic of misinformation is becoming increasingly relevant when discussing social media. In the same vein of social media being negative or unsuited to productive discussion, some participants were seemingly deterred or challenged to communicate science due to social media's affordance to disseminate misinformation. Some participants felt that the misinformation contributes to narratives and online landscapes that are challenging to combat, even with facts.

According to Jason, they are "very much aware of misinformation" on social media. They further stated, "We are very much aware of the political landscape that is not always open to discussions on climate change - especially in the US at the moment, it's [climate change] a bad word even to say." Ryan stated, "There's a lot of, like, misinformation that circulates around. Groups tend to kind of seize tightly to specific narratives, and then they don't want to hear alternative stuff." Kevin was especially concerned by misinformation on social media. They stated:

> I mentioned I might repost things, but I'm not a big user of social media, and I have to admit I'm not a big fan of social media. I'm leery of social media. I think that it's a huge source of misinformation, and I think that the real loss to society has been in journalistic integrity and the way news media has kind of given way to these people who post anything they want, and it's not fact-checked. It's again, it's a huge source of misinformation. And so, I'm not a big fan of social media. I actually think it's been contributing to the decline of civil society to be perfectly honest.

Despite these strong views, social media's affordance for misinformation sharing could be considered a challenge or an opportunity for correction. This marks that social media's imagined affordances can have opposing effects depending on how it is used (Majchrzak et al., 2013; Wu et al., 2025). While the participants' concerns regarding social media being unconducive to productive discussion, or overly conducive to echo chambers or reinforcing spirals, are valid (Williams et al., 2015; Zhao, 2009) there is also the opportunity to correct misinformation, redirect the public to accurate resources, or contribute to factual information sharing and debate. Still, social media's affordance for misinformation sharing was primarily considered a 'challenge' or 'deterrent' among the participants, perhaps due to the additionally noted 'cognitive overload' and busyness that they face as educators, researchers, and information disseminators. While their goal as science communicators is to disseminate their knowledge and research, with other stressors and responsibilities, online misinformation could likely be viewed as an additional hurdle rather than as an opportunity to educate.

Unfavourable media policies

Finally, a couple of the participants discussed Meta's recent news-sharing policies (e.g. Meta banning news articles in Canada) and how they have hindered their ability to quickly and easily share new findings and articles. Calvin and Martha stated,

> Like the banning of different information media or stopping the republication of posts from different information media in Canada because of the Canadian law about the fair compensation for media on social platforms - I think this is a prime example of how these are not sites of open, fair and informed debates and discussions. (Calvin)

> Well, actually, yeah, like right now it's the ability to share news. It would have been a lot easier for me to just flip and recite, like, amplify really interesting news articles. Cause I think that was a huge part of what I was hoping to do. And so the extra effort does [deter]. So I just do way less of it. So that's been a huge deterrent for me. (Martha)

Based on the participants' interviews, it seems that before this change, Meta's social media platforms afforded quick reposting of articles or news links that the participants deemed valuable. However, in light of these bans, Meta's platforms lost this affordance, and so the participants lost the ability to easily disseminate science in this way. As such, these participants are challenged to communicate science on these platforms because of a lost affordance.

5.5 Theme 5 – Social media support

Once the engagement of the participants was understood, we sought to understand the participants' stance on social media for climate science communication and what they felt should be done (if anything) to encourage it as a form of public outreach. The findings suggest that support for social media climate science communication varies. Its affordance for public outreach was duly noted, but so were the considerable challenges it poses to effective science communication.

5.5.1 Conditional and nuanced support for social media science communication

Despite the deterrents and challenges mentioned by the participants that may be afforded by social media, when the participants who do not actively or directly communicate science on social media were asked if they would consider doing so in the future, the overwhelming response was "Yes, if…". Yes, if they could participate indirectly, with the assistance of a specialized communications person:

> So having someone a bit more specialized would make a whole difference. Like, for instance, if the Institute of Environment had a dedicated science communication coordinator, then that would be really, really helpful. So someone, yeah, someone who has experience in science and communication. Ideally both. … And I would love to see

> someone from like STS, from Science and Technology Studies, be involved with these initiatives to provide that critical perspective on where you draw a line and engaging in conversations online, how is the social media landscape changing, and having an awareness of the different policies, like politics, development of algorithms, and how these circulate information. So that researchers can contribute to that effort knowingly, and it would help researchers gauge where their efforts are best spent. (Calvin)

Additionally, 'yes, if' they were invited to communicate a subject on which they are an expert, or if it were a group initiative supported by a group to which they belong:

> Yeah, I would consider it if I were specifically invited to speak on something that was really related to my specific research area. I would want to feel very confident that this is my field, that I can speak authoritatively on it, and that my opinion has been solicited. (Sue)

> If there was some sort of initiative, you know, that we're like a group initiative, like we're all going to mobilize and do something, then I could see [themselves engaging on social media]. This is very hypothetical. (Sue).

When asked if social media science communication, particularly for the purposes of communicating climate science, should be encouraged by Institutions, such as their university or faculty, the perceptions were mixed. Some participants felt that it should be encouraged because of the opportunity that it affords for research promotion. Calvin stated, "Yes, yes, but critically, yes," upon the condition that the university would, in return, support its faculty in this form of outreach. Mary said, "I would encourage it, but I certainly wouldn't make it mandatory or anything". Less conditionally, Chris stated, "Yeah, absolutely. I think this is like a really critical way for promotion. It should be happening in our university." Having more thoughts on the matter, Jason stated:

> We are in a very polarized climate at the moment. So we really have to be careful on how we communicate, and there are topics such as climate change that are part of a debate for some people - for us, it's not a debate. But we have to talk to these guys too, and they are certainly listening to what we do and yeah, yes. So I think it there is there is a requirement for institutions to invest in that capacity.

Others do not see the value in it because they do not think it's an effective form of science communication.

> I guess I would say no, actually, which is funny. Cynically, yeah, I would say no. I guess from my perspective as a scientist, I don't think in the end it's been very effective in terms of like behaviour change, and the degree of behaviour and system change that we need. And so I think we're, I think it might be the, not a wrong place, but like not the most effective place we could put in our efforts. (Martha)

> I think the solution [to climate misinformation] is to get one's information from reputable sources. And I don't, I don't know that we need to detract from that. There are reputable sources, and if a medium is promoting misinformation, why promote that? I know people are on it. You know, maybe there should be an effort to try to get people to engage more with the information that is reliable. … I think that a big crisis that we're facing now is that journalism is on the decline because of social media. (Kevin)

Some participants did not feel strongly about if it should be directly encouraged by their university, but they feel that researchers' institutions and universities should support all manners of science communication from their staff. Ryan stated, "We should be engaging in all of the means [of science communication] that are available. Use every tool in the toolbox. But at the same time, I am unconvinced that social media science communication is always the best way to do it." Sue simply stated, "I think it's fine." Further stating, "I guess I just don't have a strong opinion on that."

5.5.2 Institutional support and structured resources

Despite reservations about social media climate science communication among some participants, suggestions for how it can be encouraged by interested universities or institutions were made by the participants.

Institutional Recognition and Support

The environmental scientists feel that to support and encourage this medium of climate science dissemination, universities should officially recognize social media science communication as a valid form of public outreach. The participants also suggested that more be done to advertise the research and science communication of its faculty members. Science communication is often already impeded because it is seen as an activity auxiliary to researchers' other responsibilities (Andrews et al., 2005). However, acknowledgement and accommodation for science communication, in every form, as an essential part of a researcher's job, is an important first step to encourage this action.

Calvin suggested that "some recognition from the universities that this [social media] counts for something" is needed. They went on to say that The University should recognize "That it's not just like volunteering," that it counts as "teaching activities", and "So, some form of recognition of this communication effort within the faculty, that would help." Similarly, Ryan stated, "I think they should acknowledge it as an intellectual academic activity, and they should support professors who decide to go down that route."

Another institutional support could include financial aid, such as 'after project' grants aimed at promoting scientific information dissemination to the general public. This specific suggestion was not made by the participants but is a tangible action that would support further outreach. If grants were made available to promote greater public outreach following research projects, environmental scientists would likely be more willing to take the time and effort to 1) engage in alternative forms of public outreach, like social media science communication, and 2) engage with it effectively (i.e. in a way that the lay public can understand and with a wider reach).

Training and Resources

Next, they need resources and tools to facilitate the action (Vidal Valero, 2023). One resource, as suggested by the participants, could include optional training and workshops to teach researchers at all levels (graduate and beyond) how to most effectively interact with social media, especially considering the polarizing qualities of climate change as a topic among the public. Sue elaborated, "So I guess I'm thinking about, yeah, tools for like helping us engage effectively and also for helping us deal with possible negative feedback." Jason further elaborated on why they think that science communication training is needed, stating:

> Well, it's because, unfortunately, scientists are very good at doing science, but they're not necessarily the best people to communicate the results that they have. In particular, communicating these results to non-scientific audiences, which are to me those making decisions. … There is a way of communicating things that is not always ultra-negative, although it's a hard topic. So, how we achieve that is one thing that has been in my mind quite a bit.

Later in the interview, Jason continued this thought process, saying:

> I think getting training on this is very important. I think it's part of the requirements [of scientists] to share about the discoveries. Now I have to say that again, scientists are not necessarily the best communicators, so there's a need for the institutions to realize that and support them in that next step. Because that [untrained communicators] can actually lead to very poor communication and lead to things that are undesirable that you definitely don't want. And the institution will then be very uncomfortable seeing that this 'particular prof' has said this 'particular thing' that is not exactly what was meant. Science is easy to attack by those who are against it. We are in a very polarized climate at the moment. So we really have to be careful on how we communicate, and there are topics such as climate change that are part of a debate for some people - for us, it's not a debate. But we have to talk to these guys too, and they are certainly listening to what we do. So I think there is a requirement for institutions to invest in that capacity." "Yeah, I think for graduate students

in particular, I would say that having that training early on is giving them one more card to make sure that what they're doing is going to have more impact.

Although effective science communication has been discussed to help foster public trust in science, promote evidence-based policymaking, and increase the impact of research and access to funding (OECD, 2023; Vainieri et al., 2023), it is also seemingly understood that there may be a lack of training or confidence in science communication skills among scientists (Hundey et al., 2016). As per Hayhoe (2019), simply providing facts may be ineffective at changing people's beliefs or behaviours in the context of climate change. Jason and the other participants' thoughts echo this discourse.

Social media science communicators are also faced with invisible hurdles, owing to algorithmic control and engagement metrics influencing the visibility and dissemination of scientific content (Yang et al., 2025). These invisible hurdles are owed to the logic of the social media platforms (social media logic) (van Dijck & Poell, 2013). Increased social media literacy through media logic training could inform environmental scientists on how to have their dissemination have the greatest impact.

Calvin felt that "training would be helpful for people who want to engage in it." But they don't think it should necessarily be something that is "required all across the board". Mary echoed the sentiment that training and resources should be made available to scientists seeking to engage with social media for climate science communication, however, they stated, "I don't need any more training. I don't have time to do training." But they feel that "supports" are needed, such as "a communication strategy for research." A social media strategy established by the universities or faculties could be utilized by all researchers seeking to engage with social media to disseminate science. This suggestion could streamline the social media communication process and potentially improve engagement on social media for public outreach. Additionally, designated and knowledgeable staff to support research dissemination could be hired within the universities and faculties. These positions could serve to support both research promotion and general information dissemination.

Additional Supports

The participants also acknowledged that often female scientists are subjected to more attacks and negativity on social media than men are (Vidal Valero, 2023). The topic of universities standing by their researchers in the face of public criticism when disseminating science was discussed generally with the participants, but it was also discussed in the context of the disproportionate harassment that women endure on social media. In light of these experiences, one participant suggested that training or support groups for female researchers engaging in this very public form of science communication could provide them with the skills or community needed to adapt and cope with this very strong deterrent. Alternatively, if more organizational or institutional platforms were put in place for environmental scientists to utilize for science communication, they might serve as a more professional domain where targeted attacks would not be felt so personally.

Ryan shared an anecdote about when they saw a female colleague experiencing this disproportionate online harassment following her own science communication:

> So I've definitely seen evidence of this from colleagues who participate, especially from women, especially from younger women. … Wow. I mean, it can be horrendous. And you know, I have a colleague at [Canadian University] who's a little bit younger than me and who jumped into a conversation and then gave a number of media interviews around [specific conversation topic in Canada], and it just - it almost ruined her life, right? Like, I mean, for a good like four to six months, she was dealing with all kinds of hateful messages and stuff. And you know, the university didn't really back her up, at least from her perspective. And you know, it was very alienating, and she felt quite alone.

Similarly, Sue recommended that additional tools and workshops be provided to women when engaging with social media for science communication to learn how to engage with the heightened toxicity that they may experience in the media.

> So, I do think there are already some workshops that have happened for helping women, in particular, faculty engage with media. I have attended one of those. I think that kind of thing is helpful. In part, just for providing a community of other people, maybe especially

women, who can sort of give tips and at least commiserate about any negative experiences coming from that. But maybe there would also be, yeah, tips for how to do it effectively.

With these suggestions in mind, if institutions provide any of these resources, supports, or recognition practices to encourage social media science communication, their application to environmental scientists may encourage greater climate science literacy among the general public. Ultimately, if adapting to modern forms of public outreach for issues like climate change is not made a priority by the institutions that support the scientists, it will likely not be adopted by the scientists to the fullest extent.

5.6 Theme 6 – Contrasts and contradictions

As an inductive, data-driven analysis, themes were allowed to emerge outside the confines of the primary research questions. Consequently, the theme of "Contrasts and contradictions" encapsulates inconsistent and/or opposing findings and discussions on participants' views of the affordances of in-person/traditional outlets versus social media for public outreach. Moreover, this theme encompasses a discussion on the duality of social media's affordances as a space both favourable and unfavourable for science communication. As throughout, Affordance Theory frames the interpretation of these contrasts and contradictions by acknowledging that the participants' science communication is influenced by both the physical and imagined qualities of the environment, and the other people within that environment. As such, the participants have unique experiences doing public outreach, whether among different outlets or within the same ones, giving rise to contrasting or contradictory perspectives.

5.6.1 Comparisons of social media and other science communication methods

To better understand the participants' professional engagement on social media (or lack thereof), this study investigated the other forms of science communication that they engage with and how their affordances compare. When the participants were asked where else they disseminate science, outside of academic papers and conferences, the sub-themes that emerged were public talks, specialized knowledge-building forums, science cafes, public news media, with

policymakers and environmental government management, and, uniquely, through collaborations with artists.

When asked how these other science communication efforts compare to social media, most participants reported preferring in-person or traditional science communication efforts to social media. They do not view these outlets as affording the same negativity, toxicity, or misinformation as on social media. Additionally, they feel that these non-social media outlets allow them to better communicate complex topics like climate change, and they feel that it is less intimidating because they are well-practiced at it.

Calvin mentioned that they appreciate "having the time to explore and discuss the complexity of these topics, because they're complex topics that require an equally complex and balanced approach and discussion." They felt that this is what in-person events can provide in contrast to social media. "So, I like in-person events because that's what it gives us, and that's what you don't have on social media." In Ryan's experience, in-person events provide the affordance of more open discussions without censorship. They stated:

> So I've never felt the need to, you know, to censor myself or to speak differently to different audiences or to change what I would say in person. Because in person, we still have this kind of modicum of interpersonal respect where even if somebody disagrees, you know, 99 times out of 100, they're going to disagree constructively. If it is that one, you know, one out of 100, that's a problematic exchange; you don't feel under threat or anything like that.

Despite the qualities of social media that seem to afford social media science communication, the qualities of these other forms of public outreach seem to be preferred. These other outlets undoubtedly also possess dualities that implicate their affordances for climate science communication. However, whether it be familiarity or the long list of challenges and deterrents associated with social media, the participants seem to have a strong affinity toward these non-social media communication outlets.

5.6.2 Contrasts in the participants' views of the afforded reach

A motivation found among the participants for engaging with social media was its affordance for engaging the public with science. However, participant discussion surrounding this affordance in comparison to other communication outlets sparked contrasting findings. Some participants acknowledge that their reach for in-person communication events is much different, and perhaps more limited than the potential provided on social media. However, in both scenarios, in-person and on social media, participants wondered if, when communicating climate change science, they only reach people who already trust and 'believe' the science.

Sue discussed "the bubble phenomenon" that can even happen on social media, stating, "You're still mostly preaching to the converted." Accordingly, some participants felt that social media encourages echo chambers, both for and against climate activism, reducing its effectiveness for outreach. When discussing the above-mentioned "bubble phenomenon" on social media, Sue stated, "It's mostly people that already agree with you, but I guess, you know, if it's all people that agree with you, you're not gonna get the negative comments that I was worried about before."

Similarly, when discussing social media science communication, Ryan said, "You do end up largely, I think, speaking to the choir, right?" "By no intention of your own, you're already in a bit of an echo chamber because people are paying attention to you." They discussed further, saying, "I know that some colleagues will try to break out of that by being provocative, for example, right? So, you know, trying to draw attention from people who would otherwise not be paying attention by being provocative."

Participants also acknowledged that they experience these 'echo chambers' through in-person outreach events as well. For example, when talking about their experience with in-person science communication events, participants Sue and Ryan explained that they do not worry about negative interactions because the people attending these events are already interested in their subject matter. Ryan recounted their experience with this "bubble" phenomenon during an in-person science communication event:

> So I can remember giving a talk [on an environmental subject]. And then at the end of the talk - it was pretty well attended, maybe 25 or 30 people - we did like a bit of a round table, and they're [the attendees] like retired biologists and like retired policy makers and you know, people from the conservation authority. So, it's like, is there anybody here who's

actually from the public, right? Like everyone here is already pretty well informed. So, you know, that's something that I don't think you can always get around, right? Is that even when you want to speak to the public, you end up speaking to people who already have a background because they're interested, right?

So like, you know, we want to make sure that the work that we do is accessible and that we want to engage with members of the public. It's the strangest thing because people then self-select and often already have a scientific background." "So, the fact that they have a background is why they're interested. But yeah, it can be - it can be difficult. And I think too, for just generally interested members of the public, it can be intimidating. You show up at one of these things, and then the discussion goes expert anyway, right? Like, even though the material is meant to be accessible. (Ryan)

The people that show up are presumably interested. Like they know what the title is, they know what I'm gonna be talking about. So it doesn't tend to be a bunch of hecklers, you know, it tends to be people that want to hear what I have to say. (Sue)

The participants put social media's lay audience reach in question, contrasting with their own notions that it affords engagement with the public for science communication. However, understanding that their reasoning for this contrast may be caused by the media logic of the platforms, it is possible that with proper training for science communicators to escape these algorithmic bubbles they seemingly become trapped in. Therefore, with proper social media literacy training, social media may still yield broader outreach than these other outlets.

5.6.3 Social media's duality of affordances and the current political climate discourse.

Affordance theory is helpful when analysing the qualities of social media that provide an action, and understanding that these qualities can afford dual, and even opposing, purposes. Returning to the conceptualization of "Imagined Affordance" provided by Nagy & Neff (2015), a digital media environment can be shaped by the imagination of its users. As such, social media can be an outlet for climate science communication, but simultaneously, it can facilitate pointed attacks

from the public and the spread of mis/disinformation, among others. (Anderson, 2017; Brossard & Scheufele, 2024; Coletti et al., 2022; Kumar & Haneef, 2025). This duality of affordances was captured throughout the findings of this study.

Some participants discussed how social media allows them to quickly share articles or findings and engage the public with environmental science, demonstrating their acknowledgement of its affordances as a science communication tool. Conversely, the same participants, and others, discussed how social media circulates misinformation, is inconducive to thoughtful or productive discussion, and exposes them to harassment and a negative environment. Some even mentioned not wanting to use social media out of concern that it opens them to these pointed attacks, as experienced and documented by Katherine Hayhoe (see pg. 17, section 2.5) (Lévy-Leblond, 1992).

These contrasts may seem heightened for North American science communicators as the United States faces major institutional changes in its stance on climate change (Garisto & Nature magazine, 2026; Kozlov et al., 2026; The White House, 2026). Canada's neighbours to the south are facing threats of budget cuts to the Environmental Protection Agency (EPA), the National Oceanic and Atmospheric Administration (NOAA), and Non-governmental Organisations (NGOs) that, according to the second Trump administration, "focused on woke environmental justice and radical climate change research." (The White House, 2026). As of May 1st, 2026, the U.S. House of Representatives has not accepted the proposed budget cuts, but there are still calls for substantial cuts to science education and spending (Garisto & Nature magazine, 2026). Access to climate change information is being taken away from the public, from informational '.gov' domains to physical service display signage in national parks (Kopp, 2026; Qin, 2026).

These changes were felt particularly strongly by one participant (Jason), who discussed how the budget cuts to environmental programs in the U.S. will greatly affect their area of environmental research. In light of this, they feel that the public wants increased science communication from their organisation now, more than ever, with social media being one such avenue. With these backward steps in environmental and climate action, accessible science communication by environmental scientists on social media may be more needed, but also more punished than before.

In such a politically tumultuous environment, where it seems like climate change denial is everywhere, it may be important to remember that concern for the matter is a spectrum (Leiserowitz et al., 2021). With increased visibility on social media and intensified disinformation being spread

(Moghaddas, 2026), climate science communicators may consequently face more online trolling and harassment. But the existence of these opinions on social media does not singularly represent the online population's beliefs toward climate change. Their existence may, however, represent how the online trolls choose to shape the media environment that they interact with; in turn affecting the science communicators.

6.0 Conclusion

The interview data and social media science communication content provided by the participants from this eastern Canadian university have helped to contribute to a preliminary understanding of the landscape of environmental scientists as climate science communicators on social media. Specifically, this study explored how professional engagement on social media (or lack thereof) for climate science communication is shaped by the imagined affordances of the platforms. Moreover, through an Affordance Theory lens, this study compiled participants' perspectives on common social media platforms, motivations and challenges to social media climate science communication, and the actions needed (if any) on the part of universities to support this evolving method of public outreach.

6.1 Contributions

In sum, little was previously known about the engagement of Canadian environmental scientists on social media for climate science communication. Some studies that explored the motivations of scientists to communicate science in general (Andrews et al., 2005; Ho et al., 2020; Velho & Barata, 2020; Wilkinson et al., 2023); studies that explored new media science communication (Alcíbar, 2019; Brossard & Scheufele, 2024; Coletti et al., 2022; Gierth & Bromme, 2020; Hara & Woo Chae, 2025; Mojarad, 2017); and the climate science on social media (Freiling & Matthes, 2023; Haider, 2016; Ittefaq, 2024; León et al., 2023; McNeall, 2023; M. Schäfer, 2024). However, none sought to understand how environmental scientists' views of the affordances of social media for climate science communication shape their engagement.

Through the qualitative thematic analyses, it was found that among the participants of this study, there is widespread engagement on social media for science communication. However,

many of them felt that they were not as engaged as they would like to be. Their perspectives demonstrate that a variety of social media platforms can afford science communication, with notable mentions of Instagram and Twitter/X. Participants were dually motivated by a sense of societal responsibility and professional benefit. Yet, they were challenged and deterred by many factors, including a lack of time, misinformation, and views that social media is unsuited to science communication.

The motivations and challenges that shape the imagined affordances of social media for climate science communication aligned closely with previous related literature. That is to say, certain qualities of social media may afford a favourable or unfavourable communication environment to individual scientists. However, the concept of favourable or unfavourable qualities is subjective. For example, social media's affordance for misinformation sharing could be seen as an opportunity for correction or a hurdle. The subjective views of the qualities that were thematically categorized as "motivations" and "challenges" for engagement allowed contrasting and contradicting views to emerge.

This study demonstrated that engagement on social media for science communication is not necessarily shaped simply by the social media platforms themselves, but also by the scientists' imagined affordances of social media as a communication tool - adding to the existing literature which explores scientists' motivations, challenges, and patterns of engagement with science communication.

Finally, suggestions were made for what can be done to encourage environmental scientists' engagement on social media, providing practical considerations for institutions seeking to encourage this form of public outreach. If imagined affordances shape engagement, then increasing scientists' participation on social media for climate science communication requires more than encouragement; it requires fostering conditions that enable scientists to imagine social media as a legitimate, supported, and effective space for public outreach. Among the participants, institutional recognition, resources, and support were suggested to have the potential to influence greater social media participation. These resources may play a role in shaping environmental scientists' imagined affordances of social media. Therefore, this study provides an introductory conceptual foundation for developing strategies that could help to strengthen scientists' participation in public communication and outreach.

6.2 Limitations and Future Research

This study has limitations that should be considered in relation to its findings. Firstly, participants were only pooled from the environmentally oriented faculty of one university in eastern Canada. Further, of this faculty, just 8 participants volunteered to participate. Both factors limited the sample size of the study. Through in-depth interviews, this research was able to generate a deep understanding of the engagement and views of the participants at the university of interest, relating to their social media science communication. Yet new themes were emerging with each participant, so the study likely did not reach data saturation.

Secondly, differences in institutional experiences for scientists as science communicators were not considered with the university-specific sample group. These findings may not be able to be generalized across academic institutions. However, they may be able to contribute to understanding a subset of the experience of Canadian environmental researchers as science communicators.

Further, the sample of social media content that was thematically analyzed in conjunction with the interviews was limited to 1 or 2 examples per participant. Alone, this provides an illustrative, but limited, understanding of their social media experience. However, this still held value in the context of the interviews by providing tangible examples of key themes discussed. A deeper social media analysis would provide a greater illustration of their experience.

Additionally, the actual reach and impact of these examples of climate science communication are beyond the scope of this study. The thematic analysis did not explore the participants' social media literacy or their understanding of the platform's media logic. It did briefly explore their perceptions of the affordances of different social media applications, particularly in reach (see section 6.2). However, this only provides information on the imagined affordance, not the effect. Understanding social media logic, the algorithms that dictate how content is dispersed and who is seeing the content, can significantly affect the impact of the communication content (van Dijck & Poell, 2013).

That being said, a broader sample size, across differing institutions and universities, with a greater breadth of social media content analyzed, could provide greater context and understanding of the existing landscape and experience of Canadian environmental scientists on social media. This study did, however, provide a jumping point for further investigation. Future studies can consider the thematic findings of this study and apply them on a broader scale.

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7.0 Appendices

Appendix A: Participant recruitment email

The following participant recruitment email is adapted from a Recruitment Email Template by Toronto Metropolitan University (Toronto Metropolitan University, n.d.)**:**

"Hello,

As a member of the [Environmental Institute at Eastern Canadian University], I am sure you understand the importance of public science communication - especially related to climate change. I do too, which is why I am seeking members of [the environmentally-oriented faculty at an Eastern Canadian University] as participants in my study.

My name is Alysha Wenghofer. I am a Master of Arts in Education student at the University of Ottawa, with an undergraduate degree in Biology. I am contacting you to see if you might be interested in participating in a research study done as part of my Master's project, supervised by Dr. Giuliano Reis and Dr. Adam Brown.

Through a comprehensive, interview-based qualitative study, this research will examine communication methods, motivations, barriers, and the rationale of climate change experts' engagement or distancing from social media platforms to disseminate climate-related content. Specifically, it aims to answer the following questions: Do Canadian environmental scientists engage with social media as a tool for climate change communication? What factors influence their motivations, strategies, or decisions to either participate or not?

We are looking to recruit environmentally focused researchers from the [Eastern Canadian University]'s [environmental institute], with a master's degree or higher in an Environmental Science-related topic. As such, participants would have 5 or more years of academic or professional environmental science-related experience, as 'experts' on climate change. I am reaching out to a very limited pool of potential participants, so if you think you might qualify as a participant for this study, but you are not quite sure, please reach out and ask!

If you agree to volunteer, you will be asked to participate in a ~30-minute recorded virtual interview to understand your experience, or lack thereof, of social media climate science communication. You may additionally be asked to share a piece of your science communication content, if applicable. Participants are welcome to participate in English and French.

If you have never participated in social media science communication, please don't let that deter you from volunteering. We welcome all and any insight.

If you are interested in more information about the study or would like to volunteer, please read the attached Participant Informed Consent Form and reply to this email or call ___-___-____."

Appendix B: Participant Interview Question Guide

1. What is your position within The University/Environmnetally-oriented faculty?
    a. What is the focus of your research?
2. Have you participated in social media science communication before at any capacity?
    a. Yes →
        i. Was it climate change-focused/related?
        ii. What platforms do you use, and why?
            1. Do you think that certain platforms are better suited for science communication? Why?
        iii. What led you to engage with social media for science communication?
        iv. Are you still actively participating in social media science communication?
            1. Yes →
                a. On a scale from 1-10, how would you rate your level of engagement on social media for science communication (1 would be very little engagement, and 10 would be extremely engaged)?
                b. How would you define your engagement on social media? Specifically, is it a casual activity for you, or something that you consider part of your professional career? Please expand.
                c. What motivates you to continue to disseminate climate change information on social media?
                d. Do you face any challenges or deterrents related to social media climate change communication?
            2. No →
                a. What motivated you in the past to disseminate climate change information on social media?
                b. What caused you to stop? / What deterred you from continuing?
    b. No →
        i. Have you seen or interacted with science communication content on social media?

ii. How did you decide not to engage in social media science communication?
    1. Are there any specific challenges or factors that deter you from it, specifically relating to climate change?
iii. Would you consider engaging in social media science communication to disseminate climate change information in the future?
    1. What would encourage you to do so?

3. Do you actively communicate your research elsewhere (not including traditional scientific communication outlets)?
    a. **Yes →**
        i. How do you feel that those outlets compare to social media?
        ii. Are the motivators and/or deterrents similar and/or different?
    b. **No →** Do the factors that deter you from social media climate science communication also deter you from public science communication in general?
4. Do you feel that social media science communication should be encouraged by the faculty/institution? Please explain.
    a. **Yes →** What do you think institutionally is needed to support and encourage researchers to engage in climate change communication on social media?

Appendix C: Participant social media content

To maintain the anonymity of the participants, all names, handles, faces, and logos were censored. The censored content was searched through Google's reverse image search feature to ensure they cannot be linked back to the participants. These examples are included in the appendices to provide additional context for the findings.

Table 1. **The following qualities were used to thematically analyze the social media content and derive the themes of 'Engagement', 'Platform Affordances', and 'Motivations'.** Specific codes that were used to derive the themes can be found in the Figure descriptions below.

QUALITIES	DESCRIPTION	ASSOCIATED THEME
PLATFORM:	Where was it posted?	Engagement
POST-TYPE:	What kind of post is it? (E.g. Text-based post, image post, video post, repost or original post?)	Engagement
CAPTION QUALITIES:	Length (in sentences)? Hashtags? Tags?	Platform Affordances
PHOTO/VIDEO QUALITIES:	What do the videos/photos portray?	Platform Affordances
POST MESSAGE:	What message does the post carry? Is there any message?	Motivations
POST FUNCTION:	What is the purpose of the post (e.g., education, advertisements)? Is it related to climate change?	Motivations
INTENDED AUDIENCE:	Who does this post seem targeted to? (e.g. General public, other academics, policy makers?)	Platform Affordances

Jason: Bluesky and LinkedIn

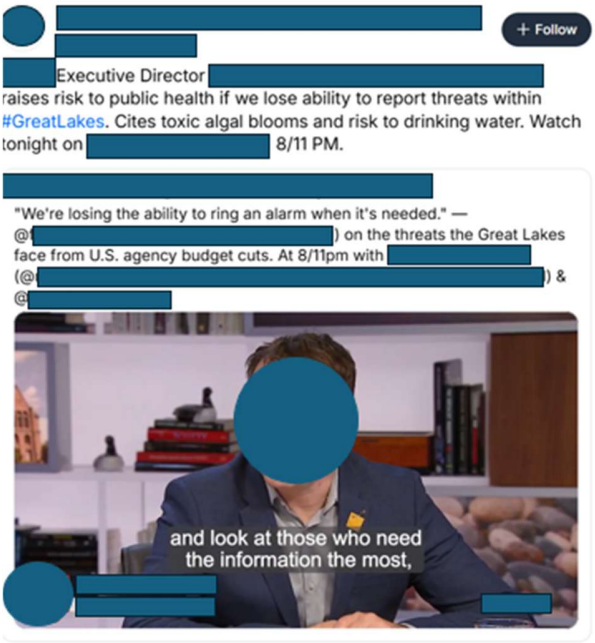

Figure 1. **Jason's social media content, themes and associated codes.**

Engagement: Bluesky, Reposted video

Affordances: Consice caption, Consice video, Community connection, Discoverable, Professional media, Wide audience

Motivations: Research marketing, Public Education, Environmental/Climate messaging

Figure 2. **Jason's social media content, themes and associated codes.**

Engagement: LinkedIn, Text-based post

Affordances: Concise caption, Accessible, Informative, Discoverable, Wide audience

Motivations: Research marketing & Public Education, Environmental/Climate messaging

Calvin: YouTube

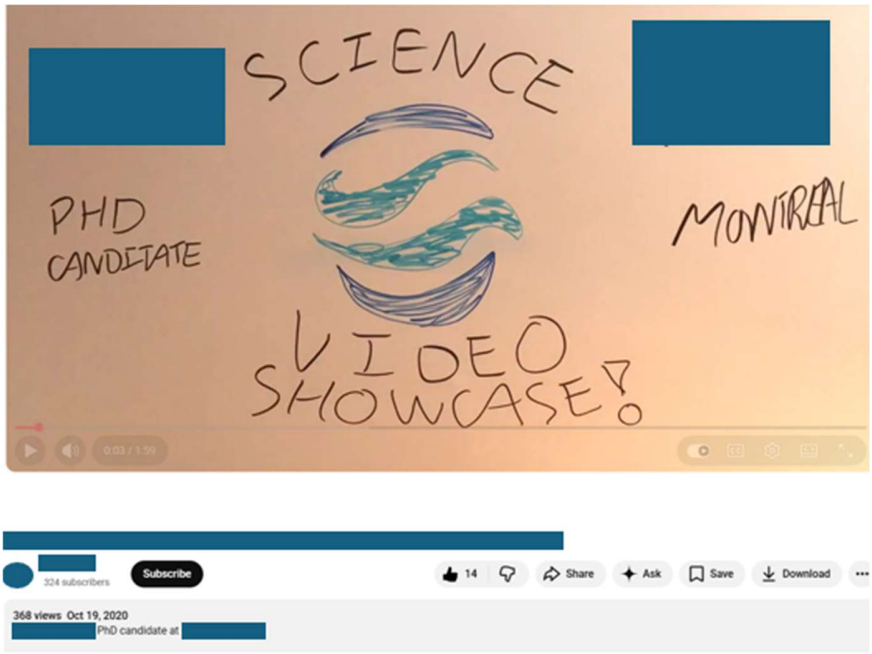

Figure 3. **Calvin's social media content, themes and associated codes.**

Engagement: YouTube, Original video

Affordances: Consice caption, Concise video, professional media, Wide audience

Motivations: Research marketing, Environmental/Climate messaging

Chris: Facebook

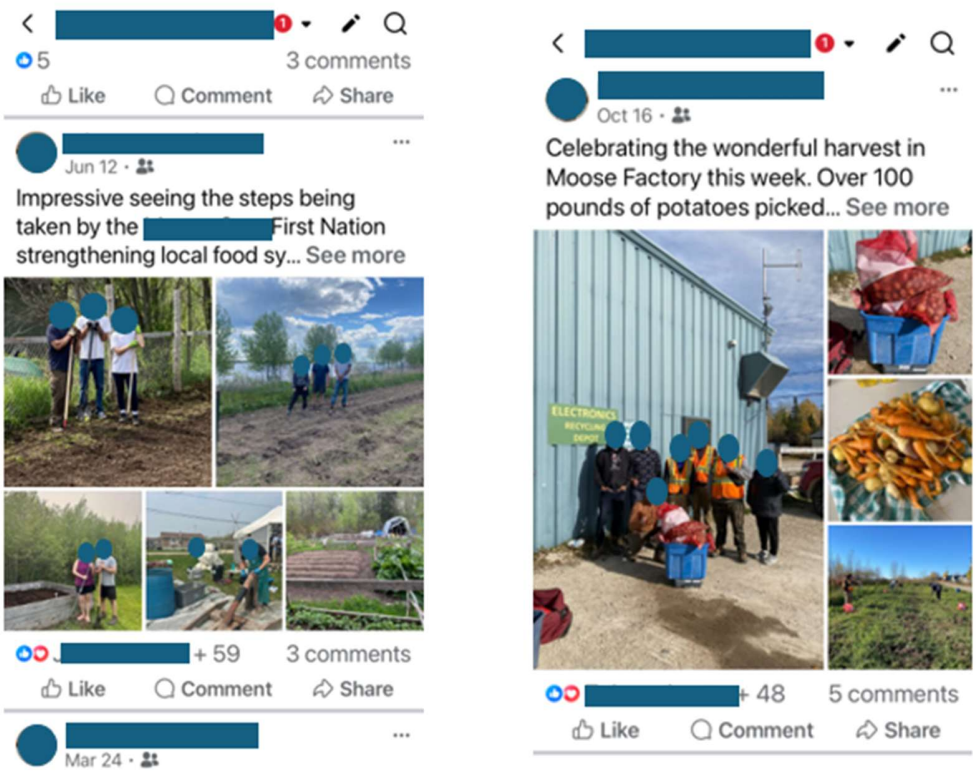

Figure 4. **Chris' social media content, themes and associated codes.**

Engagement: Facebook, Photo share

Affordances: Consice caption, Informal photo sharing, Narrow audience

Motivations: Community outreach, Research marketing, Community messaging

Martha: Instagram

Figure 5. **Martha's social media content, themes and associated codes.**

Engagement: Instagram, Photo share

Affordances: Concise caption, Informative caption, Informal photo sharing, Narrow audience

Motivations: Research marketing, Environmental/Climate messaging

Mary: LinkedIn

Figure 6. **Mary's social media content, themes and associated codes.**

Engagement: LinkedIn, Reposted advertisement

Affordances: Informative, Accessible, Community connection, Advertisement, Narrow audience

Motivations: Research opportunity sharing

Kevin: X

Figure 7. **Kevin's social media content, themes and associated codes.**

Engagement: X (Twitter), Reposted text and image-based post

Affordances: Concise caption, Discoverable, Community connection, Informative

Motivations: Environmental/Climate messaging, Research marketing, Public education