Exploring Advancements in Rural Equity and Prosperity in the Oregon Labor-Intensive Forest Industry: The Practical Application of Transdisciplinarity and Science Communication

by

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ABSTRACT OF THE PROJECT OF

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Disproportionate exposure to exploitative working conditions, social marginalization, and a lack of equitable living conditions are among the many issues that migrant Latinx populations face daily in the United States. However, such issues cannot be addressed by relying solely on traditional academic research approaches without the participation and direction of the very forest workers who experience these issues. This type of research is called transdisciplinary, and it aims to foster collaboration and knowledge sharing between researchers and those directly impacted by the issues. By leveraging principles of science communication, the knowledge generated through this collaborative research can then be provided back to the vulnerable communities. This capstone report discusses transdisciplinary research and science communication in the context of a specific research project being carried out in Oregon. Ultimately, the project seeks to empower and enhance the capacity of Latinx forest workers, as well as improve the quality of life for the rural communities in which they reside. This will be accomplished through collaboration with several community and development organizations that represent and advocate for Latinx forest workers. Through an exploration of this real-world challenge and active research project, this paper seeks to provide an in-depth discussion and application of transdisciplinarity and science communication in an effort to illustrate why these concepts are valuable and practical in addressing some of the world's most challenging problems.

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Introduction

Ecological and social systems are undergoing unprecedented and widespread transformations (Chaffin & Gunderson, 2016; Shrivastava et al., 2020). Multifaceted challenges exceed the rigid boundaries of individual systems and result from the interaction between social and ecological systems (Reid et al., 2005). These challenges include issues that range from societal to health, economic, and environmental (Kalmar & Stenfert, 2020). Due to their complexity, they require an approach informed by a diversity of knowledge sources and a myriad of experiences and perspectives. An approach of this nature is transdisciplinarity (TD), an extension of multidisciplinarity and interdisciplinarity where scientific and non-scientific actors work together to address complex problems.

As a theoretical approach to research, TD encompasses more than the production and dissemination of knowledge; it also uses that new knowledge to educate and inform the people affected by the problem. In this way, it contributes to advancements both in societal and scientific discourses and leads to tangible, meaningful outcomes (Jahn et al., 2012). Further, it involves the integration of transformative learning and communication practices. As a result, the principles and practices of science communication are well suited for promoting a successful transdisciplinary research process. They provide systematic and practical methods and strategies for the dissemination and application of findings in a way that is widely accessible and relevant (Jahn et al., 2012).

The transdisciplinary research (TDR) process can be more easily understood when contextualized within a real-world challenge. As such, this capstone paper aims to discuss and examine the theoretical background, process, and outcomes of a specific transdisciplinary research process. Additionally, this paper will examine how transdisciplinarity and TDR can be used to facilitate collaborative learning and communication, as well as discuss its effectiveness in disseminating scientific findings that promote societal discourse and action.

The challenge addressed in this paper pertains to conditions of workers within the labor-intensive forest industry and the New Forest Economy, specifically, the journal this industry, who constitute the majority of the workforce and are a very underserved community. A comprehensive research project organized by the Oregon State University Extension program is currently being conducted that addresses this issue, titled "Advancing Rural Prosperity And Equity Through The New Forest Economy" (Davis et al., 2021, p. 2). Dr. Emily Jane Davis is

conducting this study in collaboration with several community and development organizations that represent and advocate for Latinx forest workers and will engage and consult directly with forest workers to identify their needs, concerns, and interests. Dr. Davis' project intends to employ a combination of quantitative and qualitative research methods to build new knowledge about the market and labor structures, policies, and social factors that drive and inhibit equitable employment and ethical labor practices. In turn, this will help enhance education and Extension efforts by applying research findings to design and implement targeted interventions that will support more equitable policies, practices, and programs and provide benefits to marginalized and underrepresented communities, such as the Latinx forest workers. It is the purpose of this paper to demonstrate how this Extension research project is a timely and practical exemplification of transdisciplinarity and the TDR process that addresses the needs of marginalized communities and employs appropriate scientific communication methods to ensure the research results and benefits are distributed equitably among the researchers and workers (Davis et al., 2021, p. 2).

Furthermore, this paper is one of four components of a Master of Forestry capstone project that all address issues related to the labor-intensive forest industry and the working conditions and realities of Latinx migrant forest workers. The second component of this project is an annotated bibliography, which reviews and summarizes the existing academic and practitioner literature on the labor-intensive forest workforce within the United States. The information in the annotated bibliography is used to inform the third and fourth components. The third component, a perspective paper, will be submitted to the journal *Society and Natural Resources*, which will summarize the current state of the literature on the labor-intensive forest workforce, identify areas of research that are underdeveloped or outdated, and explain why engaging in research on this topic is important. The fourth and final component is a consultation guide for forest landowners interested in hiring a restoration contractor, which will be made available on the Oregon State University's Extension website. These last two components will serve as examples of alternative science communication formats. Each aim to reach different audiences, address different needs and concerns, and employ an appropriate lexicon to address different audience types.

Structure of this Capstone Paper

This capstone paper has three sections. The purpose of the first section is to discuss transdisciplinary research and provide an introduction to Extension and the value that can be realized when Extension engages in research that integrates social sciences alongside biophysical sciences. This will be followed by a discussion on how the Extension forest workers project exemplifies a transdisciplinary research approach in which the findings have the potential to increase equity and inclusion.

The second section further develops the discussion of transdisciplinarity and the TDR process for forest workers by examining it within the framework of scientific communication and providing practical science communication methods and principles that are compatible with transdisciplinarity. This will be supported by a discussion of science communication within Extension, including the common science communication challenges that Extension personnel experience and the appropriate methods and strategies to address these challenges. It will finish by discussing the process and application of science communication incorporated into the forest workers project.

The third section discusses the process and logic behind producing the other three components of this capstone project: the annotated bibliography, the perspectives paper, and the consulting guide. It concludes with a reflection on my engagement with Extension in a research and professional capacity, as well as participation in several Extension-hosted programs and the lessons learned throughout this capstone project.

Introduction to Section One

In section one of the capstone paper, the concept of transdisciplinary research is described, followed by a discussion of how it distinguishes itself from multidisciplinary and interdisciplinary research. Next, the paper discusses the importance of incorporating equity-centered methods within transdisciplinarity and TDR to engage marginalized and underrepresented populations more effectively and meaningfully.

Following this is an introduction and discussion of Extension as a program, as well as a brief examination of its purpose and practice. The topic will be further elaborated on by discussing how the application of social sciences to an Extension research process can contribute to more robust and credible research. This section culminates with a comprehensive overview of the labor-intensive forest industry and the Latinx migrant workers employed in this industry, accompanied by a discussion on how an Extension research project intends to address the needs and objectives outlined in this study to promote an equitable and inclusive future for forest workers.

A Comparison of Disciplinarity: Multidisciplinarity, Interdisciplinarity, and Transdisciplinarity

To a large extent, disciplinary norms have shaped how complex social and ecological challenges have been addressed, primarily based on the belief that ecological and social systems exist independently and vice versa (Kivunja & Kuyini, 2017). In this sense, any shifts and developments in ecological systems is considered to be beyond the influence of the social system, and the same is believed to be true of changes in social systems (Chaffin et al., 2016). In light of this, distinct disciplines and branches of knowledge were established, in which each studied the world based upon knowledge drawn from within its own boundaries. As a result, scientists developed their own ways of knowing and understanding the world while showing limited commitment to identifying the connections across the scientific disciplines and systems (Kivunja & Kuyini 2017).

It should be noted that tackling some challenges from the context of a single field can be perfectly acceptable and is often the most appropriate course of action. Generally, this occurs when a single topic is studied within a single system, for example, when a botanist attempts to create a new genetically modified corn variety or when a sociologist attempts to identify the

social impacts that beauty influencers have on young girls. In neither case will a researcher necessarily need to look beyond the boundaries of their discipline to adequately address the pertinent issues. The botanist is not necessarily concerned with how social systems affect the development of genetically modified corn. Conversely, the sociologist does not need to examine the ecological system to understand the social impact of beauty influencers.

Nevertheless, the more complex a problem is, the more difficult it is to study it from a singular disciplinary approach. As the problems scientists seek to address have grown in complexity, this recognition has become more readily accepted. Accordingly, researchers have begun to question the explicit distinction between the social and the ecological, as they more readily acknowledge that there exist profound links between the two spheres and that whatever takes place in one sphere will affect the other (Chaffin et al., 2016).

Therefore, these complex challenges are well suited to a variety of research approaches that combine different scientific disciplines; among these approaches are multidisciplinarity, interdisciplinarity, and transdisciplinarity. To an individual unfamiliar with these research processes or who only has experience engaging in a single discipline, these three processes might appear interchangeable rather than distinct. That is why it is essential to note the nuances them among the three, which might not appear self-evident, but nevertheless are quite considerable.

Multidisciplinarity is the approach least rooted in collaboration and disciplinary integration. Instead, it adheres to disciplinary-specific parameters and focuses on achieving disciplinary goals (Park & Son, 2010). When working on a multidisciplinary research project, scientists may cooperate, but each apply their own disciplinary knowledge and analysis without attempting to recognize the linkages across their disciplines. In this way, they work in tandem or sequentially, bringing their disciplinary-specific expertise to address a common problem (Rosenfield, 1992). As a result, the final product resembles a collection of reports and analyses assembled without integrating or synthesizing the findings across the disciplines (Max-Neef, 2005).

On the other hand, interdisciplinarity is understood as the collaboration and interaction between researchers from differing disciplines while still adhering to disciplinary-specific fundamentals to address a common problem (Rosenfield, 1992). In an interdisciplinary research project, scientists share accepted beliefs and theories rooted in scientific and academic knowledge, encouraging them to identify how their disciplinary borders "overlap," which guides how they define their research strategies and objectives. The research process is based on

integrating concepts, methods, and principles from the various disciplines, where findings are intended to contribute to advancements in science (Lawrence, 2010). Nevertheless, interdisciplinarity still predominantly confines its application of knowledge and findings within the boundaries of academic and scientific disciplines, limiting the extent to which scholars and scientists collaborate with individuals outside of the scientific community (Park & Son, 2010).

In practice, how might it look go beyond interdisciplinarity to synthesize scientific disciplines with extra-scientific knowledge and perspectives to holistically address complex challenges that bridge social and ecological systems? Such an approach is known as transdisciplinarity, a natural extension of interdisciplinarity that devotes greater emphasis to the collaboration among scientific and non-scientific participants (Jahn et al., 2012). To provide a context for understanding how transdisciplinarity might function in practice, an analogy from medicine may be helpful. A patient has just broken a bone and can no longer perform their favorite activity, leading them to become depressed. The patient visits two specialists to address their problems: first, an orthopedic surgeon to fix their bone, and second, a therapist to manage their depression. Consequently, these specialists lack the training and expertise to perform the other professional's role. The doctor and psychiatrist can only address what is within the boundaries of what they know, even though the symptoms they are treating are connected: the broken bone has triggered the onset of depression.

The two specialists could address each of the patient's symptoms either independently or collaboratively. Perhaps the orthopedic surgeon provides the patient with opioids to manage the pain. While this would address their physical pain, the patient still struggles mentally, and soon their depression begins to impact the way they operate day-to-day. Eventually, they begin to socially isolate themselves, which strains their relationships. Ergo, prescribing opioids only provides the patient minimal ease of pain, as it does not address their inability to participate in their favorite activities or socialize. Conversely, the therapist could encourage the patient to socialize with their friends to get their mind off their pain and depression, yet this still would not help with the physical pain the patient is experiencing.

In this way, pain is not simply a physical manifestation but has become an amalgamation of pain sources, including physical, psychological, and social. For a patient to fully recover, all three sources of their pain must be accounted for not as separate issues but collectively. In this situation, the best course of action is for each of the three actors, the orthopedic surgeon, the

therapist, and the patient, to collaborate and share their own knowledge, insights, and experiences to treat the pain in a systematic manner (Katona & Curtin, 1980). In other words, each specialist must be willing to work with others outside their domain of expertise and experience and integrate input from the patient as part of a collaborative process to resolve the problem as comprehensively as possible.

Such collaboration is also the key to solving complex challenges in social and ecological systems. Rather than rigidify the boundaries between scientific disciplines and social boundaries between scientists and non-scientists, scientists and non-scientists should be encouraged to engage in collaborative endeavors aimed at integrating different ways of knowing and doing. Just as the two specialists listened to the patient's needs and concerns to gain a complete understanding of the situation, and then they all collaborated to determine how to proceed, scientists and communities follow the same process when conducting research. To address the social and ecological challenges affecting a community, it is crucial to hear that community's experiences, insights, and knowledge. As a result, the researcher can identify more practical and viable methods of resolving the issue and benefitting the community. Moreover, when engaging in this type of collaboration, there might be instances in which it is advantageous to integrate community-based knowledge into the research process, even if the knowledge extends beyond the traditional Western understanding of what constitutes valid knowledge and science. In this way, scientists must be willing to listen to and trust knowledge derived from extra-scientific audiences, who view the world from a variety of perspectives, experiences, and interpretations (Lang et al., 2012; Polk & Diver, 2020).

An approach like this is called transdisciplinarity, and this paper adopts the definition as proposed by Jahn et al. (2012):

> "[A] critical and self-reflexive research approach that relates societal with scientific problems; it produces new knowledge by integrating different scientific and extra-scientific insights; its aim is to contribute to both societal and scientific progress; integration is the cognitive operation of establishing a novel, hitherto non-existent connection between the distinct epistemic, social–organizational, and communicative entities that make up the given problem context" (p. 8-9).

From this definition, transdisciplinarity is understood not as a distinct theory or methodology with a set of rules or an explicit framework, but rather as a demand-driven approach to research

that aims to unravel the complex challenges that span societal and ecological systems by examining the systems themselves. This is an important distinction between transdisciplinarity and interdisciplinary research, in that interdisciplinary research relies on the integration and cooperation across academic and scientific disciplines, while transdisciplinarity expands the knowledge base it draws from and the challenges it explores, bridging the interface between scientific questions and societal challenges (Jahn et al., 2012; Baumber, 2021). Such "cross-fertilization" of knowledge and experiences allows researchers to understand the role of the local context, allowing them to develop new explanatory theories and gain new knowledge that can address problems. Such a process can result in what Lawrence (2010) described as "achieving innovative goals, enriched understanding, and a synergy of new methods" (p. 126).

A successful transdisciplinarity research project can be seen in Delhi, India, where poor urban populations were forcibly relocated to periurban areas (Marshall et al., 2018). These areas lacked adequate sanitation and infrastructure, which caused an endemic of gastroenteritis and diarrheal disease, resulting in illness and even death. Community-based organizations (CBOs) and local residents attempted to share their experiences and observations with the government to obtain assistance that would help clean up their communities. Yet their claims were ignored as they challenged the dominant narrative set forth by the elite, who placed the blame on the residents themselves for their own unsanitary behavior instead of their lack of access to proper infrastructure. In this case, the issue was systemic, rooted in the structural and environmental injustices and discriminatory policies that disproportionately harmed the health and safety of the poor, while the elite and decision-makers remained unaffected.

Ultimately, the community realized that to have their needs and concerns addressed, they would need to have their demands heard and legitimized. So, the community enlisted the assistance of an academic researcher to provide research that would complement the already existing knowledge of the community members. Through the facilitation of a transdisciplinary team, they were able to examine the "dynamics of the crisis and its underlying causes, analyze official outbreak control measures, and begin to articulate alternative pathways for intervention and ongoing development" (Marshall et al., 2018, p. 8). By using community-based and scientifically-based knowledge, the community and researcher were able to identify planning principles and policies that directly addressed the needs of the impoverished community, particularly those most profoundly impacted by the problem. This enabled them to commence

implementing a more democratic environmental decision-making process. Moreover, as awareness spread about the community's efforts to address structural and ecological injustices, other nearby communities began to recognize the injustices in the distribution of public resources in their own communities, particularly for the poor communities. As a result of this spreading of information and action, the local municipal officials decided to officially address the issue.

Soon, community members began working with municipal staff to clean up the parts of the poorly maintained infrastructure that had been most neglected and were responsible for the unsanitary conditions. In this example, the integration of scientific and non-scientific knowledge production and collaboration led to the emergence of transformative change that addressed the power dynamics that influenced these injustices, with the explicit goal of developing a more equitable distribution of public resources and bringing back agency to communities. Despite the disparate power dynamics between the periurban poor and the affluent, this example demonstrates how collaboration between communities and researchers can contribute to more equitable outcomes and enhanced community development.

In summary, transdisciplinarity is an approach to research and action that aims to address systemic issues that are intrinsically bound to the ecological and social systems in which we live. As a demand-driven, community-led form of research that utilizes a multiplicity of knowledge sources, it is capable of empowering marginalized and underrepresented communities while contributing to the advancement of both social and scientific discourse and practice (Jahn et al., 2012). Even though transdisciplinarity is not ideally suited to address all social or ecological issues, it can successfully address those that bridge the interface of social and ecological systems. Transdisciplinarity and TDR enables communities and researchers to address some of the most complex and daunting challenges facing our society through inclusive engagement, accessible communication of science and findings, and tackling concerns related to equity and access.

Centering Equity in Transdisciplinarity

A long-standing approach to science was centered around research that advanced the interests of scientists, and any research that contributed to social advancement was for the benefit of privileged communities, such as those who are white and male (Puritty et al., 2017). As such, these approaches tended to establish a tradition of scientific ideals and values that had racist and discriminatory roots. This was predominantly the case when scientists sought to conduct research

in communities with marginalized populations, typically communities of color, who often had little to no choice in the sort of research being conducted on or in their community (Puritty et al., 2017). Such research often served to reinforce the prevailing societal hierarchy, in which white and privileged communities were regarded as more important than communities of color and continually propagated harmful stereotypes and beliefs about these marginalized communities. In time, due to systemic barriers, such as racism, poverty, and lack of political power and resources, that exacerbate disparities in scientific research, marginalized and underrepresented populations suffer disproportionately from harmful outcomes of such research and bear the brunt of resulting environmental injustices (Walker, 2012; Taylor, 2016; EDF, 2022).

An example of environmental injustice resulting from exploitive working conditions and biased research conclusions is the direct exposure to pesticides that migrant Latinx farmworkers bear daily (Quintero-Somaini et al., 2004). Many Latinx workers apply pesticides without proper protective gear, work under unsafe and exploitative conditions, and bring pesticide residue into their homes on their clothes. Starting around the 1990s, many science and research organizations issued warnings about the negative impacts that pesticides might have on workers, including an increased risk of certain cancers and other serious health problems, as well as an elevated risk for neurodevelopmental problems in children of these workers due to secondhand exposure to pesticides (Quintero-Somaini et al., 2004). However, in an effort to reject stricter pesticide regulations, other researchers and governmental research agencies concluded, on the basis of insufficient evidence, that pesticides posed no significant risk as long as the purported benefits of the pesticides outweighed the harm to the worker (Donley et al., 2022; Quintero-Somaini et al., 2004). Although the use of these pesticides has positive benefits - such as pest prevention, reduced disease transmission, and increased food production – this comes at the expense of disproportionate harm to marginalized communities, further compounded by their overall lack of access to preventative health services and other medical care (Donley et al., 2022). While there are much stricter pesticide regulations today as a result of more rigorous and ethical research, this example shows that research, although it can be beneficial on a broad scale, can still significantly adversely affect a community of color in the pursuit of scientific and societal advancement (Donley et al., 2022).

Today, scientists have a much stricter code of ethical practices. Nevertheless, when addressing complex challenges that span social and ecological systems, that does not necessarily

mean that the advancements gained are equitably distributed or that marginalized communities have an equal say in the research conducted near or around them (Taylor, 2016; Rongerude & Sandoval, 2016). In these instances, it is important to adopt equity-centered practices that acknowledge historical and current inequities in society and the environment, which can be done through TDR (Taylor, 2016; Minow, 2021).

Though not all transdisciplinarity research endeavors are aimed directly at serving marginalized populations or are a panacea to issues that are structural and systemic, such as racism, transdisciplinarity is still an effective and valuable approach to research. It is important when engaging marginalized and underrepresented populations in TDR to ensure that equitable and inclusive research practices are employed a that will center their voices throughout the process and allow them to be heard despite inherent systemic barriers (Rongerude & Sandofact, 2016). Thus, research and practices must be grounded in principles related to environmental justice and equity, which recognize the rights and fair treatment of marginalized communities through identifying how social and environmental inequities are interconnected in our society. Effective transdisciplinarity and TDR is not constrained by approaches that prioritize and hears only the voices and experiences of privileged audiences. Through TDR, the goals, analysis, and outcomes of the research are purposefully centered on building equity and ensuring the inclusion of all affected communities.

A Real-world Application of Transdisciplinarity

Transdisciplinary research and projects can take many forms and involve diverse organizations and partnering individuals. Numerous established institutions and scientific research programs already collaborate with community educational and developmental organizations and provide a conducive platform for the application of transdisciplinarity. Among these are the Extension programs and services housed in each state's land-grant institution. These cooperative programs overseen by academic and scientific institutions focus on the practical application of research through collaboration with and education of community members seeking to expand their knowledge and skills-based experiences (Campus Explorer, 2021). Serving as a platform for universities to partner with communities throughout the state, it is the role of Extension employees to assist communities in identifying and addressing local needs, challenges, and interests (though this distribution is not always been equitable or just, it is currently being

better addressed–see Appendix A). This drives the type of education and information disseminated so that collaborative action can address local challenges, develop leadership and professional skills, and manage natural resources wisely (OSU Extension, 2022).

There are many similarities between Extension and transdisciplinarity in terms of values and methodologies. Both are driven by community needs and interests, in which researchers and Extension personnel provide resources and opportunities to address local societal and scientific problems (Clyde et al., 2018), such as Latinx forest workers who report intense back pain from the physically demanding work of trimming trees (Kearney et al., 2020). In the process, community capacity is assessed, including identifying the knowledge, skills, and resources required to address the problem. The options for tree trimmers might include finding community opportunities to obtain adequate health care, exercises to maintain their back health, or identifying innovative labor practices that require less physical effort. By serving as a liaison between researchers and the community, the Extension personnel can identify new opportunities for expanding access to resources or alternative ways to deliver the knowledge required to solve the problem. Extension personnel might recognize that it could prove beneficial for tree trimmers to contact researchers in the field of occupational health and safety who can conduct health assessments or provide research on the positive physical effects of alternative, light-weight chainsaws on workers (Kearney et al., 2020). This integration is followed by an assessment of the positive impacts on the community by asking the question, "has a positive difference been made in the community?" (Radhakrishna et al., 2014).

Whenever conducting such activities, it is crucial to identify if any limitations or barriers exist in the community which could hinder how research can benefit the research community participants in a meaningful manner. In such cases as working with Latino forest workers experiencing back pain, barriers may exist between the researcher and the workers, often due to social and cultural differences. In such cases, it can be challenging to address workers' concerns equitably if these differences and barriers are not addressed adequately. It may not be enough to approach this issue solely with biophysical science. Instead, the research might be bolstered by incorporating social science as well. This approach would allow researchers to gain a deeper understanding of the issue and address it more effectively and efficiently.

How Extension can be used to address social issues using social sciences

Extension is increasingly incorporating social science methods and ideologies, which promotes a more holistic and comprehensive understanding of a community, as well as more inclusive community engagement. Social science adds value by providing access to alternative approaches, viewpoints, and ways of knowing, leading to more valid, reliable, and useful research (Gardner, 2014).

Social science is understood as the systematic study of people and groups, including their behaviors and relationships with each other and their surroundings; it includes fields such as sociology, linguistics, ethnic studies, economics, political science, psychology, and more (Sheehan, 2018). Social science explores how different individuals and groups view social reality and how this perception influences the choices and decisions that individuals, communities, and nations make. It allows scientists to identify motivations, values, constraints (capacity), opportunities, or enabling factors, providing more insight into a community by shedding light on how it is organized and operates. Additionally, social science allows scientists to understand the roles that individuals adopt or are assigned within social groups, communities, organizations, agencies, or networks and the social and policy context within which they all operate (governance). By identifying individual and group roles, researchers are better equipped to identify and navigate areas of conflict or controversy that may be hindering progress. Also, understanding conflict and controversy allow researchers to determine the causes of the issues and implement potential procedures for addressing conflicts and making progress.

Social scientists vastly differ in their specialties and research paradigms, approaching problems with diverse theories, critiques, or mixed research methods (Bhattacherjee, 2012). While biophysical science primarily uses quantitative methods to generate data, social science may use qualitative, quantitative, or a combination of both methods (Bhattacherjee, 2012). The diversity of data types and research provides researchers with a toolbox to select the most appropriate approach to address a specific problem, with consideration of the context and systems in which it operates.

In the context of transdisciplinarity, the integration of social and biophysical sciences considers how issues are influenced by both the social and ecological systems in which they are embedded (Bhattacherjee, 2012). This provides insight into the relationship and interactions of humans with their environment, both on the small scale and large scale, such as a forest worker

choosing to use a new, light-weight chainsaw or the US Forest Service limiting timber harvest. Social science is an influential and essential component of the transdisciplinary research process and can provide grounds for more inclusive and equitable research. This ability is a significant and meaningful addition to Extension's ability to engage in practical and inclusive research.

Furthermore, the social sciences are well equipped with the knowledge and approaches required to identify ways to meaningfully engage and communicate with diverse audiences (Bhattacherjee, 2012). This provides Extension the opportunity to more deeply understand a local community, transcending simply its demographic characteristics. As a result, social science provides Extension personnel with strategies to reach populations that have historically been underrepresented and ostracized from research. Such populations are often communities of color, which means that Extension personnel must understand how to respectfully and appropriately approach racially driven conflicts and experiences in the United States. One relevant social science discipline is ethnic studies. This field examines the experiences, differences, cultures, and issues within racial-ethnic groups, and it encompasses Latinx studies, African American studies, Native American studies, and Asian American studies. Focusing on ethnic studies can guide Extension workers on the most appropriate and productive approaches to engage with migrant Latinx forest workers in research that recognizes critical cultural practices and beliefs embedded in Latinx communities. Researchers who come from a position of power and privilege must recognize the systemic differences between themselves and Latinx forest workers. The social sciences can serve as valuable sources of knowledge to educate and inform oneself and others, as well as ensure that privileged positions do not take precedence. Moreover, integrating Latinx studies can provide means for addressing language and cultural barriers that are prevalent when communicating with Latinx individuals, facilitating more meaningful cultural exchanges that foster trust, and ensuring information is presented in culturally accessible formats (Kudo & Wood, 2020).

The Pineros Project and Why TD Research as a Good Fit

Introduction to the problem

A transdisciplinary approach to identifying sustainable solutions is well suited to address the socio-ecological challenges that contribute to occupational inequity and exploitation in the forest

management industry, which impacts the livelihoods and economies of rural communities and the diverse communities that reside in them. This can be seen in rural forest communities that are dependent on nearby forests to sustain their livelihoods, contribute to the community and economic vitality, and enhance local visual amenities. However, many of these communities lack meaningful decision-making authority concerning the forest management activities occurring in these forests, particularly on federal lands in the U.S. West. In the West alone, the federal government owns and manages over half of the total land, granting the government considerable authority over the management and use of the land, particularly how rural and resource-dependent communities can interact with the land (CRS, 2020). Regarding forestland, the federal and state governments own and manage 70 percent of all forestlands in the West; in Oregon alone, the federal government owns and manages 50 percent of all forestlands (CRS, 2020).

While management decisions on federal forestlands are ultimately the responsibility of the government, management activities are contracted out to private forest sector businesses, who provide labor-intensive services such as planting and maintaining tree seedlings, thinning trees, burning brush, applying manual herbicides, and suppressing wildfires (Moseley et al., 2014). Despite the majority of these firms being owned and managed by white people, the vast majority of workers performing these labor-intensive activities are migrants, most of whom have emigrated from Central and South America (Brodbeck et al., 2018). Many of these laborers are undocumented or have unclear legal standing, which places them in a vulnerable position, increasing their risk of experiencing labor exploitation and unsafe working conditions (Sarathy, 2006). There is little knowledge or awareness among policymakers or the general public about the realities of these forest workers and the exploitation and abuse they are subjected to on a regular basis. Because these workers, their circumstances, and experiences remain largely unknown to the outside world, the exploitative and abusive practices they endure will continue unchecked and, if not addressed, will only continue to intensify.

In light of the lack of public awareness, it is essential to engage with Latinx forest workers to provide them with opportunities to share their experiences and realities, which may then be applied to produce real, tangible change. Accordingly, carrying out such a project falls ideally within the scope of Extension, which may be further enhanced by adopting a TDR approach that incorporates equity-centered methods intended to identify sustainable solutions. But first, to fully comprehend the realities of forest workers and the conditions under which they are employed, it

is necessary to understand just how the labor-intensive activities in the U.S. federal forests have come to be dominated by migrant Latinx workers.

The West and The Northwest Forest Plan

Until the 1990s logging was the dominant activity conducted on federal forestlands, and any restoration work was secondary, directly related to the amount of logging done (Moseley & Reyes, 2008). However, due to litigation over species protection under the Endangered Species Act and National Forest Management Act, as well as the logging bans in the Pacific Northwest due to over-harvesting of the existing old-growth trees – the trees most preferred for logging due to the amount of wood a single tree provides, lending to greater profitability – there was a call for more sustainable forest harvesting practices (Charnley et al., 2008). In response, the Northwest Forest Plan (NWFP) was developed in 1994 in an effort to ensure the long-term health of the forests and wildlife, as well as to reimagine the management of forest activities and protect Northern spotted owl populations and marbled murrelet populations (Charnley et al., 2008).

In the years following the introduction of the NWFP, logging activities drastically declined (though they had been drastically declining since the late 1980s and early 1990s due to lawsuits and court decisions), effectively reducing the number of authorized cuts on federal forests by roughly 90 percent and effectively prohibiting large-scale logging on national forests (Haynes & Sanchez, 2001). In the aftermath of these restrictions, many rural, forest-dependent communities faced an uncertain economic future (Hibbard & Lurie, 2013). As the once-booming logging industry continued to decline, so did the well-being and prosperity of rural communities, which only further exacerbated the economic disparity between rural and urban areas (Moseley & Shankle, 2001). In response, rural communities sought new avenues to support local economies and create new economic bases that would develop more employment opportunities and revitalize their communities (Hibbard & Lurie, 2013).

This search for new economic opportunities brought recognition to the importance of diversifying and broadening economic bases and the range of activities on forestlands, which could improve local economies and enhance their environmental and social resources. This eventually led forest-dependent communities to develop the new forest economy (NFE), which

based economic development on activities that promote the restoration, productivity, and enhancement of forest health and watershed functions (Davis et al., 2021). Among them are labor-intensive and mechanized activities such as tree thinning, tree planting, brush removal, improvements to forest roads and stream health, and environmental assessments, most of which are conducted on federal lands (Davis et al., 2021). However, while some communities have benefited from this new economic base, this has not necessarily been the case for all communities. As much of the NFE work is being performed on federal forests, there are restrictive forest management policies in place, which often demand that such activities be administered through contracting regulations and practices.

Contracts are typically awarded to the lowest bidder, which results in many small rural businesses and communities being unable to compete with larger-scale contracting firms, as rural businesses and communities cannot perform the work for such low prices (Moseley & Shankle, 2001; Moseley, 2006). Many contractors submit low bids for contracts, which are frequently so low that they fail to fully cover the costs of paying their workers. As a means of compensating for labor costs not covered by the low bid and maximizing profits, contractors have looked for ways to keep labor costs to a minimum, and many resorted to employing various exploitative and unethical labor practices. Such practices were made possible by relying upon a workforce composed of mobile, partially undocumented Latinx laborers, thereby leading to the Latinization of labor-intensive work (Wilmsen et al., 2015, 2019; Charnley et al., 2018).

The Latinization of forest management

Throughout the 20th century, the United States has experienced an extensive influx of immigrants originating from not only European countries but also from Latin American countries. The rise of immigration can be partially attributed to the Bracero Program, a program established in the mid-1940s in response to wartime labor shortages, in which Latinx immigrants came to the U.S. to work as low-wage agricultural laborers (McDaniel & Casanova, 2003). In 1951, the Bracero Program was permanently instituted, and by 1960, the number of bracero visas had nearly doubled since the program was established, employing approximately one-half million laborers. While the program officially ended in 1965, undocumented workers continued to migrate to the U.S. to work in the agricultural industry (Sarathy, 2006).

One prominent destination that migrant Latinx laborers chose to settle in was southern Oregon, particularly the Rogue Valley. It was there that they found steady work in the agricultural sector by harvesting fruits for the local orchards. By the early 1970s, a community of migrant Latinx families had been established within the Rogue Valley (McDaniel & Casanova, 2003). As time passed, there emerged a shift in the local labor market, and many workers began to transition from agriculture to forestry-related labor, such as working in local sawmills or as tree planters on federal forestlands (Sarathy, 2006; Sifuentez, 2016). These new employment opportunities were largely due to the introduction of new forestry regulations, which also enabled the community to grow, though they continued to face social and racial discrimination on the part of their predominantly white neighbors. Over the following years, Latinx laborers came to constitute the majority of reforestation workers.

However, another shift in the labor market soon emerged, namely, in the type of forest-related activities occurring. During this transition, the dominant forest activity shifted from reforestation to ecosystem management guided by the NWFP. Latinx forest workers and contractors were quick to make the shift to this manually intensive labor, and Sarathy (2006) identifies three main reasons for this trend. First, Latinx forest contractors were "primed" to take on this work, given their experience in labor-intensive reforestation activities and the chance to advance in their careers. Next, the United States Forest Service and Bureau of Land Management reserved a set number of service contracts specifically for minority-owned and operated businesses, including work in the restoration industry. This provided an opportunity for Latinx forest laborers to advance in their careers, especially those with English language skills and U.S. citizenship. Finally, few others were willing to undertake the new restoration activities other than the Latinx workforce. Thus, despite the decline in logging and reforestation contracts, the Latinx forest workforce has grown since the 1990s, reflecting the disproportionate representation of Latinx forest workers engaged in labor-intensive activities on federal forest lands. Today, Latinx forest workers, also called pineros (Spanish for men of the pines), account for over 60 to 80 percent of those working in this industry in Oregon (Charnley et al., 2012; Sifuentez, 2016).

Latinx workers' experience and the workforce environment

In many cases, Latinx forest workers arrive in the United States in one of two ways: either upon issuance of H-2B visas by the Department of Labor, which interested employers apply for

to hire migrant workers for non-agricultural work, or by entering the country undocumented (Sarathy, 2006). Although undocumented workers have comprised the majority of the labor-intensive forest workforce in the Pacific Northwest for many years, the number of H-2B workers has grown significantly in recent years (Sarathy & Casanova, 2008). This prevalence of unauthorized workers employed as forest labor in the Pacific Northwest can be attributed to many factors, including kinship networks and social networks. Latinx workers advanced in the forestry industry, many fulfilling supervisory positions, from which they assumed responsibility for recruiting and hiring new employees. Consequently, they began hiring friends and family members within their social and kinship networks, which gave rise to a workforce that was largely made up of family members and other close relationships (Sarathy, 2006). With time, these networks become instrumental in helping to recruit new migrant workers to enter the labor-intensive forest industry.

The rise of undocumented workers in the labor-intensive forest industry can also be attributed to often being more willing to accept lower wages than Americans (Sarathy, 2006). Contractors may take advantage of this situation because many of these workers will work for low wages to support their families, and they are less likely to seek legal recourse against their employers for such unethical practices due to their fears of deportation and lack of awareness of their labor rights (Moseley, 2006). Contractors continue to engage in these exploitative practices due, in part, to the lack of the public and policymakers' awareness of the experiences and realities of undocumented pineros (Knudson & Amezcua, 2005; Sarathy and Casanova, 2008). In general, this lack of exposure is believed to be caused by undocumented pineros' fear of deportation and employer retaliation, a fear that is further compounded by the abuse and exploitation they experience at the hands of forest contractors (Knudson & Amezcua, 2005; Sarathy, 2008; Sarathy & Casanova, 2008).

In addition, due to this lack of awareness, the struggles of Latinx forest workers have been almost entirely absent in the current discourse on forest management and rural community development (Davis et al., 2021). Therefore, future research is required to investigate forest workers' experiences more thoroughly, promote more public awareness of pineros' reality, and identify steps to empower forest workers through more equitable and inclusive livelihood opportunities (Davis et al., 2021). Although past research indicates that undocumented pineros are more hesitant to participate in research, there has been a considerable growth in H-2B guest

workers in the Pacific Northwest, who may be more willing and able to participate (Sarathy, 2006; OFLC, 2021). In fact, over the last ten years, there has been a 650% increase in the number of H-2B guest workers employed in the forest industry (from 664 to 4,314) (OFLC, 2021). It remains unclear why this growth has occurred and this unclarity is partially attributed to the lack of overall research conducted on forest labor and labor-intensive forest workers. Consequently, this growth could potentially provide an additional avenue worth investigating in connection with this research project.

In light of the growing Latinization of the forestry industry, it has become increasingly important to ensure that these workers have access to ethical working conditions, equitable wages, and the chance to expand their livelihoods in order to enhance their opportunities to contribute to the economic and social wellbeing of their communities. Furthermore, as a complex challenge, it is well suited to be examined through a TDR approach, which provides researchers with opportunities to use equitable research practices, systematically assess how research can most effectively serve pineros, and engage in demand-driven, action-oriented research that will directly benefit forest workers.

Project Description, Needs Being Met, and Major Objectives

The forest workers project's purpose is to create more "vibrant and prosperous rural communities and Latinx populations" (Davis et al., 2021, p. 1), with the objective "to achieve prosperity in the New Forest Economy" (Davis et al., 2021, p. 2). In the context of the study, prosperity refers to equitable employment and economic mobility for minority populations. The concept of equitable employment refers to an individual's right to safe working conditions, fair and just wages, and opportunities for career advancement, such as business ownership and operation, regardless of barriers (for example, language and immigration status). Additionally, economic mobility refers to the ability of individuals and families to advance in their economic position by gaining access to better-paying and more stable jobs. The project aims to address injustices through identifying interlinkage between cultural norms, values, labor rules (e.g., laws on labor breaks, poor transportation), labor regulations (e.g., fair contracts, workers employed under H-2B visas), behaviors (i.e., no working breaks or unsafe working practices), policies (e.g., contracts from the USFS), and decisions made (e.g., by contractors, workers, or agencies),

as well as, to identify equity-centered practices that will create a more equitable and prosperous forest labor workforce.

It is the intention that part of this project will present more advocacy opportunities and educational programs for Latinx workers and communities, including career training workshops, more intensive safety training, and information regarding their labor rights, occupational safety, and health resources. Ideally, this will result in more equitable opportunities to achieve a more sustainable and prosperous reality, which includes safe and decent jobs, adequate housing, and health care.

The nature and design of this project provide an opportunity to demonstrate how transdisciplinarity and TDR can be effectively implemented. It also presents the opportunity to illustrate how equity-centered practices are employed to address environmental and labor injustices and can be used to expand collaboration between scientists, forest workers, and organizations that advocate for these groups.

Transdisciplinarity, equity, and collaborating organizations

If successful, the success of the forest workers project will be due to the collaboration of relevant participants, which include the migrant forest workers and members of the Latinx communities. The project is headed by Oregon State University's Extension Services, in collaboration with the Ecosystem Workforce Program (EWP) at Oregon State University and the University of Oregon, Northwest Forest Worker Center (NFWC), Lomakatsi Restoration Project, and Western Rural Development Center (WRDC) at Utah State University. These organizations are experienced in collaborating on projects and are committed to promoting more inclusive and equitable opportunities for marginalized communities. The following is a discussion of the relevant knowledge and expertise that each collaborating organization will contribute to this project.

The NFWC, located in Medford, Oregon, has a mission of empowering underrepresented forest workers to improve their lives and livelihoods through education, outreach, training, advocacy, and providing small grants to community groups (NFWC, n.d.). One educational program that the NFWC founded is the promotora program, Sí, Sé: Salud y Seguridad en el Trabajo—Yes, I Know: Health and Safety on the Job (Bush et al., 2014). This program offers health and safety-based education for forest workers. As the NFWC (n.d.) website describes, the

program “employs women from the forest worker community in Medford, Oregon, as promotoras (lay health educators or community health workers) to train forest workers in preventing on-the-job injuries and educating them about their rights.” As a demand-driven and community-led program, it is the promotoras and forest workers who are in charge of what is taught, the methods employed, and the decisions on what adaptions are needed to improve the effectiveness of knowledge transfer. At the heart of this program is to improve equity and prosperity for the Latinx community and forest workers, empower the promotoras through leadership opportunities that will benefit their community, and provide the resources and knowledge that are needed to improve the livelihoods and lives of those living in the community (Bush et al., 2014). In 2020, the promotoras program was officially taken over by Lomakatsi with the intent to enhance and expand the program.

The Lomakatsi Restoration Project is an organization focused on restoring ecosystems and building the sustainability of communities, cultures, and economies. This program also provides vocational and on-the-job training and employment opportunities within the ecological restoration sector. Additionally, it facilitates partnerships with relevant organizations and communities, with the intention to build community capacity to accomplish restoration at a landscape scale. Furthermore, the NFWC and Lomakatsi have a shared history of identifying and acting on issues affecting worker safety and community development outcomes for federal forestland management, making them uniquely suited to collaborate on this research project. Both programs have contact information for hundreds of forest workers, which helps provide access to a vast network of potential participants and collaborators who could contribute their insight and experience to inform the research.

Additionally, the Lomakatsi Restoration Project has been creating jobs, developing the forestry workforce, and advancing contractor capacity within the new forest economy. It has accomplished this by holding training opportunities to build a skilled local workforce and a team of professionals. It now manages the promotoras program, as it was officially transferred from the NWFC to Lomakatsi in 2020, with the intention of enhancing and expanding the program to further improve livelihoods and increase educational and training opportunities available to forest workers. Through collaboration with Extension on this project, the promotoras program will hopefully be implemented in other communities throughout the state and country, so they too can provide more equitable and inclusive opportunities (Bush et al., 2014). In this way, the

program provides a significant contribution to the TDR process, as it aims to integrate the new knowledge generated through research and gained from the workers and Latinx community into the future learning and program content.

The next organization to collaborate on the forest workers project is the Western Rural Development Center (WRDC) at Utah State University, which provides strong expertise in working directly with rural communities in addressing community and economic development concerns. Also, WRDC has extensive partnership networks that allow the project collaborators to create and share information with the western region's and nation's land-grant university system, notably amongst Extension programs and rural residents, making it ideally suited to assist in expanding the promotora program beyond Oregon.

As an Extension-led project, the OSU Extension Program, alongside the EWP, will seek to develop opportunities to accelerate knowledge transfer and provide interactive Extension educational and culturally appropriate and accessible materials, with the hopes of promoting action on the part of decision-makers so that there are policy developments for increased labor and equity rights.

As this is a collaborative project involving the cooperation of several organizations and actors, equity and inclusion will be promoted in various ways with the intent to accomplish the project’s goal, though not all of these goals are guaranteed to be reached. To begin with, a primary goal of the project is to establish social discourse and action on the realities of forest workers and migrant communities to enable them greater access to better livelihood opportunities and working conditions. Additionally, the project seeks to disrupt the discriminatory narrative that Latinx workers are merely passive victims who lack the skills, knowledge, or authority to defend themselves and must depend upon outside assistance. Instead, it is designed to support Latinx communities in making their own decisions about what problems to address and what actions to implement and providing them the resources and support to disseminate information on their own terms. Thus, the scientists and researchers do not "save" the community or receive all the benefits from the research. Instead, the research is driven by the community for empowering and enhancing community capacity and promoting leadership opportunities for community residents. Furthermore, this research will seek to enhance the agency of undocumented individuals and workers in order to provide them with greater mobility

and more ease of access to jobs offering better pay and economic independence in positions of business ownership and leadership.

This project is structured around several social science research methods to elicit relevant data from participants in order to produce new scientific findings and, thus, inform the development of effective and practical educational products and opportunities that will help support and promote equitable working conditions. Several methods are identified as effective in finding ways to effectively engage with communities, such as semi-structured interviews and focus groups, and both methods will be used during the project. It is intended that these tools and frameworks will promote mutual learning and knowledge production to identify actions and strategies that will meet the needs of a community.

Semi-structured interviews will be used to engage with Latinx forest workers to "elicit information about current trends, drivers, issues, and opportunities for Latinx workers in the area, including how they enter the forest workforce, common paths, and potential for mobility and entrepreneurship; as well as their perspectives about culturally and locally-appropriate means of accessing Latinx forest worker populations" (Davis et al., 2021). The forest workers who participate in the interviews will be invited to participate in various educational workshops, providing them with additional opportunities to evaluate the workshops they attended, which will assess their understanding and application of the material covered. This information will inform future modifications and enhancements for future implementations and iterations of the program.

Furthermore, the research findings will contribute to the enhancement and expansion of the promotoras program, in which the learning materials have been primarily developed and adapted by the promotoras themselves. During the course of this program, the promotoras undertook a comprehensive process of evaluation and revision of the educational material. This process was informed by identifying topics that required a shift in focus and modifications to material presentation to better meet the learning needs and capabilities of the learners (Bush et al., 2014). They will continue to be crucial contributors to the project by providing constructive feedback and input that will influence the success and impact that the program has on forest worker behavior and empowerment. Therefore, the community affected by the complex issue of inequity and exploitation in the labor-intensive forest workforce will act as integral collaborators to the project, contributing their experiences and knowledge to further enhance the success of the transdisciplinary research process.

In conclusion, the aim of the research is to raise awareness and engender a sense of urgency among decision-makers and the public regarding the current conditions and realities of the migrant workforce managing public forest lands and how management decisions and policies contribute to the injustices these forest workers face on a daily basis. Additionally, opportunities for development and capacity building for forest workers and organizations will be explored, with the ultimate intention developing new educational products and programs, as well as practical and applicable solutions to their concerns. Accordingly, these innovative educational products and programs will aim to contribute to the advancement of transdisciplinarity and TDR to continue fostering more equitable labor practices and improving livelihood prospects and career advancement for forest workers. Finally, while it is not guaranteed, it is the intention of this project to contribute to societal progress by improving the capacity and management of Latinx forest workers, as well as enhancing the economic and social prosperity of rural communities in which they reside.

Introduction to Section Two - Science Communication and the Scientist

Communicating scientific knowledge to the general public in an easily understandable form is not generally a priority for scientists, as historically, scientists have focused their communications primarily for their peers. They may find themselves more comfortable in their institution, where they are able to discuss complex topics with their colleagues in a language that is difficult for an audience unfamiliar with specialized scientific discourse to fully comprehend. Moreover, when scientists are asked to communicate their work to the public, their academic training may lead them to focus on the specific details of their research rather than explaining and demonstrating its broader significance and relevance to the audience (Dean, 2009). This may result in the public assuming that the scientist is ineffective and insensitive as a communicator rather than realizing that scientists may lack the training necessary to engage the public in inclusive and equitable ways (Davies, 2008).

However, many scientists are successful in communicating their research in a manner that is easily accessible for public consumption. Many scientists are actively striving to engage in effective science communication, which as a process entails informing, educating, and raising

awareness of science-related subjects and practical skills. Effective science communication may establish awareness, address relevant interests or provide enjoyment, inform and shape opinion, promote understanding, or provide knowledge for practical application (Burns et al., 2003). These outcomes are evident in examples such as guest scientists who appear on the -Ologies science podcast, the countless scientists active on social media (e.g., Tik Tok and Twitter), or Ted Talks geared towards diverse audience types. In such instances, scientists are seeking alternative ways to share their work with a broader audience and using language that is more accessible than scientific jargon.

It should be noted that simply communicating science by posting a published article or research project on a website is not enough to ensure that these findings will result in greater public understanding, engagement, and awareness (Shindler et al., 2002; National Academies of Sciences, Engineering, and Medicine, 2017; Howarth et al., 2020). Ensuring that information is understood and utilized appropriately by an audience requires several factors to be considered, such as the social and cultural contexts that influence how information and knowledge are communicated and received (Mercer-Mapstone & Kuchel, 2017). Take the forest workers project as an example. As learners, these forest workers often require alternative approaches to science communication to be adopted that acknowledge and reflect their distinct cultural and social characteristics, as well as the constraints they may be facing (e.g., language barriers and social exclusion). For example, Latinx migrant may be limited in their English-speaking abilities, and many fear any government-related officials, as they represent the potential for deportation (Ballard & Sarathy, 2008). Still, these workers might benefit from science communication. For example, they are at significant risk of developing chronic physical pain due to their work that requires non-neutral postures and repetitive movements (Granzow et al., 2018). As such, these workers would benefit from information about improved tree planting techniques that are more ergonomic and less physically demanding (Granzow et al., 2018). Researchers or Extension specialists might decide to offer educational opportunities and resources about these new techniques. While they could distribute their research findings without direct interaction with forest workers, such as by sending them informational pamphlets outlining the new techniques, this limits the extent to which the information will benefit the workers, as only a finite amount of information can be provided in this format and limited assistance can be offered in navigating the

material. Instead, engaging workers on the ground and in-person to develop appropriate learning approaches may better ensure the message can be delivered effectively.

Additionally, the researchers should reflect on how their position as researchers and outsiders may appear threatening to the workers if they were to connect in person. For instance, the researchers must recognize that even though they have no intention of reporting the workers to immigration officials, they already pose a threat to the workers based on their government affiliation. Consequently, the migrant workers might resist working with the researchers until mutual trust is established and maintained. Moreover, if most of these workers speak only Spanish, have a limited grasp of English, or do not possess strong literacy skills, they might find written resources unusable. Thus, even if researchers have good intentions, communication could be ineffective if it fails to consider the limitations and barriers that exist among the audience.

The following section discusses the role of science communication within the context of transdisciplinarity and Extension, with a focus on promoting opportunities for equity and justice for Latinx migrant forest workers. This section aims to illustrate communication strategies through a discussion of common and real-world challenges to science communication in Extension and transdisciplinarity and TDR, as well as strategies and practices to address them.

The Role of Science Communication in Transdisciplinarity

As noted earlier, transdisciplinarity is intended to promote constructive social and scientific advancements within the communities most impacted by the research challenge, in addition to contributing to scientific advancement. Moreover, for research to have the greatest benefits to the community, findings must be made available and communicated in a way that is relevant and understandable to their needs while also providing practical solutions to their concerns. Consequently, science communication plays a fundamental role in ensuring sustainable impacts from TDR and participant commitment to its success. Done well, it can also further develop solutions and approaches to societal challenges. In this way, science communication supports transdisciplinarity and TDR by facilitating communication and collaboration across disciplinary boundaries, as well as bridging professional and societal boundaries between scientists and non-scientists (Mattor et al., 2014).

It should be noted that within the context of transdisciplinarity, the audience for science communication is often, in many ways, the non-scientific research participants themselves, and

in particular, those who have actively participated in the research process and are embedded in the research problem (Jahn et al., 2012). Although disseminating the newly generated knowledge might suggest that the community, i.e., the audience, is no longer equally engaged in the process, this is not true, as their role in the process has somewhat shifted. The community plays different roles during the process of science communication, namely as the audience (i.e., the recipients of the information) and/or as the communicator (i.e., the one who disseminates the information) (Hilger et al., 2021). In this regard, they are still actively involved in the development and implementation of science communication, and their knowledge and feedback will often be incorporated into the development of the content.

As TDR contributes to community empowerment and enhances community capacity, so too does the process of science communication, as the new knowledge is integrated into the development of effective and practical educational products and opportunities that can enhance and promote community capacity and personal empowerment. Additionally, participants are able to express their questions and concerns during this process and share their expertise, knowledge, and experiences. Consequently, a comprehensive understanding of the issue may be attained, setting the stage for the development of more effective and sustainable solutions to community challenges (Kalmar & Stenfert, 2020). In the case of Latinx forest workers, following the workers and other key members of the community's direct involvement in the research process, their input is used to support the development and delivery of science communication products, where these workers serve as the audiences and recipients of the educational products for the purposes of promoting and supporting equitable working conditions.

The engagement of the community as both partner and audience through science communication requires recursive evaluation and reflection in order to evaluate whether methods, products, or programs effectively meet community needs (Cartwright et al., 2016). This iterative process is enabled by a sustained cooperative effort as well as an active exchange of information and feedback between communicators and their intended audiences (Robinson, 2013). As a result, the audience is provided an opportunity to express opinions and recommendations for areas of improvement, including how knowledge can be used to better inform societal and scientific discourses and meet community needs (Cartwright et al., 2016).

While communication in transdisciplinarity and TDR is typically iterative, not all science communication or Extension processes are. An example would be written communication

materials, such as a guide for forest landowners to hire an ethical and equitable contractor for forest restoration. In this case, the guide will only be published once, and it will not need to be iteratively updated or improved on a regular basis. On the other hand, an iterative process might be useful for ongoing events, such as a series of workshops providing forest workers with information on their rights in regard to labor and safety. As these workshops will be held in different communities, it would be helpful to use an iterative evaluation process to continuously improve the message and ensure it provides relevant and practical information to the intended audiences. This process enables science communicators to maximize the effectiveness of their material to effectively reach the intended audience and transfer knowledge in a way that is accessible to all audience members, especially historically marginalized audiences such as Latinx forest workers.

Science Communication in Extension

A central purpose of Extension is to provide community education and resources and effectively disseminate relevant skills and knowledge by facilitating interactions and discussions between Extension personnel and their audiences (OSU Extension, 2022). Therefore, the ability to communicate science and information in an appropriate, accessible manner is a valuable skill that Extension personnel must possess and is essential to their success and integration into the community. In addition, Extension personnel must remain adaptable and open to the changing needs and interests of the community. As a result, how Extension personnel engage and promote science communication depends on the community and its needs at any given time (OSU Extension, 2022). Extension personnel should approach science communication as a continuous and dynamic process driven by the needs and interests of the community, and that takes into account the diversity of interests and perspectives within each community.

It is important that Extension personnel do not position themselves at the center of a discussion, but rather they remain as objective resources that provide fact-based knowledge and serve as facilitators for bridging science and the public. Yet there are still inherent challenges that communicators encounter in Extension. This requires recognizing the context in which the challenges exist, the perception of the communicator by the audience, and how to best address these challenges and promote the best possible learning outcomes and practice.

Challenges and Best Practices of Effective Science Communication in Extension

The work carried out by Extension does not occur in a vacuum, untouched by politics, social hierarchies, and bureaucracy. Like any public service program, the social and political environment in which Extension operates affects its daily operations, either limiting or enhancing its capacity to accomplish its goals. As Extension services are primarily driven by community needs and interests, a diverse spectrum of audiences is invested, each with different backgrounds; this will shape how Extension is carried out within each community. Thus, Extension personnel assume a role akin to that of a politician, in the sense that they represent a prominent institution and hold a considerable amount of influence in their community, as well as serving as advocates for their community's needs and development (L. Grande, personal communication, January 2022). However, unlike a politician, it is the Extension personnel's responsibility to adhere to the facts, remaining apolitical and objective in both their role and their interactions with their community. This is particularly important when sharing information on contentious matters that might elicit negative or critical responses, such as the realities of undocumented forest workers or the importance of supporting policies that promote more equitable treatment of these workers (L. Grande, personal communication, January 2022). As such, it is imperative that Extension personnel know how their community operates, including understanding the best strategies to employ when addressing such matters, delivering only objective information, and cultivating trust between them and their community.

Moreover, Extension personnel's success and reception by a community are greatly dependent upon how well they communicate a particular message and how well that information is received by the community. To successfully serve in this role, Extension personnel must be aware of the inherent challenges associated with the position, particularly those related to how they conduct science communication and foster community participation. Despite the fact that no one science communication practice or method can completely meet the needs of every single community, these challenges can be addressed by applying various established science communication practices and principles. Accordingly, often the best-suited course of action to ensure effective communication of science to a given community can only be identified over time as a result of establishing trust and rapport through open and honest communication. Nevertheless, there are an array of valuable practices and principles to consider to achieve the

desired outcomes from a communication effort and promote the engagement and inclusion of marginalized and underrepresented populations to maximize the efficiency and inclusivity of that effort (Halbleib & Jepson, 2016).

This section describes five of the most prevalent challenges that Extension personnel will encounter when engaging in communication efforts, along with a compilation of recognized communication principles and practices that will assist in addressing these challenges (Jenkins et al., 2020; L. Grande, personal communication, January 2022). These were identified through extensive literature review and interviews with several Extension personnel who provide science communication products and opportunities to their community. By recognizing and addressing each of challenges, Extension personnel will be better equipped to deliver more effective science communication and enhance their credibility as science communicators.

Challenge 1: Building and maintaining trust between communicators and audience members

Establishing trust with a particular audience is the key to ensuring that science communication is well received and leaves a lasting impact (Wilson et al., 2017). Even though the public often ranks scientists as one of the most trusted groups, their trustworthiness is questioned by various groups of non-scientific individuals, particularly by those who reside in rural areas (Krause et al., 2019). It has been suggested that this mistrust may occur due to the lack of local scientific representation and lack of familiarity with how science can be utilized to address local issues (Steltzer, 2021). It may also be attributed to the disadvantages that rural communities face when accessing resources and opportunities pertinent to their needs and concerns and a feeling that their values and priorities are not respected (Steltzer, 2021). Even if communities are able to understand the science, they often find it challenging to recognize how it relates to them, especially if the information comes from a distant scientist. Thus, when rural communities cannot develop a relationship with scientists or are not able to participate in local research, they struggle to find science relevant and credible.

As a scientist at a rural college, Steltzer (2021) notes that her community trusts the information she shares about climate change, not because she was a lead author for the 2019 Intergovernmental Panel on Climate Change report but because she lives within the community as a neighbor and friend. Her community trusts her since they recognize that she has their best

interests at heart and can relate to and empathize with their concerns and priorities. In contrast to distant scientists who may share their research in a way that leaves it up to the audience to find it (e.g., publishing it online), she is a reliable and readily available source of information for her community. The widespread sense of mistrust of science on the part of rural audiences can extend to the work being done in Extension. Thus, Extension personnel must establish a foundation of trust and mutual respect between themselves and their communities. In addition, because Extension personnel are themselves residents of the communities they serve, they have the opportunity to be credible community resources, much like Steltzer is in her community, where they build relationships and a rapport with members of the community and are perceived as a reliable source of information (K. Baylog, personal communication, January 2022).

The following are practices and strategies that aim to build and maintain trust between communicators and audiences throughout any science communication experience.

1.1 Building and sustaining trust must be treated as a continual process. For trust to be created, all key participants must be included throughout the process, beginning with the initial planning stage and continuing to the final step (Shindler et al., 2002). This process provides opportunities to familiarize audiences with the process and the team behind it, including encouraging open communication regarding the concerns and demands that motivate the message and fostering community commitment for long-term success.

1.2 When dealing with audiences prone to distrust, it is important to draw on sources that have credibility and influence with the audience being addressed (J. Creighton, personal communication, January 2022). Additionally, in citing these references, all relevant credentials, including education, experience, and values-based achievements, should be cited while also taking care that the qualifications are relevant to the message and the audience being addressed (Jenkins et al., 2020). In the case of the forest workers' project, this would involve referencing the work of forest worker advocacy groups like the Northwest Forest Worker Center (NFWC) and ecological restoration organizations like the Lomakatsi Restoration Project (Wilmsen et al., 2015; Wilmsen et al., 2019). In addition to establishing and maintaining relationships with forest workers, these two organizations have researched the institutional racism that underlies the structural vulnerabilities facing forest workers, including health disparities and labor exploitation

(Wilmsen et al., 2019). As a result of this prior experience working together, the workers are more likely to engage with the material and recognize how it benefits them.

1.3 There should be no attempt to cover up past mistakes but rather one should acknowledge them, invite the audience to share their thoughts and concerns about the issue, and explain how they are being addressed (Jenkins et al., 2020). For instance, forest workers might express concerns about the lack of enforcement of labor laws and regulations by the government, despite witnessing numerous instances of labor violations in the field. This negligence has resulted in workers sustaining serious injuries while on the job, some of which were career-ending or even fatal. Workers may be reluctant to believe that the tradition of neglect is likely to change. Therefore, it is imperative that these forest workers have the opportunity to express their concerns and that their concerns are taken seriously throughout the entire process. Discussing these concerns can be further facilitated by sharing corrective actions taken, such as implementing more stringent health and safety oversight for non-compliance or more equitable provisions in guest labor policies.

1.4 It is important to emphasize the benefits of a message and message framing so that the audience better understands how learning and applying what they have learned is beneficial to them now and in the future (Jenkins et al., 2020). For forest workers, this means illustrating how learning opportunities can enhance their familiarity with safety practices, potentially reducing their risk of injury while simultaneously improving productivity and working conditions. In addition, participating in career and entrepreneurship training will enable them to acquire skills that will help them advance their professional careers, as well as facilitate their development as individuals and a broader community.

1.5 An effective strategy to establish trust with marginalized audiences is to enlist a trusted community member to deliver the message, preferably someone prominent. Local leaders who are already trusted may be able to ensure that messages and methods are in alignment with cultural values, beliefs, and experiences, thus making them more credible to the community (Schweizer et al., 2009; Rongerude & Sandoval, 2016). Regarding the forest workers project, trusted local leaders take the role of promotoras, who are responsible for educating community members–in this case, forest workers–on

topics related to forest management and occupational health and safety. Given that the promotoras themselves are members of the community they are educating, they are already knowledgeable about local cultural values, have shared experiences with the audience, and maintain relationships with local cultural and social organizations (Grzywacz et al., 2009).

Challenge 2: Recognizing audience diversity to anticipate their needs

It is not feasible to meet all expectations, especially if the audience consists of individuals from diverse backgrounds, interests, educational backgrounds, cultural norms, and demographics (Mercer-Mapstone & Kuchel 2017). Thus, a significant challenge is appropriately addressing the diversity of the audience, where each individual maintains their own beliefs and biases, which impact their perception of the speaker and their response to the message (Fiske & Dupree, 2014).

In an Extension setting, audience members may include forest landowners, teachers, conservationists, restoration contractors, forest workers, ranchers, and so forth. Thus, Extension personnel must be able to deal with and balance such contrasting perspectives when they work with an audience that is diverse in both background and circumstance (J. Creighton, personal communication, January 2022; Kalmar & Stenfert, 2020). This is particularly important when communicating about polarizing topics, where audiences have conflicting views, gather information from different sources, and are influenced by their ideological biases (Cartwright et al., 2016). Navigating challenging topics and issues to diverse audiences is not an easy task. Extension personnel must do so by facilitating respectful and productive dialogue while validating individual experiences and beliefs. To accomplish this requires forethought, imagination, observation, research, and an understanding of which aspects of the science are ideally suited to the intended audience and their needs, which is more readily accomplished by employing the social sciences into the process (Cooke et al., 2017).

Following is a list of recommendations to help evaluate and address audiences' differences so that appropriate science communication techniques can be employed that effectively respond to their concerns and needs.

2.1 Extension personnel can identify the needs and interests of the community by conducting needs assessments and informational interviews with diverse groups of members of the community (J. Creighton, personal communication, January 2022). This

can be accomplished through a variety of formal and informal methods, including surveys, interviews, consultations, direct observation, and even casual gatherings over coffee or lunch. By engaging the community in these ways, it is possible to ascertain what the community views as the most critical issues, as well as what improvements or opportunities they would like to see (Curtis et al., 2012; L. Grande, personal communication, January 2022).

2.2 It is possible that a program or an event may not be successful or practical because it is inaccessible to members of the audience who face constraints due to work, family responsibilities, or lack of transportation (J. Creighton, personal communication, January 2022; K. Baylog, personal communication, January 2022). To improve accessibility to events and programs, it is important to anticipate the logistical requirements of the audience. One approach is to know the demographics of the community, including audience types and community composition (i.e., are there a lot of young families/small children, older people, racial minorities, etc.). The objective is to create programs and learning opportunities that are readily accessible to the audiences and are structured to accommodate their needs, constraints, and life circumstances. For example, a workshop could be held at a convenient location, and, if this cannot be achieved, transportation could be arranged for participants who do not own personal transportation or would prefer not to drive (Curtis et al., 2012; L. Grande, personal communication, January 2022). The following are additional strategies to address audience constraints and barriers to participation:

- People have busy schedules, so if the intended audience comprises low-income individuals working multiple jobs, events should be organized convenient times (J. Creighton, personal communication, January 2022; L. Grande, personal communication, January 2022). In addition, providing multiple meeting times during the week would accommodate more people's schedules. Furthermore, it may be feasible to hold a meeting in the evening if most of the audience consists of working individuals. However, if some people work in the evening or have multiple jobs, a weekend meeting may be more convenient. Forest workers, for instance, typically work six days a week, sometimes up to fourteen hours a day (between traveling to and from work and doing the actual work) (Sifuentez,

2016). For this reason, it is essential to plan workshops that fit their busy schedules, including scheduling multiple times for an event and at a convenient location (e.g., a central community center). Although forest workers may choose not to attend, it is still important to provide programs and events that take into consideration their needs as audience members and make the meeting as accessible and available as possible.

- Sometimes childcare could be provided during the meeting if the intended audience consists primarily of parents with young children, as it will increase the likelihood that the parents will attend the meeting without having to worry about finding childcare, which can be challenging and/or expensive.
- If some participants cannot attend in person, it may be possible to offer alternative opportunities to participate, such as telephone or web-based participation or the ability to download a recording after the meeting. As a result of these options, people who are busy or vulnerable are better able to access such events.

2.3 Resources and opportunities should be chosen to accommodate the constraints and needs of the audience (J. Creighton, personal communication, January 2022). Despite what researchers and communicators may assume to be an effective communication method, it may not be the approach that the intended audience deems to be most suitable for their given circumstance. For example, in the forest workers project, researchers may believe that holding an interactive workshop to teach a specific topic regarding professional development would be more beneficial to all parties involved. However, the forest workers may not have the time or energy to participate in a workshop. Instead, they might prefer a quick guide that outlines the information clearly and concisely to read it on their own time, thereby providing a more practical alternative that meets their needs while respecting their time constraints (Moseley, 2006). Accordingly, it is important that the researchers remain adaptable in their approaches, accept constructive criticism from the audiences and use a flexible approach to the design of materials (Jenkins et al., 2020; L. Grande, personal communication, January 2022).

Challenge 3: Accounting for varying levels of knowledge and abilities of audience members

Participants may exhibit differences in their understanding and abilities regarding different topic areas (Halbleib & Jepson, 2016). Some audience members may have decades of experience and a wealth of knowledge on a given topic, while others may be newly introduced to it. For instance, forestland owners may differ drastically in their experiences with hiring a forest restoration contractor, as well as their knowledge of what to look for and ask when hiring a contractor, such as contract pricing and the types of services provided (L. Grande, personal communication, January 2022). Some might be long-time forestland owners who have such experience and do not require an introduction to the process but would like to learn more about specific topics related to contracting practices, such as ethical labor practices and expanding their network with other experienced forest owners. Conversely, a teacher without prior experience in forestry or land management may just have inherited a small parcel of forest land from a family member and now must learn the basics to successfully hire a contractor for restoration work.

In this case, while both parties might participate in the same Extension-led program taught by the same Extension personnel, both are at substantially different places in their learning needs and interests. Thus, Extension personnel must be aware of such differences to deliver an effective and useful program (L. Grande, personal communication, January 2022). Understanding and accepting the differences in learning levels can lead to more effective and purposeful teaching, improved comprehension for long-term use and application, and increased engagement.

The following practices and strategies are designed to assist science communicators in achieving such a goal.

3.1 To ensure that the content is as accessible and inclusive as possible to a wide range of audiences, the material should use language kept at an 8th- to 10-grade level, which is the most comfortable level for general audiences (Jenkins et al., 2020). Nevertheless, the level should be adjusted to meet the learning needs of the specific audience (Jenkins et al., 2020). This includes avoiding technical jargon as much as possible and, if it is important to the integrity of the message, making sure terms are explained in an understandable manner to all audience members (Baram-Tsabari & Lewenstein, 2012). Furthermore, to assist in the accessibility and engagement of the learning material,

graphics and visuals should be incorporated as alternatives to text (Baram-Tsabari & Lewenstein, 2012).

3.2 When there are substantial differences in learning levels among participants in a workshop, participants can be encouraged to engage in peer-to-peer learning by partnering more knowledgeable and skilled participants with those newer to the subject matter. Along with providing additional opportunities for knowledge transfer, this also permits cross-group interaction and facilitates the expansion of social and professional networks among participants (J. Creighton, personal communication, January 2022; L. Grande, personal communication, January 2022). In the case of long-time forestland owners and new forestland owners, a long-time owner could provide mentorship, expertise, and guidance to a new forestland owner, or they could both learn something new from each other. This would offer new and long-time owners opportunities to collaborate and share knowledge and expertise while also creating a more inclusive and collaborative learning environment.

3.3 Events should include in hands-on and interactive activities. Even if adult learners appear hesitant at first to participate, Extension personnel can demonstrate the benefits of participating, emphasizing how they contribute to addressing their professional and practical needs. Furthermore, while more knowledgeable and experienced participants may already possess the skills taught in the activities, participation may still teach them something new or strengthen an old skill through additional practice (L. Grande, personal communication, January 2012).

Challenge 4: Increasing knowledge on how to create equitable and inclusive learning opportunities

Scientists are often influenced by the values and beliefs of the culture in which they are embedded (Penrose & Katz, 2010). Thus, many science communication principles and practices that scientists employ, as well as those used by Extension, are informed by dominant and homogeneous voices, chiefly white and educated scientists (Purrity et al., 2017). This limits the educational opportunities and products that are applicable to the needs and interests of marginalized and underrepresented communities, thereby further discouraging their engagement (Purrity et al., 2017; Kudo & Wood, 2020).

This exclusion may be attributable to a lack of acknowledgment by many scientists and science communicators of their positionality regarding power and privilege relative to the communities (Polk & Diver, 2020). Self-reflection can encourage scientists and science communicators to adopt inclusive practices and be more open to addressing equity concerns in their science communication to avoid the risks of controlling the narrative, ignoring marginalized voices, or assuming their perspective is the only legitimate one (Polk & Diver, 2020).

Applied Extension practices also have a history of not promoting equity and inclusivity in science communication. In fact, Extension personnel have previously reported that they do not feel adequately prepared to relate to and educate marginalized and underrepresented populations, especially regarding environmental issues (Wyman et al., 2011). Adding to these feelings of inadequacy, Extension personnel often encounter cultural differences and linguistic barriers when attempting to connect culturally sensitive and meaningfully with these communities (Wyman et al., 2011).

Latinx communities are an example of communities with which Extension personnel have had difficulty establishing successful relationships (K. Baylog, personal communication, January 2022). This population would benefit from Extension resources and education but has been overlooked due to systemic cultural and linguistic barriers. Even though Latinx communities are actively engaged in natural resource management activities, such as forest management, little attention is given to producing Extension materials designed specifically for them. As a result, Spanish-speaking communities do not participate in Extension activities or make use of Extension resources that are not geared toward their learning needs (Wyman et al., 2011). Even when Extension personnel produce what they believe to be practical resources specifically tailored to Spanish-speaking audiences, these resources have been criticized as insufficient or irrelevant (Wyman et al., 2011).

Thus, Extension personnel must remain aware of the cultural diversities within their community and be committed to delivering resources and opportunities that respectfully incorporate multiple worldviews and experiences into the learning strategies and practices (Baram-Tsabari & Lewenstein, 2012).

The following are strategies and approaches that encourage considering the needs and realities of traditionally marginalized communities when designing learning material.

4.1 Communicators can work effectively with participants who have difficulty with English and literacy by offering alternatives to literacy-based materials (e.g., videos, graphics, infographics, etc.). For instance, graphics or videos can be used to convey messages without making participants read, and infographics may be used to present statistics and data in an easy-to-understand format (Jenkins et al., 2020). Additionally, it is important to apply the same inclusive and visual strategies to outreach and training tools rather than relying on literacy-based material. This will allow a more diverse range of audiences to be reached, which will, in turn, encourage more individuals to participate and share their perspectives (Bush et al., 2014).

4.2 When interacting with participants who have difficulty communicating in English, it is important to address language barriers by offering supportive resources, such as arranging for a translator to be present at events or providing learning material in an alternative language (J. Creighton, personal communication, January 2022).

4.3 Cultural exchange can be promoted through activities such as discussions or exchange of food, cultural values, or other culturally relevant insights and experiences. Doing so may facilitate more equitable collaboration, as participants can gain an understanding of one another and each other's cultural and social experiences. This can be accomplished by facilitating excursions to meaningful locations (e.g., active work sites, community cultural centers, or other organizations with local experiential knowledge that can provided mentorship). Here learners are encouraged to observe how others experience life, as well as to discuss, evaluate, question, and critique the ways their ideas and values are exchanged and communicated across groups (Kudo & Wood, 2020). Furthermore, this approach can enable migrant community members not only to question and explore communities in a new way but to share their own knowledge and experiences via a variety of mediums (Kudo & Wood, 2020). Many forest workers have settled in their communities, where there are now numerous businesses and cultural and social organizations that provide services to them (Sarathy, 2006). Encouraging the other participants in the project to get involved by visiting and patronizing these centers can lead to a more meaningful and inclusive project and encourage them to connect over shared values and concerns. Doing so indicates that the other participants are interested in learning more about the forest workers as individuals with culturally relevant insights

and experiences. Furthermore, participating in such events as sharing food or attending cultural events contributes to creating relationships that transcend professional boundaries and may evolve into meaningful social connections (Kudo & Wood, 2020).

Challenge 5: Developing methods to sustain long-term results

In any science communication presentation, the communicator identifies the central message they hope to convey to the audience, along with the outcomes and impacts they intend to impart for future use of the information (J. Creighton, personal communication, January 2022). When a message is intended to be consistently delivered or to have lasting behavioral or environmental changes, those long-term impacts need to be apparent. In the case of the forest workers project, a long-term impact would be to increase forest workers' health, and therefore reinforcement and repetition of the knowledge acquired may be necessary.

Consequently, it is imperative to continually reevaluate the science communication approaches and methods being used, review and adjust predetermined goals and outcomes as necessary, and remain committed to anticipating and responding to changes to science communication strategies as they arise (Cooke et al., 2017).

Below are some recommendations for ensuring that outcomes are meaningful, effective, and sustainable.

5.1 It is essential to evaluate the relevance and societal impact of the learning approach employed when communicating (Cartwright et al., 2016). It is important to question what sorts of methods constitute effective communication to audiences, what requirements the audience needs to understand and apply the information delivered, or to what extent it is incumbent on the communicator to ensure the audience understands.

5.2 Requesting feedback should be a continual process, where audience members are asked where and how programs, resources, or learning materials can be improved to make them more effective and relevant to the community's needs and concerns (Brown et al., 2021). This can be achieved by employing either formal methods, such as surveys or interviews, or informal methods, like casual conversations over coffee or lunch. Offering opportunities for participants to share their opinions and insights can contribute to the ongoing quality and effectiveness of a program. For example, the promotora health education program has employed various evaluation methods to assess its effectiveness

and relevance, including focus groups, committee evaluation meetings, program debriefing sessions, and post-tests with participants after the training workshop (Wilmsen et al., 2015). Employing these evaluation tactics brought awareness to the program of the various workplace safety issues that workers encountered as well as their inexperience with labor laws.

Science Communication in the Context of the Forest Workers Project

The educational objective of the forest workers project is to create and implement educational programming and management strategies that will be used to address barriers to equitable employment for Latinx forest workers and businesses by collaborating with established educational programs and organizations to enhance and expand workers' skills and opportunities (Davis et al., 2021). If successful, the results of this project will be used to inform the development of practical educational material that aims to improve the knowledge and skills of landowners, Extension personnel, and forest workers to collectively create equitable employment and working environments.

The needs and interests of each population differ and will be met in various ways. Forestland owners who often require the service of a restoration contractor will likely have questions regarding how to identify a reputable contractor and how to hire one who adheres to ethical and equitable labor and employment practices. This project will develop a consulting guide with the intention of providing guidance to these forest landowners in their search for a reputable and ethical contractor, as well as to inform them of important questions to ask during the process.

In return, by learning about ways to more ethically engage with and hire these contractors, more forest owners may contribute to ensuring the ethical treatment of Latinx forest workers and supporting equitable labor practices, including fair wages, the right to safe working conditions, breaks or healthcare, and open lines of communication between employers and employees.

The needs and interests of Extension and its partnering organizations will be to gain insight into how to engage forest workers more effectively, establish a basis for future research and literature on this topic, and facilitate the development of knowledge to improve decision-making practices by people and organizations at every scale, from national forest policymakers to forest workers on the ground. Moreover, it is intended that Latinx forest workers will gain the opportunity to become more aware of their rights to fair and safe labor and working conditions,

as well as enhance their professional development, gain more access to equitable employment, and receive educational resources that are sensitive to their cultural and social needs.

The products generated from both this forest workers project and through my capstone project are intended to inform the above audiences and take the form of fact sheets that summarize findings, interactive workshops, briefings targeting a range of governmental agencies, and other interactive Extension products. These products, including educational materials and events, will draw upon many of the practices and strategies outlined in this paper and will be explained in the following section.

Extension activities

The forest workers project involves the development of several science communication products and events that will be produced incrementally throughout the project, including the following examples. First, short project updates are to be prepared twice annually to show that the project is meeting its intended goals and objectives. These updates will be created to keep the project participants accountable to the federal funders and the forest workers, who are the primary audience to be impacted by this project. The updates will be available in English and Spanish to reach more audiences, specifically the Latinx forest workers. Other education material will include information based on research findings and evaluations, presented in a bilingual "Seeing the Forest for the People" product series, and will be presented as fact sheets, an interactive infographic, and a short educational video. The fact sheet will be written in plain language and include research results and lessons learned from the education evaluation component. The interactive infographic will be presented in a "choose your own adventure" format to "creatively illustrate key decision points in forest policy and contracting processes as identified through research, and how different choices may affect outcomes for rural businesses and communities" (Davis et al., 2021, p. 16). Furthermore, a video will illustrate the paths and challenges Latinx workers and communities encounter in the new forest economy, thereby enabling the general public to become more aware of the experiences and realities of these forest workers.

Finally, the project will hold Extension led workshops where relevant research findings will be presented to project participants. The findings of the research will be summarized in a pilot infographic; workshops will test the utility of the infographic and obtain feedback on the

educational video from participants. A process of iterative evaluation will be beneficial to refining these two products, as feedback will be used to better meet the needs of the audience.

Working alongside established programs

A key element will be partnering with the promotora program (Bush et al., 2014). As discussed in part one of this capstone paper, the promotora program utilizes local, trusted community members (i.e., wives of forest workers) as the educators to inform forest workers of their workplace rights, improve their occupational safety, and provide opportunities to participate in career development training (Williams et al., 2010; Bush et al., 2014). These women are no strangers to hearing about the exploitative working conditions in the forests and labor issues their husbands experience and, thus, already have relevant personal and community knowledge, understand the cultural and social factors, and know how to navigate these issues in a culturally appropriate way, such as overcoming the English-Spanish language barrier that often exists amongst researchers and the forest workers (Bush et al., 2014).

As a community and science communication program, the promotoras have been trained to educate their community, which informed the development of previous educational products and materials, that would provide health and safety training, skill-building workshops, and informational sessions for the empowerment of forest workers and their families (Bush et al., 2014).

Throughout the process of conducting workshops and informational sessions, promotoras have undertaken an iterative process to assess how well the products communicated the information, followed by revising and simplifying the communicated information to better fit the needs of the audience. This has often meant meeting the participants where they were at in terms of knowledge level, literacy abilities, and basic needs. All in all, the promotoras have been successful in reaching many forest workers and have been met with much positive feedback, which has been valuable in helping to develop relevant resources and training that will be useful to their community. Additionally, these experiences have promoted more self-confidence and leadership skills for the promotoras.

Expanding this successful program's capacity and reach more forest workers is crucial, and it is the intention of the forest workers project to accomplish this goal. In partnering with Lomakatsi and promotoras, the researchers will act as facilitators of dialogue and provide

resources, collaborating in a two-way exchange of information, trusting the promotoras' thoughts and criticism of the program. In having the promotoras guide and inform the program, more innovative methods can be implemented, with the intention to improve their delivery of the material and better address inequity, specifically with a focus on fostering career advancement and entrepreneurship. It is the intention that by expanding and enhancing the program, the lessons learned will be documented and used to inform how the program can be expanded beyond the state of Oregon. In this way, other states with a high concentration of Latinx forest workers and businesses will also benefit and address the inequity and injustice that exists in the labor-intensive forest industry in their state.

Introduction to Section Three: Process and Reflection of the Capstone Project

During this Master of Forestry capstone project, several science communication products were developed to further meet the forest workers project objectives and incorporate principles detailed in this paper. Each product was developed with an intended audience, which entailed writing for different levels of language proficiency, presenting information in different formats to ensure that the audience would be able to effectively utilize it, fulfilling relevant needs and concerns, and delivering the information as objective and fact-based. Each of these products required different approaches and processes, which are discussed below.

The first product was an annotated bibliography, which synthesized all academic and practitioner literature focused on the United States' labor-intensive forest industry. This product was written for an academic audience, specifically the principal researchers on the forest workers project. The document was organized and structured to be clear, concise, and easy to navigate. The needs of the researchers were to have a document that compiled and summarized all of the relevant literature to inform and facilitate the development of an academic paper, produce a consulting guide, and offer insight into the direction of future research.

The academic paper, more accurately called a "perspectives paper," is to be submitted to the journal *Society and Natural Resources*. The purpose of this paper is to provide an overview of the current and future directions of research on the labor-intensive forest industry, based on the current state of knowledge as informed by the annotated bibliography. This paper aims to appeal

to a scholarly audience, and thus the language is more complex and formal to suit the expected tone of this type of paper. The paper also serves the needs of the audience as it lays out the direction for future research and literature on this topic so as to facilitate greater discussion on how to improve future policies related to labor laws and practices, increase social awareness of the issue, and foster greater equity within the industry.

Finally, the consulting guide (in development) aims to provide guidance to forest landowners through the process of hiring restoration contractors and emphasize the importance of selecting contractors who are ethical, qualified, fair, and transparent. Considering that this process can be challenging to navigate, the guide will provide landowners with questions they should ask, concerns they should consider, and potential issues they should be aware of and be prepared to address. Keeping in mind that this is intended for a non-academic audience, the language is kept simple and straightforward, as appropriate for the structure of a brief consulting guide. The guide also provides links to external sources, including federal and state labor sites, which provide information about the laws that contractors must follow, as well as the site where contractors should be reported if they violate federal labor laws.

Considering that each of these science communication materials is published at a single point in time, they do not require a reiterative evaluation process. Nevertheless, since they will inform future action and guide specific processes, they are well suited to be evaluated for actual impact and ability to achieve the intended goals and outcomes.

In this section of my capstone paper, I will discuss the methods and processes I used to develop the annotated bibliography, including the steps I took to compile relevant articles by determining which aligned with predefined criteria. Following this, I will explain how the annotated bibliography informed the development of the perspectives paper and the consulting guide, which I developed in collaboration with Dr. Emily Jane Davis and Dr. Carl Wilmsen.

Lastly, I will describe my experience participating in an Extension-supported research project, as well as other Extension-related experiences that helped familiarize me with what a career in Extension, or community development and education, could entail. I will also discuss how these opportunities have helped me develop a clearer idea of what exactly my future career will look like, as well as how such experiences will benefit me in the future in terms of both practical and communication skills. And while there are several matters that I think I would have done differently with regard to my experience participating in this project, I feel that it provided

me with valuable opportunities to enhance my writing and analytical skills, as well an awareness of the lack of equity and inclusion that is pervasive in the labor-intensive forest industry; I intend to continue speaking out about this issue into the future.

Process of annotated bibliography

The purpose of the annotated bibliography was to compile, review, and summarize published scientific and practitioner literature regarding the labor-intensive forest workforce. By applying a three-stage process, literature was found and identified following predetermined criteria, and each stage informed the method of the following stage. As I reviewed each piece of literature, I generated a corresponding annotated bibliography entry that covered five primary areas: identifying which fields of research the piece orients itself within; the purpose and research question(s)/hypotheses; methods used; relevant findings; and implications and conclusions. Each stage was meticulously tracked, organized, and documented to assist in efficient literature analysis and facilitate transparency and replicability. The final annotated bibliography includes 28 pieces of scientific and practitioner literature, all of which meet the criteria described below.

Topical Focus and Research Parameters:

The annotated bibliography examined the labor-intensive forest workforce in the United States that performs activities related to forest restoration and hazardous fuel reduction. The publications that met these criteria could have been from any period of time but ultimately resulted in a period spanning 2001-2021, with the majority of the literature originating during the mid to late 2000s. I was not required to focus exclusively on the literature pertaining to Latinx forest workers. Nevertheless, the majority of articles included focused on this population, demonstrating the dependence on and dominance of Latinx workers in the restoration industry.

Stages of Research

The annotated bibliography was completed in three stages, where all steps were documented and tracked in a single Excel document; an overview of the rounds is shown in **Figure 1.1** (see appendix A). Each stage had its own Excel sheet, which detailed each article's title, author(s), citation, year, and author-provided keywords (if applicable). Each stage gathered relevant citations as follows:

- Stage 1: Relevant citations found in the project proposal
- Stage 2: Citation of the stage 1 document(s) that cited the piece.
- Stage 3: Search engine used to locate the article; search string (for Google Scholar); and similarity rating (for Connected Papers).

Stage 1: I began by reviewing the project's proposal submission to the USDA AFRI, titled "Advancing Rural Prosperity and Equity Through the New Forest Economy." I scanned through the literature cited in this document and selected those that appeared to meet the topical and geographical criteria. In addition, to determine whether the articles were relevant, I reviewed each one individually, reading the abstract and sometimes skimming the body of the work to determine if it met the criteria. Overall, 11 pieces met the criteria and were selected for inclusion in the annotated bibliography.

Stage 2: For stage two, I began by searching each article identified in stage one in Google Scholar, then made a list of all the articles that had cited it, and finally selected those that satisfied my criteria. For example, in Stage 1, I identified the article titled "System failure: work organization and injury outcomes among Latinx forest workers" (2019). When I searched this article in Google Scholar, I saw that seven articles had cited it, and one of those fit my criteria: "Occupational Hazards and Health and Safety Risks for Latinx Tree Trimmers in the Pine Forest Industry" (2020). Accordingly, after searching each of the 11 articles from Stage 1 and listing all relevant citations in the Excel spreadsheet, the total was 157 citations from which to select. In reviewing each citation, I categorized and used a color-coding system to track which articles did or did not meet the criteria and then recorded the number of articles that did or did not meet the criteria. In total, seven new articles met the criteria for inclusion in the annotated bibliography.

Stage 3: As a final step, I conducted additional research using the search engines Google Scholar and Connected Papers. Results were tracked on additional Excel pages, where specific terms and combinations and connected articles were recorded. To facilitate understanding of this step, **Figure 1.2** (see appendix B) shows the step-by-step process used to identify and select articles that met my criteria. Step one of **Figure 1.2** shows my process of finding articles using each search engine:

- As described above, I used Google Scholar (Step 1, Orange box) to search for specific terms and combinations of terms, and then I screened the first five pages of results for articles that seemed to meet the criteria. The terms and combinations I searched are as

follows: [occupational health AND safety AND forestry AND migrant]; [Latinx AND forest management]; [migrant labor AND forestry workforce]; [undocumented forest worker AND national forests]. In total, eight new pieces appeared to fit the criteria and were selected to be reviewed in subsequent steps.

- Connected Papers is a visual tool that assists researchers in finding and exploring academic pieces related to a chosen paper. Using a selected piece of literature as a basis for the search, the tool creates a web of related articles, where each article is rated on a scale of 0-100 based on its similarities to the source paper. To determine whether any articles met the criteria, I entered each article from Stages 1 and 2 and screened each result. Articles meeting the criteria were then recorded on the Excel sheet, and their similarity to the source was documented. In total, five new papers appeared to fit the criteria and were selected to be reviewed.

After locating articles in step one that appeared to meet the criteria, I conducted a preliminary review of the abstracts (step 2). This enabled me to determine whether the article should be excluded or sent on to the next step. The articles that met the criteria in step 2 were subsequently reviewed by reading them in full (step 3), after which I determined whether they met the criteria or not. As a result, eight articles were chosen to be included in the annotated bibliography; five articles were excluded. Overall, for the entirety of the annotated bibliography, 28 pieces met the criteria and were selected for inclusion in the annotated bibliography.

Literature Analysis

To make for an easy and streamlined review of all the collected literature, I created an additional Excel page to review and analyze the assembled papers, including listing identification of connections, themes, and trends, as well as a visual tool for analysis. Each piece of literature listed included its title, author(s), year, author-provided keywords (if available), and citation. Additional information recorded included: Research questions/hypothesis, location where the research took place, study subjects, types of workers studied (e.g., H-2B, Pineros), limitations and biases, next steps or future research questions, where and how data were collected, the field of research the piece orients itself within, and key themes. I used a color-coding system for different reoccurring trends in several categories for ease of organization and

analysis. This analysis provided substantial information on which to base the next steps and deliverables of the capstone project: the annotated bibliography, perspective paper, and consulting guide.

Process of Additional Deliverables

Perspective paper

The third component of my capstone project is to contribute to the publication of a perspectives paper to be submitted to *Society and Natural Resources*, which will discuss the current state of the literature on the labor-intensive forest industry and the direction that research should take in the future. As per the guidelines provided *by Society and Natural Resources*, a perspective paper should include "an overview of the current state and future directions related to the paper's topic, the perspective the author is advancing, and accurate presentation of the state of knowledge" (*Society and Natural Resources*, N.D.). The required elements will be informed in part by my annotated bibliography, which will provide information concerning the current state of the topic and provide a more accurate picture of the current situation.

This paper will be developed through the collaboration of myself, Dr. Emily Jane Davis, and Dr. Carl Wilmsen. Through this collaboration, we have discussed and outlined how this paper will address the required elements and what we believe to be important issues to address in future research on the topic. Dr. Davis will take the lead role of author to develop this paper, write the main body, and organize its structure. After completing the paper, Dr. Wilmsen and I will provide constructive feedback, which includes suggestions for additional topics and factors to consider, as well as editing recommendations.

Though uncomplete at the time of submitting this capstone, upon completion of the final revision, the perspectives paper will be submitted to *Society and Natural Resources* for peer review; if accepted, it will be published and made available on the journal's website.

Consulting Guide: Choosing a Forestry Service Contractor-Practical, Ethical, and Environmental Considerations

The final component of my capstone project was to contribute to a consulting guide to assist forest owners and managers when hiring a forestry service contractor to conduct restoration work on their land. The guide was developed through the collaboration of myself, Dr. Davis, and Dr.

Wilmsen. We discussed and outlined the main purpose of the guide, its intended impact, and practical application for users, as well as what themes, questions, and concerns are crucial to address when selecting a forestry service contractor.

Dr. Wilmsen took the lead role of author in developing the guide, outlining the foundational topics and questions to consider when hiring a forestry service provider, along with appropriate answers. After, Dr. Davis and I provided constructive feedback, which included suggestions for additional questions and concerns to be addressed in the guide. I then prepared a brief write-up to be added to the guide that addressed the ethical and general issues to consider when selecting a contractor. Among these considerations are exploitation practices, treatment of migrant workers, and recognizing the potential consequences of accepting a low-bid offer.

On completion of the final revisions, the consulting guide was sent to Extension for peer review, after which it will be published on the Extension website and made publicly available.

Reflection on My Capstone Experience

This capstone project gave me an opportunity to explore what a career in Extension may look like, as well as observe how science communication and community development are applied to community events and used on a day-to-day basis. These experiences have provided me with the opportunity to establish connections with many Extension professionals, take part in Extension-led programs, gain valuable insights into how Extension operates, and develop valuable professional skills and perspectives that can be applied to my future career.

Prior to this project, I was unsure about the direction my career might take as well as the types of careers that might interest me. Generally, I knew it would involve natural resources and that I would work with people in some capacity. Still, I didn't have a clear idea of what a desirable job would look like, just that I knew that a career solely focused on scientific research was not in the cards for me. Truth be told, it was this confusion that prompted my decision to switch from a Master of Science to a Master of Forestry, which proved to be the right choice. As a result of this transition, I was exposed to Extension and this project, and had the opportunity to become involved in numerous opportunities that were made available to me because of this transition. Based on these experiences, I realized that I needed a career in natural resources that would enable me to play an active role in community development and resilience-building on the basis of community education and empowerment. I am much more confident and optimistic

about my future now that I have a much better sense of the direction in which my career will take me.

One of the most rewarding experiences I have had with Extension was conducting informational interviews with several Extension professionals specializing in areas that I am interested in pursuing, either within or outside of Extension. These individuals discussed their experiences with Extension, described best Extension practices, and highlighted the skills and qualities crucial to success in a career that involves community engagement and collaborative work in natural resources. In fact, these interviews contributed to significant sections of my capstone, particularly in Part 2, when I discussed the challenges common to Extension and the most effective approaches for addressing them and achieving successful science communication.

An aspect of my project that was particularly significant for me was the opportunity to become familiar with the labor-intensive forest industry and the treatment of migrant Latinx forest workers. Prior to this project, I knew next to nothing about this workforce and its challenges, which illustrates why this problem is so pervasive; the lack of widespread awareness. As an invisible group, these workers receive virtually no support and are systematically denied access to equitable and safe working conditions and opportunities to advance their careers. It was very eye-opening to read the literature, and it really highlighted the privilege I take for granted as a white female from a middle-class background.

This is a particularly exciting project in that it aims to address the lack of equity and prosperity in the labor-intensive forest industry, especially given that Extension has traditionally provided resources and opportunities for predominantly white audiences. My informational interviews with Extension personnel shared that working with marginalized communities is challenging because there is a lack of visibility, trust, and understanding of how to provide resources and opportunities to meet the needs and interests of these communities. Since this Extension project is a large project with an overarching goal of producing meaningful benefits and progress directed toward marginalized and underrepresented communities, it appears that Extension is taking measures to address the issues of diversity, inclusion, and access.

Upon reflection, there are several things I wish I had done differently during this project or that I had had the opportunity to participate in if given a chance. For example, there was the possibility for me to take part in interviews with relevant stakeholders involved in this project, including contractors and government agencies. Despite not being able to partake in this

opportunity due to logistics and timing, I feel that I could benefit a great deal from this experience, in addition to being able to engage in some hands-on qualitative research. Also, it would have been interesting and valuable to have started working on this project sooner, to be able to contribute to its development and even to write the grant proposal earlier in the process. Although I am not certain that this would have been practical or even permissible, it would have been interesting to at least observe the process of developing such a large-scale project. In addition, it would have presented me with the opportunity to become more familiar with the grant writing and application process, which is a valuable skill to possess for future employment opportunities.

Overall, I believe that my capstone project experience has been extremely eye-opening and rewarding. While I wish I had more hands-on experience and not so much time spent working with established research, I still feel that this project helped me develop skills that I can apply to my future career, as well as some much-needed professional and personal direction, which I was formerly lacking. Furthermore, I was quite pleased I was capable of writing a paper of this length and depth and that I was able to develop coherent sections and a coherent flow of content. This is the first time I have written a paper of this size, and it is quite empowering to know that I am capable of accomplishing something of this magnitude and have the determination to hold myself accountable for accomplishing it. In a way, I became an expert in this rather limited field of natural resource management and research, which is, in reality, an extremely prominent issue within natural resource management. Though I am not sure exactly what my future career path will be, I hope to use the skills and knowledge I acquired in some capacity and continue to advocate for Latinx forest workers in the labor-intensive forest industry.

Conclusion

As complex and dynamic challenges emerge, they will need to be addressed by engaging the full spectrum of knowledge sources, diverse experiences, and perspectives to promote an equitable and inclusive future. A transdisciplinary research approach provides a viable strategy for addressing these dynamic challenges by extending the traditional understanding of disciplinary boundaries and integrating scientific and non-scientific knowledge. By applying newly generated information and knowledge, audiences and communities will be better equipped

to overcome complex challenges and facilitate greater community development. As an instrumental component of transdisciplinarity and TDR, science communication offers the opportunity to further engage with communities on multiple fronts, including providing information, materials, and resources tailored to the audience's specific needs, concerns, and interests.

This capstone project has demonstrated a practical application of transdisciplinarity and the TDR process and science communication on a dynamic challenge that impacts a marginalized and underrepresented group through equity-centered and collaborative research approaches. This paper aims to provide a deeper understanding of how unethical and exploitative labor practices adversely affect Latinx migrant forest workers in the Oregon labor-intensive forest industry. This challenge was studied by taking a systematic examination of the broader contextual background to gain a comprehensive understanding of it, as well as considering how this challenge has contributed to a range of societal, health, economic, and environmental issues. It is also examined how Latinx workers have become so dominant in this industry and how their exploitation has been exacerbated by unethical forest restoration practices that have become so prevalent amongst forest restoration contractors (Kalmar & Stenfert, 2020). Together with several forest worker advocacy organizations and other universities, Oregon State University Extension is seeking to address this challenge through transdisciplinarity by employing a TDR approach and the use of science communication principles. The goal of their project is to create a more equitable and prosperous forest labor workforce so that Latinx forest workers may achieve a more sustainable and prosperous life, which includes safe jobs, enough housing, and health care, as well as personal empowerment. Additionally, this capstone project has provided me with a chance to contribute to this larger effort through the development of an annotated bibliography, a consulting guide, and the publication of a perspective paper, all of which have provided me with a chance to practice developing different forms of science communication.

Former research and interactions with forest workers have identified issues relating to inequitable and exploitative working conditions. However, there exist some societal concerns, such as immigration, that deter Latinx populations from taking action against these issues. As previously noted, one of the reasons for this is the fear Latinx forest workers have of government officials, who they believe will report them as undocumented and subject them to deportation (Ballard & Sarathy, 2008). Therefore, conducting transdisciplinary research, a process requiring

extensive collaboration, can be challenging when working with these workers, as these individuals are often a "hidden" population due to mutually reinforcing factors of social marginalization and fear of retribution (Heckathorn, 2002; Romero & Umaña-Taylor, 2018).

The critical importance of social engagement and collaboration needs to be recognized to foster sustainable, meaningful change that influences decision-makers to enact policies aimed at improving working conditions for migrant workers as well as enhancing the quality of life in local communities. Nevertheless, the disadvantages associated with race, status, and social visibility have been significant barriers to the development of transformative change and collaborative action.

As the Latinx forest workers' population continues to grow, so do the needs of their community. As such, further research is crucial in order to continue the work of established programs, such as the promotoras and career training programs. How can Latinx forest workers in Oregon expand their capacity and capability to take action against barriers that prevent them from accessing a more equitable and prosperous forest labor workforce and community? Taking part in research that focuses on implementing collaborative and equity-oriented practices and that produces educational and skill-building opportunities is sure to prove to be a valuable resource to increase workers' ability to obtain equitable working conditions, foster personal empowerment, and promote public and policymakers' awareness of how land-use decisions and policies impact equity outcomes for workers.

Appendix A: Note of Importance: Indigenous People and Extension

Transdisciplinary research emphasizes the importance of researchers reflecting on their role and place in power dynamics and the ways in which the institution they represent perpetuates the disenfranchisement of marginalized groups, specifically Indigenous People (Baumber 2021). Therefore, it is important to acknowledge that the emergence of land grant Extension programs owes its origins to the dispossession of Indigenous people from their native homelands (Lee & Ahtone, 2020).

Land grant universities, sometimes referred to as land-grab universities, were established under the 1862 Morrill Act. Under this legislation, the federal government distributed 10.7 million acres of land to the universities representing each state's land-grant university, for the express purpose that the universities would sell the land to fund the establishment of their Extension programs. However, the land the U.S. government had acquired for the land-grant universities was often taken by force and violently seized from Native Americans or under coercive means. The resulting effects impacted over 245 tribal nations across the USA; over 160 of these nations were subjected to "violence-backed land cessions" and were driven out of their ancestral homelands under the guise of academic research and scientific advancement (Lee & Ahtone, 2020).

The U.S. government paid less than $400,000 to all tribal nations throughout the United States, and many nations received no payment. As a result of the sale of lands to fund Extension programs, universities raised almost 23 million dollars collectively, a return greater than 57 times what Native Nations had been paid. Oregon State University (OSU), the university where this Extension research project is housed, was granted 91,629 acres of appropriated Indigenous land by the U.S. government. In turn, OSU generated a revenue of $208,112 from this land (Lee & Ahtone, 2020). OSU's Extension programs have benefited from and continue to benefit from land that encompasses the ancestral homelands of more than seven tribal nations and stretches across the entirety of Oregon. These tribal nations include the Calapooia (whose land Oregon State University is located), the Klamath Tribes, the Confederated Bands of Willamette Valley, the Coast Tribes of Oregon, and the Shoshoni (Western bands). Furthermore, many other Oregon tribal nations were displaced from their homelands to benefit other land grant universities throughout the United States. Therefore, land grant universities have historically and

continuously benefited and profited from the forced displacement and removal of Indigenous populations from their ancestral homelands.

Acknowledging the atrocities committed against tribal nations that stripped them of their ancestral homelands does not attempt to make excuses for the history that Extension was founded upon. Rather it is an essential issue to address when discussing the purpose and use of Extension programs and land-grant universities. Reflecting on our roles and how we benefit from stolen land as both researchers and privileged individuals is critical to ensuring we do not center ourselves in this process, do not promote Western ideas as the only legitimate way of living, and do not attempt to justify the violent history on which our nation was founded.

It should be noted that there are real movements and actions taking place to address Extension's history of mistreatment against Indigenous nations and remedy their injustices. In many Extension programs, there has been a greater emphasis on developing collaborative relationships with Tribal Nations, such as supporting the tribe in preserving and sharing traditional ways of understanding ecological systems. Some have worked to support the enhancement of local Indigenous nations' food production and marketing practices. And among others, they have created outreach programs for pre-college Indigenous youth aimed at increasing their access to and understanding of the process of pursuing a college education. This is particularly relevant in Oregon, where the number of students who identify as American Indian at Oregon State University is less than 0.5% of the total student population (OSU Extension, 2020). These are but a few of the actions that are being taken, and it is imperative that we continue to take action to right these wrongs, as well as to continue recognizing and taking responsibility for the ways we profit and benefit from stolen Indigenous land. Among other actions that can be taken include educating yourself as to whose land you occupy and from which you benefit, advocating for and supporting the land back movement - which is trying to facilitate the return of land back to the hands of Indigenous nations- - and supporting policies that support Indigenous nations through financial and legal means, including paying reparations for the violence that has occurred and continues to occur against the Indigenous peoples of the United States.

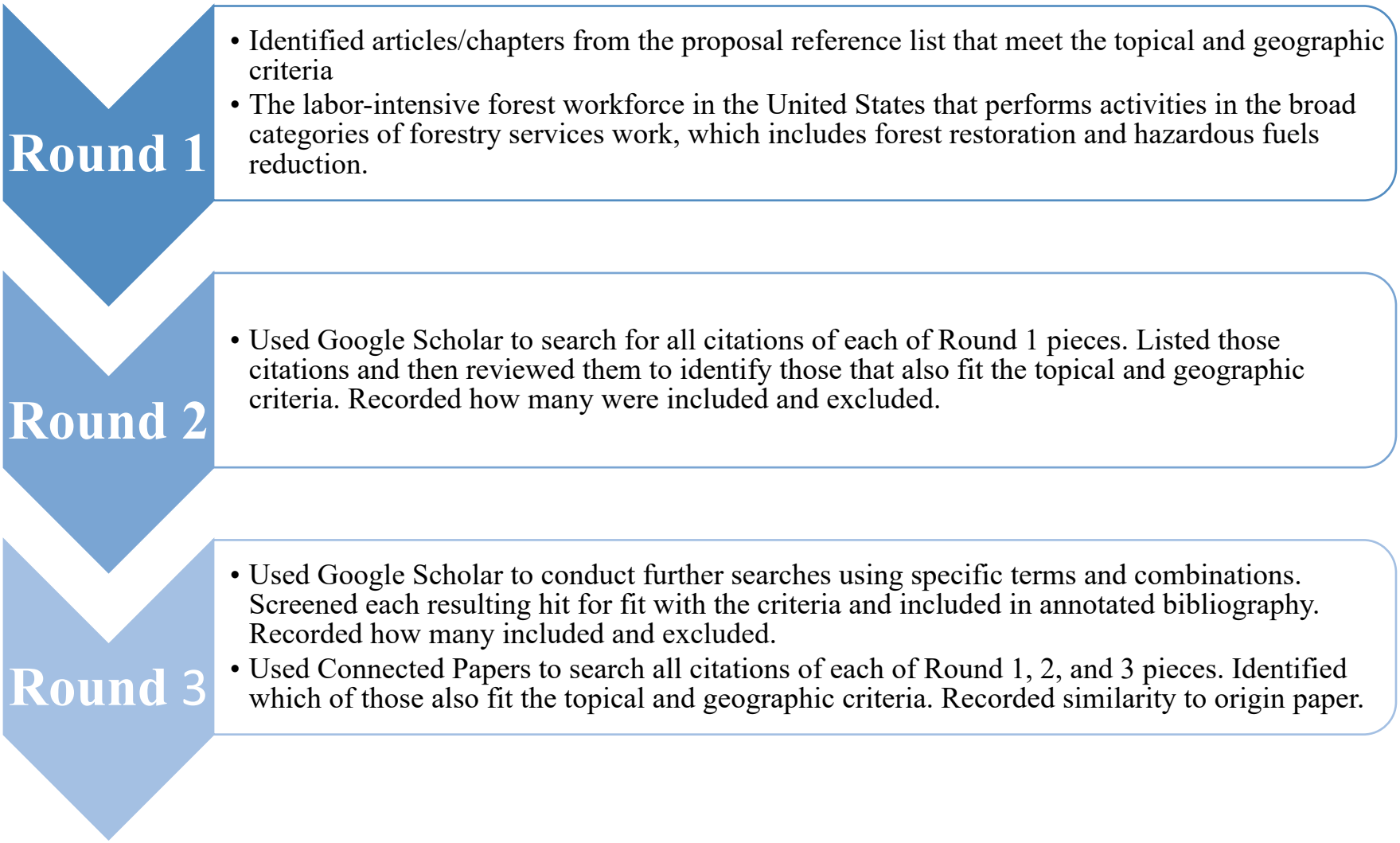

Fig.1.1: Overview of rounds of the systematic literature review

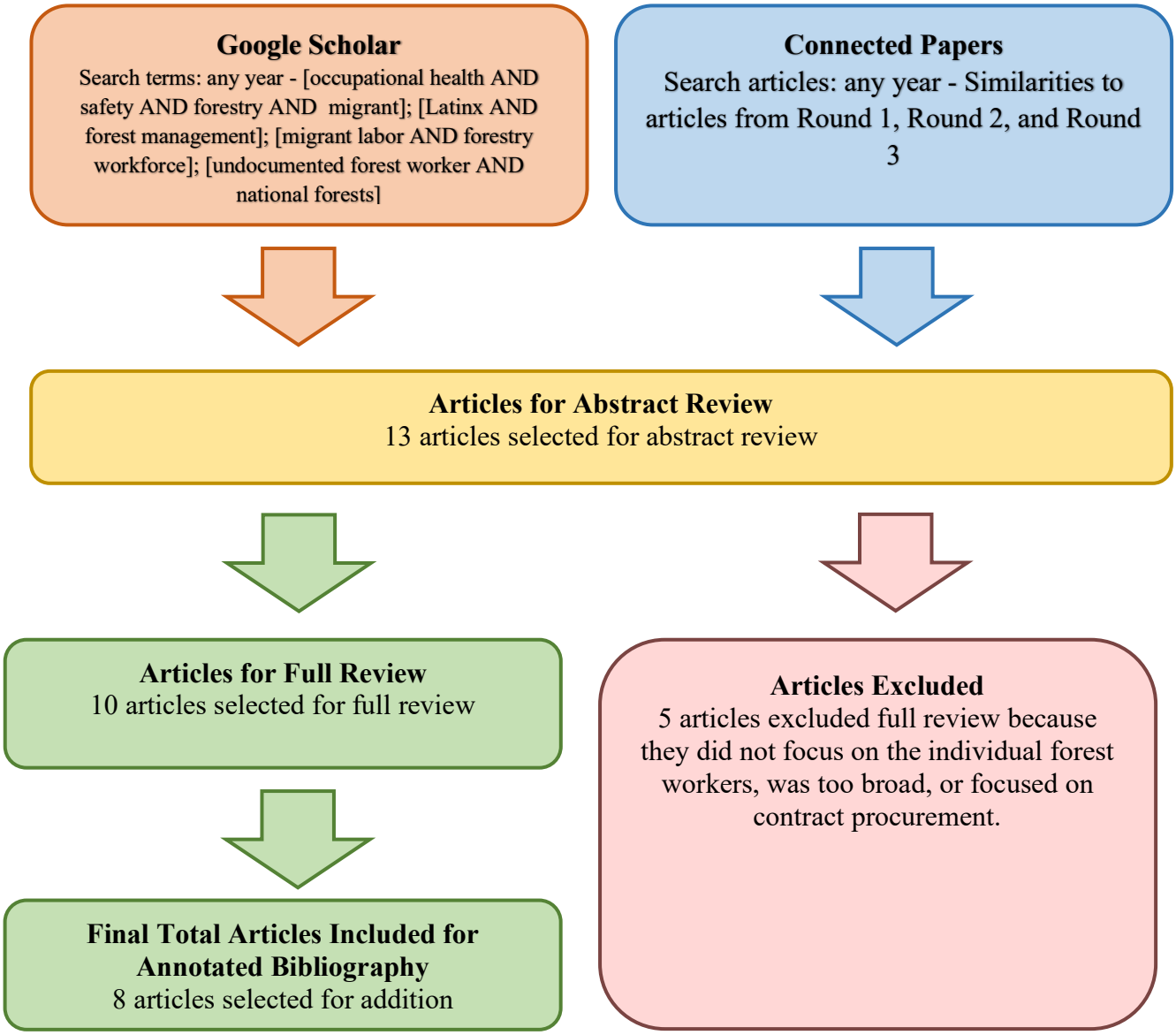

Fig.1.2: Process of the 3rd round of literature review

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