How extension enhances the knowledge and practice of innovative silviculture in British Columbia, Canada

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Abstract

The pressures facing natural resource sectors have grown in recent decades, especially as they intersect with Indigenous Rights and Title, environmental sustainability, and economic interests. In British Columbia (BC), Canada, forest management and forestry practices have come under significant scrutiny, largely sparked by the public opposition to the harvesting of old-growth forests, increasing severity of wildfires, economic declines in the forest industry, and the impacts of a changing climate. As the pace and scale of these challenges grow, the forest sector must be equipped to innovate and adapt. Here, we contribute our understanding of "how to do extension" in the forest sector and, building on an historical perspective of extension in BC and beyond, offer recommendations for how extension can support innovative silviculture in BC. Extension is a knowledge process that is practiced in five different forms: one-way knowledge sharing, two-way knowledge exchange, participatory exchange, co-produced knowledge generation, and anticipatory knowledge generation. The outcomes of extension include empowering individuals, organizations, and communities to collaborate and connect knowledge and practice to address complex forest-based challenges. Extension in innovative silviculture, and forestry in general, ensures that disconnected knowledge and scientific systems are bridged, providing pathways to help ensure applied research projects fill knowledge gaps for practitioners, and that forest planning and operations meaningfully identify and manage for multiple values.

Key words: extension, forestry, innovation, silviculture, British Columbia, knowledge

1. Introduction

As the pace and scale of economic, environmental, and social challenges grow, the forest sector must be equipped to innovate and adapt. Extension is a process that empowers individuals, organizations, and communities to connect knowledge and practice to address complex forest-based challenges through innovation. The forest sector has a long history of innovation, but in recent decades has evolved to incorporate a wider diversity of interests, including researchers and practitioners with broad training and expertise, and Indigenous and local communities (Weiss et al. 2020).

In the province of British Columbia (BC), Canada, extension is a critical need across many sectors, particularly natural resource sectors tasked with managing systems or processes, such as wildfire, ecosystems, wildlife, water, agriculture, and forest resources. Pressures facing natural resource sectors have grown in recent decades, especially as they intersect with Indigenous Rights and Title, environmental sustainability, and economic interests. In response to these pressures there is an urgent need to meaningfully connect those tasked with managing resources within these sectors with knowledge to address new and emerging realities.

Forest management and forestry practices have come under significant scrutiny in BC, largely sparked by the public

opposition to the harvesting of old-growth forests, increasing severity of wildfires, economic declines in the forest industry, ongoing assertions of Indigenous sovereignty, and the current and future impacts of a changing climate (Hagerman et al. 2010; Sutherland et al. 2023). In addition, recent legislative changes to the *Forest and Range Practices Act* have focused on the importance of Indigenous and provincial co-governance of forests, as well as the need to diversify the range of values for which forests are managed and creating clear outcomes through Forest Landscape Planning processes (Government of British Columbia 2025).

Considering these changes, forest managers, practitioners, and researchers have been asked to engage in extension that will support a new forestry model that emphasizes partnerships with First Nations, collaboration with forest licensees, and is focused on innovation and adaptive management. Unfortunately, extension is often a "side of the desk" task that includes invisible labor that is not always supported, such as few training opportunities on how to develop, synthesize, or share information in digestible formats that reach multiple audiences (Hoffman et al. 2024; Cvitanovic et al. 2025).

In this perspective, we contribute our understanding of "how to do extension" in the forest sector, providing a summary of the history of extension globally and in BC (including

Fig. 1. Description of the five forms of extension (or knowledge exchange systems) described in this perspective. The five forms of extension include one-way, two-way, participatory, co-produced, and anticipatory. These have evolved through time with greater emphasis on participatory exchange rather than dissemination or one-way knowledge delivery. New forms of extension focus on user feedback, empowerment, and network decision-making. Graphic by Laura Stanton.
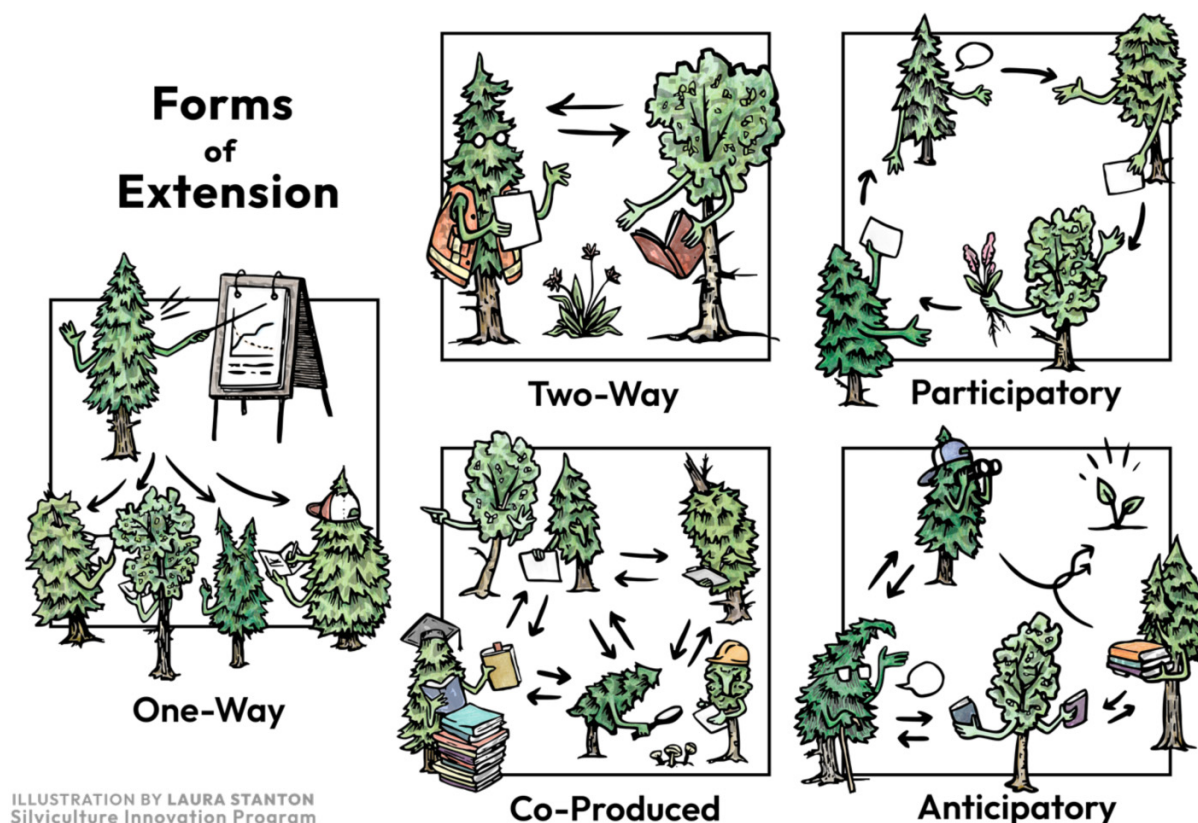
reflecting on the anti-Indigenous origins of extension), and offer recommendations for how extension can support innovative silviculture in BC. Our objectives are to highlight the needed inputs and the potential outputs and outcomes of extension, following a foundational logic model of extension (Workman and Scheer 2012; University of Wisconsin Extension 2025). Extension inputs include the capacities needed to undertake extension, such as staff with specific skills and training, dedicated time, funding, and partnerships. Extension outputs include activities (such as workshops, product development, and/or trainings) and participants (who are involved in activities), with a focus on accessibility and diversity of materials that support information sharing, learning, and decision-making for forest practitioners. Extension outcomes focus on short-term participant learnings, medium-term participant actions, and long-term changes to societal conditions, which requires engaging more effectively across the forest sector and broader public.

2. What is extension?

Effective extension connects the producers of knowledge with the users of knowledge to ensure outputs and outcomes are useful and impactful, such as informing the implementation of decisions and supporting policy and practice stan-

dards and/or changes (Grimm et al. 2022; Hoffman et al. 2024). Knowledge can take a variety of forms or blend different forms together, including place-based, practitioner, Indigenous, and scientific (Roux et al. 2006), gathered through observation, monitoring, and research. Explicit knowledge is often codified into tools that can support decision-making, such as processes (e.g., workshops) or products (e.g., accessible research summaries), whereas tacit knowledge is more place-based and experiential and may be oral, story-based, or anecdotal (e.g., Indigenous oral stories, practitioner observations) (Roux et al. 2006; McFayden et al. 2023). Recognizing the importance of these different forms of knowledge, extension supports active engagement with diverse communities in knowledge creation and all levels of government (Indigenous and municipal, provincial, federal) to identify opportunities and synergies (Fig. 1). Effective extension is guided by an appropriate understanding of the target audiences' and knowledge holders' needs, typically identified through formal needs assessments (Etling 1995; Caravella 2006).

Extension is a knowledge process. Rather than viewing knowledge as discrete, extractable information, extension considers knowledge as a dynamic, context specific process that emerges based on social–cultural interactions (Cote and Nightingale 2012; Turnhout 2018). Knowledge, and its uses, is thus inherently deliberate and depends on who developed

Table 1. Five forms of extension and example outputs and outcomes in the context of innovative silviculture.

Form of extension	Brief description	Example outputs	Example outcomes
One-way	Producer shares information	Technical extension notes of existing research	Raise practitioner awareness of existing research
Two-way	Vertical or lateral knowledge exchange	Workshop with researchers and practitioners	Raise researcher and practitioner awareness of existing knowledge
Participatory	Users involved in supporting knowledge production	Tailored, place-based knowledge and practice needs assessments	Advisory body; mutual trust and respect for different types of knowledge
Co-produced	Knowledges evolve together; communities of practice empowered	Place-based tools	Empowered and networked communities of practice
Anticipatory	Reflexive, long-term knowledge co-production process	Decision-support tools that include a range of future imagined scenarios	Sustainable process for co-produced knowledge and practice

Note: Five forms of extension are based on typologies by Bamzai-Dodson et al. (2021) and Westwood et al. (2021). See Fig. 1 for a graphical representation of the five discussed forms of extension.

it, who is using it, and for what purposes. Recognizing knowledge as a process can help address existing power imbalances in the application of knowledge, such as when Indigenous or local knowledge is less respected than academic knowledge (Bohensky and Maru 2011). A foundational principle of extension is spanning physical, cognitive, and social boundaries that may limit two-way knowledge creation and mobilization (Hoffman et al. 2024). Extension actively reframes, translates, and mobilizes knowledge rather than focusing solely on one-way knowledge sharing (Roux et al. 2006) but uses appropriate strategies depending on the context (Black 2000; Bamzai-Dodson et al. 2021; Westwood et al. 2021). Connecting knowledge to practice across different experiences and audiences is a core strength of extension, both in terms of outcomes and outputs.

Extension combines the understanding of knowledge as a process with the goals of knowledge exchange (KE) and communication. KE tends to be situated in research-based or academic contexts (Mitton et al. 2007; McFayden et al. 2023) whereas communication can be more operational or commercial, although it is also a growing part of more academically focused SciComm (Science Communication; Burns et al. 2003). Both are practice-based, meaning they are actively and intentionally undertaken (Craig 2006) and as such, must be undertaken by individuals with specific tailored skills and expertise. In KE, these skills include building relationships and trust to foster collaborative exchange pathways (Coleman and Stern 2018; Cvitanovic et al. 2021). In communication, these skills include translating knowledge and developing appropriate outputs based on the target audience and intended uses (Burns et al. 2003; Samuels et al. 2006). Extension specialists utilize these skills, as well as subject matter expertise and needs assessments, to foster processes for knowledge co-creation, such as collaborative research, as well as mutually beneficial knowledge-based outputs and outcomes.

Many of the principles of extension are already embedded within the practice of forestry, especially for forest practitioners and researchers. Forest practitioners are often called upon to understand and integrate public and community values into decision-making and researchers are evolving research programs as needs change. In the wake of rapidly changing societal, legislative, environmental, and climatic conditions,

foresters in BC have further been asked to diversify the range of values for which forests are managed and increase the range of forest practices applied to the landscape through "innovative silviculture". Innovative silviculture systems are driven by an appreciation of ecological, social, cultural, and economic values of forests (Achim et al. 2022) as well as external pressures or crises that prompt change (Holling 2001). A holistic perspective of silviculture requires dedicated observation through collaborative research and monitoring by practitioners and researchers, which can in turn inform adaptation strategies (Achim et al. 2022). Innovative silviculture is embedded within stewardship that focuses on maintaining dynamic ecosystem processes and functions; many of these principles have been implemented by Indigenous peoples for millennia (Turner et al. 2000). Extension can play a critical role in supporting the implementation of innovative silviculture.

To have the broadest impact, employing a variety of extension forms is necessary because it diversifies the activities and potential participants (the outputs) and creates opportunities for diverse outcomes, including short-term learning, medium-term actions, and long-term changes to conditions. The forms of extension are differentiated based on the extent to which producers and users of knowledge interact to generate and share knowledge and can be grouped into the following (adapted from Westwood et al. 2021; Bamzai-Dodson et al. 2021; Kapoor et al. 2025): (1) one-way knowledge sharing; (2) two-way KE; (3) participatory exchange; (4) co-produced knowledge generation; and (5) anticipatory knowledge generation (Fig. 1; Table 1). Although extension has evolved from one-way knowledge sharing to more participatory, co-produced, and anticipatory processes with changing technology (spurring greater connectivity) and more access to communities of practice, we suggest that all forms of extension are still valuable and useful. For example, many organizations have shifted away from extension that focuses on one-way exchange (producer shares information with user) to more participatory or co-produced knowledge generation (Kapoor et al. 2025), such as through applied and collaborative research, recognizing the diversity of people who hold knowledge. However, there is sometimes still a need to reach broad audiences to quickly disseminate new knowledge that

may arise because of emerging research or the development of a novel product.

In the context of extension, the more participatory forms of extension (participatory exchange; co-produced knowledge generation and anticipatory knowledge generation) have demonstrated that they are better equipped to span boundaries, empower individuals, and support knowledge co-production and partnerships (Bamzai-Dodson et al. 2021). However, there is still a tangible gap in access to different forms of knowledge, especially those (such as scientific) that can be difficult for non-academics to access (Trisos et al. 2021); as such, one-way KE can still be important (Fig. 1). We suggest that knowledge generation and forestry practices in BC need to re-examine the process and reciprocity of knowledge sharing, especially given ongoing power imbalances of different knowledges (Copes-Gerbitz et al. 2024) and do so with a focus on outputs and outcomes. Critical questions could include the following: Who needs information? What activities and forms of extension are needed to supply it? How can we make it digestible, usable, and respectful? What knowledge (short-term outcomes) will lead to a change in actions (medium-term outcomes) and conditions (long-term outcomes)? These questions are particularly important because they help connect the development of outputs to the realization of outcomes, the latter of which is a stronger measure of the impact of extension work (Arnold 2002; Workman and Scheer 2012). Answers to these questions can be guided by needs assessments conducted with target communities and governments, partners, and advisory groups through both quantitative and qualitative methods (Caravella 2006; Bayer et al. 2020).

3. A brief history of extension

Across the globe, the principles of extension can be traced back to a long history of clubs and societies, proceedings and reports, technical schools, traveling lecturers or specialists, and professional associations (Jones and Gaforth 1997). Government supported and legislated extension programs have existed for a long time, with an early and lasting focus in the agricultural sector. For example, the first government-funded agriculture extension service was established in 1879 in France (Jones and Gaforth 1997). Extension programs were further formalized in England in the late nineteenth century when the universities of Oxford and Cambridge began discussions on how to educate local populations (Jones and Gaforth 1997). In 1867, a formal "university extension" program was established and quickly grew, covering literary and social topics, as well as agriculture (Jones 1994).

In the United States, extension programs were formalized when the federal government gave land to states (a process known as "land grant") to create higher education institutions primarily focused on agriculture. Land-grant institutions were established under the Morrill Act in 1862 and further expanded by a second iteration of the Act in 1890 (Collins 2015). Land-grant institutions were based on a three-pronged approach of instruction, research, and extension, with the purpose of translating theoretical knowledge to applied knowledge through outreach and engagement with rural populations (Collins 2015).

Initially, land-grant extension programs focused on ensuring research that was done at universities was being delivered to farmers, largely because universities depended on the use of local farms to study subjects like plants, soils, and animals (Cornell Cooperative Extension 2021). In this context, researchers at land-grant institutions shared knowledge with local farmers through in-person demonstrations and training. Experimenting with the latest agricultural innovations and new technologies allowed for shared learnings about successes and failures of techniques across different regions. In 1914, the Smith–Lever Act formalized extension programs and made them permanent fixtures by establishing the Cooperative Extension Service. In this way a system of extension was created, where cooperative extension professors (also referred to as professors of practice), and county-based extension advisors (or agents) engaged in knowledge creation and extension in a reciprocal continuum. In this system, state universities act as primary extension agencies with significant resources and staff to carry out extension work, particularly with satellite offices in smaller, rural communities. For example, nearly 20% of academic positions at the University of California are campus-based cooperative extension faculty, with 200 local county-based advisors, and nine Research and Extension Centers throughout California (Hoffman et al. 2024).

While early extension programs were predominantly focused on agriculture, it was recognized that many disciplines would benefit from extension. In the late 1980s, the Food and Agriculture Organization (FAO) of the United Nations developed two recommendations for implementation of forestry extension programs globally and defined forestry extension as "*a process of integrating Indigenous and derived knowledge, attitudes and skills to determine what is needed, how it can be done, what local cooperation and resources can be mobilized and what additional assistance is available and may be necessary to overcome particular obstacles*" (Sim and Himli 1987). The FAO strongly advocated for a bottom-up approach, building on place-based and Indigenous knowledges to enhance land practices. Extension was encouraged as "*a framework of discussion and cooperation between the people and the extension organizations*" (Sim and Himli 1987).

In the United States, legislation was adapted to address the necessity for forestry extension, and state forest departments were eventually added to land-grant universities to support research and extension on wildfire, tree planting, and to provide support to woodlot owners (Bickell 2022). These forest extension programs, which employ nearly 250 full time staff nationwide, act as the primary service delivering landowner education to encourage sustainable forest management on private lands and increasingly focuses on education of novel threats and holistic approaches to forest management, such as overall forest health and climate change impacts (Sagor et al. 2014). In Canada, there is no collaborative network of locally or regionally based extension professionals that operate through campus-based universities that matches the structure and scale of the United States or Europe. However, the work of extension, in principle and in practice, has occurred throughout Canada and BC for decades. Current perspectives of "extension" have focused on implementation in a broad manner with a focus on building relationships among

groups and co-creating products and tools (McFayden et al. 2024), such as efforts by organizations including the Canadian Forest Service (Kapoor et al. 2025). Newer terms borrowed from economics, such as "boundary spanners", are also used to describe the work of extension, as individuals and organizations that can work in complex spaces that cross multiple cultural, cognitive, social, and geographic boundaries (Hatch et al. 2023; Hoffman et al. 2024). Much of this extension work has emerged through collaborative and applied research among governments, academics, and communities.

4. Reflecting on the anti-Indigenous origins of extension

Importantly, the origins of publicly funded land-grant universities and associated extension programs in the United States and Canada require a reflection on their origins. In the US, the history of land-grant universities is founded on the unjust dispossession of Indigenous peoples from their traditional lands and the re-appropriation of those "public lands" to fund universities and higher education. In the US, the Morrill Act (1862) led to roughly eleven million acres of land from nearly 250 tribes, bands, and communities taken and given to fund new universities across the United States (Lee and Ahtone 2020). Over a quarter of the land claimed by the US and provided to states for land-grant universities was taken through unratified treaties or confiscated by seizure (Lee and Ahtone 2020).

Canadian universities have also benefited from land dispossession and transfers. In BC, the provincial University Endowment Act (1907) reserved up to two million acres of land across BC to raise funds for the establishment of the University of British Columbia (UBC) through the sale of agricultural land. In 1910, the site for UBC was selected at the tip of Point Grey on unceded Musqueam territory. Following difficulties generating revenue from the two million acres across northern and interior BC, the government eventually swapped the original two million acres for roughly three thousand acres surrounding Point Grey to fund the University (Hives and Wodarczak 2018). This area, called the University Endowment Lands, has been sold over time for residential, commercial, and recreational uses, but has never been returned to the Musqueam people.

With increasing interest in extension programs in Canada, we have the responsibility to acknowledge and work to address historical and ongoing impacts to Indigenous peoples and other marginalized communities. The colonial origins of land-grant universities and extension continue to have repercussions today, such as unequal access to the "wealth" generated by the land and an accumulation of decision-making power within (typically) white, college-educated communities (Stein 2020). To address these ongoing issues, ethical extension must be focused on co-creating knowledge that is grounded in reciprocity, equity of multiple knowledge systems, and the empowerment of underrepresented and marginalized communities. Extension practice must also recognize and work to redress power imbalances, particularly

for forms of Indigenous and local knowledges that continue to be underrecognized and in some cases, disrespected or dismissed (Goodrich et al. 2020). Indigenous communities, independent reviews, provincial government reports, and researchers in BC and Canada continue to call for more equitable and ethical research, KE, and practice (e.g., Abbott and Chapman 2018; Sankey 2018; Gorley and Merkel 2020; Wong et al. 2020; Dickson-Hoyle and John 2021; First Nations Leadership Council 2022).

5. Forestry extension in BC

Early efforts in forestry extension in BC were largely focused on the commercial production aspects of forestry and primarily took the form of training delivered by government staff to forest licensees on topics such as forest practices regulation (e.g., Forest Practices Code of British Columbia Act) and best practices for reforestation. These early forms of forestry extension in the province, much like the rest of North America, were restricted to the communities they served and outside of the professional practice realm were not inclusive to a wide range of disciplines or communities, for example Indigenous communities and knowledges. These early approaches at extension reinforced the perception that academic and "western scientific" knowledge was more valid than Indigenous or local knowledges (Hoffman et al. 2024).

Forestry extension advanced the establishment of "Research Forests" beginning in the 1920s, where experimental research helped answer pressing operational questions. These forests are still active today and are instrumental in testing and demonstrating silviculture practices and techniques and are celebrated as outside classrooms.

- In 1924, the Government of BC initially established the Aleza Lake Forest Experiment Station Reserve. In 2001, University of Northern BC (UNBC) assumed management and transitioned it into the Aleza Lakes Research Forest.
- The UBC established the Malcolm Knapp Research Forest in Maple Ridge in 1949. Over a thousand research studies have been undertaken at the Malcolm Knapp Research Forest, many of which are long-term projects.
- In 1987, the Alex Fraser Research Forest was established by UBC and located on the traditional, ancestral, and unceded territory of the Williams Lake First Nation (T'exelc), Xatśūll First Nation, and Esk'etemc. It is known for its education, research, demonstrations, and public outreach programs.
- In 1996, the John Prince Research Forest was established and is co-managed by the Tl'azt'en First Nation and UNBC.

In 1985, a non-profit education society called the Silviculture Institute of BC (SIBC) was established to offer advanced training for forestry practitioners in a transmission style of extension, funded by the provincial government. The SIBC offered advanced education for Registered Professional Foresters, including a UBC Diploma in Forestry (Advanced Silviculture), and ran five 2-week long in-residence course modules with the purpose to "develop and refine the professional forester's capabilities to make sound silvicultural prescriptions" (Weetman et al. 1992). Graduates of the program noted

improvement in the consideration of prescriptions for alternative harvesting techniques to clearcutting (or "innovative silviculture"), stronger ability to plan on longer time scales (i.e., planning for multiple rotations), and increased confidence in decision making (Weetman et al. 1992). While the SIBC had notable successes, the program ceased operation during a time when dramatic cuts were being made to research and forest management budgets in BC (Parfitt 2010).

In 1998, BC created a community forest agreement, which is an area-based forest licence managed collaboratively by municipalities, First Nations, and/or community held organizations with the management intent driven by community values. The first community forest pilot agreement was tested in 1998 and eventually community forest tenures became eligible for 25-year licenses. As of writing, there are 61 community Forests in BC, although they only account for 2% of the area and 4% of the annual timber harvest in BC. Community forests have demonstrated leadership in innovative silviculture, particularly in managing wildfire risk and forest health issues, while balancing a wide range of other social, economic, and cultural values through a variety of extension activities (Dickson-Hoyle et al. 2023).

The work of extension in forestry has also been integrated by the provincial government. The Research Program in the Ministry of Forests is over 100 years old with a network of scientists working across the province to conduct applied research addressing current forest management challenges (Copes-Gerbitz et al. 2022). Early research was housed both provincially and within different districts to represent different forest types and focused on growth-and-yield and regeneration studies. These early efforts were enhanced in the 1950s with the permanent establishment of regional forest research offices, which were staffed with foresters, agrologists, and a dedicated extension officer, to (among other policies) "*demonstrate on a practical scale the application of research findings for the benefit of government, industrial, and private foresters*" (pg. 8; BC Forest Service 1957). In contrast to more recent extension efforts, the early establishment of these research programs excluded Indigenous and local communities.

In 1986, the Ministry Forests and Lands formalized Communication and Extension Services as a dedicated research branch. In 2000, this was bolstered by the Forest Research Extension Partnership (FORREX) that operated across BC to link people to knowledge and facilitated continuous innovation and improvements in natural resource management. FORREX primarily focused on translating knowledge and conducting syntheses for science-based decision-making, and extending knowledge (e.g., peer reviewed papers, technical notes); however, it was discontinued due to changing budget priorities and constraints (Dave Wilford, BC Ministry of Forests emeritus scientist (personal communication, 2024)). Nevertheless, the combination of these programs established several long-term (multi-decadal) research installations, which are still being maintained by the Ministry of Forests, including

- Silvicultural systems research experimental trials (e.g., Date Creek Research Forest; Silviculture Treatments for Ecosystem Management in the Sayward)

- Watershed studies (e.g., Upper Penticton Creek Watershed Experiment; Carnation Creek Watershed Experiment)
- Soils experimental trials (e.g., Long-term Soil Productivity Study, which is a part of a larger North American network)

Extension work has been identified as a key need in Canada for helping to deliver innovative solutions to complex problems, for example in wildland fire (Sankey 2018). In research contexts, transdisciplinary research is emerging as an opportunity to embed collaboration and multiple forms of knowledge in research (Copes-Gerbitz et al. 2024). Several extension efforts in BC focus on knowledge transfer and translation, but also include efforts to build trust, grow relationships, and enable capacity for collaborations so that knowledge producers and knowledge users can co-create research projects.

There are multiple examples of extension outcomes and outputs in different forestry models in BC, including universities (though in an informal way), Indigenous communities/forestry companies, research forests, community forests, communities of practice, and the provincial government. Nevertheless, working across silos to create new relationships or reduce redundancies has been undervalued in BC and Canada and most people doing extension describe their work as wearing "different hats" or "off the side of their desk" or "pursuing passion projects", unaware that they are working in extension without being appropriately compensated or recognized for these efforts (Hoffman et al. 2024). Providing further support for those already engaged in extension work on part-time or voluntary bases, as well as establishing dedicated and formal extension programs, will help address some of these gaps.

6. How can we value and support long-term forestry extension in BC?

In 2023, the BC government funded the establishment of the Silviculture Innovation Program (SIP) to address recommendations put forward in the Old Growth Strategic Review (Gorley and Merkel 2020). Early conversations with program advisors and diverse experts, part of the needs assessment process, cautioned against collecting new knowledge and instead urged the program to make practitioners aware of existing knowledge (specifically long-held Indigenous science and knowledge of forest stewardship practices) and supporting forestry through mentorship and KE. As a result, the SIP launched an extension and applied research program to improve knowledge regarding innovative silviculture with a core mission that program outcomes and outputs would serve a diverse community of knowledge users and support the work of practitioners in applying innovative silviculture (Fig. 2). To further this mission, the SIP conducted a structured needs assessment process by hosting a Knowledge Summit (11–13 March 2024) with diverse participants working in forestry and natural resources in BC. The objective of the summit was to create a roadmap that articulated the knowledge gaps and contextualized why the knowledge gaps were important and how they could be addressed through research and extension (Silviculture Innovation Pro-

Fig. 2. Illustrated conceptual relationship between extension and innovative silviculture and its implementation. The green map represents British Columbia that is depicted with multiple values that communities rely on. The red toolbox provides forester options such as prescriptions, models, or decision-support systems to determine how best to managed values. The space between "values & practice" and "knowledge & tools" is what requires extension. Graphic by Laura Stanton.

gram 2024). Through this needs assessment process, the SIP summarized what participants shared into five broad yet actionable categories. This has enabled the program to strategically identify areas of focus and investment opportunities such as (1) create a knowledge repository of existing information, (2) build and grow communities of practice, (3) support new research, (4) synthesize existing knowledge, and (5) extend knowledge into practice (Silviculture Innovation Program 2024).

There has been increasing awareness and desire to use silviculture to manage forests as complex adaptive systems (Puettmann et al. 2009; Sutherland et al. 2023). To effectively do so, it is essential that forest stewardship be placed within the context of the silvicultural system, where evaluation, planning, harvesting, planting, and tending to harvesting again are done in an iterative and cyclical way that embraces spatial and temporal diversity.Achim et al. (2022) propose a holistic conception of silviculture that uses new sets of practices to meet evolving societal demands and a multiplicity of desired outcomes, such as "innovative silviculture". The term "innovative silviculture", also sometimes called "adaptive silviculture", creates a framework for stewarding multiple values at the stand and landscape scale, ranging from the physical to the spiritual. Innovative silviculture is focused on systems where the primary objective is to achieve improved stewardship of the land over longer time frames, where patterns and processes shift across temporal and spatial scales. Being innovative requires seeking out new and existing knowledge, incorporating monitoring processes, and

adapting to current and future realities to guide changing practice (Day and Pérez 2013; Sutherland et al. 2023). It expands ideas of innovation in the forest sector beyond just the creation of new products (Innes 2009) to a more holistic approach that incorporates the diverse perspectives of individuals operating within the forest sector (Weiss et al. 2020), which can be facilitated by extension.

The objectives for innovative silviculture can be driven by climate adaptation planning, wildfire resilience, maintaining or enhancing old forest attributes, conserving water supply or improving water quality, wildlife habitat management, maintaining timber production, berry production, recreational use, spiritual connections, ceremony, cultural values, local economies, and many more. It can also include any combination of compatible objectives where timber is not the single most important value (Fig. 2). Innovative silviculture treatments can include variable retention systems (also known as partial harvest), thinning, prescribed and cultural fire, and intensive silviculture for achieving multiple values. Community forests in BC embody many of the elements of innovative silviculture and extension, such as managing for multiple values guided by community input, trialing different practices and treatments, building capacity for operators, sharing knowledge through communities of practice and collaborative research, and focusing on longer-term stewardship of their tenure (Dickson-Hoyle et al. 2023; BC Community Forest Association 2024). For example, Tumbler Ridge Community Forest used partial harvesting to salvage timber killed by the mountain pine beetle to ensure

the economic value was not lost while also reducing wildfire risk around the town of Tumbler Ridge (Dickson-Hoyle et al. 2023), while Chinook Community Forest partnered with researchers to use Light Detection and Ranging technology to enhance their old growth inventory and guide management specific to the values of six local First Nations (Chinook Community Forest 2024).

Importantly, the idea of innovative silviculture is not new—innovative silviculture techniques, such as variable retention and thinning, have been implemented in BC before, but not at the same scale and pace as industrial clearcutting of forests (Beese et al. 2019). Similarly, some practices such as broadcast and prescribed burning used to be much more common but concerns over liability and smoke led to a decrease in the practice with unintended consequences of increasing fire risk in some places (Hoffman et al. 2022). Indeed, some of the techniques today considered innovative, such as cultural burning, are embedded in more holistic approaches to land management long practiced, advocated for, and taught by First Nations (Turner et al. 2000; Pellatt et al. 2015; Hoffman et al. 2017; Dickson-Hoyle and John 2021).

We propose that the recent shift towards innovative silviculture, drawing from historical practices, with a coordinated implementation of extension can support the management of forests for multiple values. Foresters are well poised to embrace extension as managing forests requires a deep understanding of the needs and concerns of those whose livelihoods, culture, economies, and health are tied to forest ecosystems. Foresters also encompass many of the driving principles of extension, such as regularly exchanging knowledge, continuous learning, centering community, and understanding the value of place-based applications. KE systems have evolved through time with greater emphasis on participatory and reciprocal exchange rather than dissemination or one-way knowledge delivery (Fig. 1). New KE systems focus on user feedback, empowerment, and network decision-making. Other contributors to the forest sector, including researchers and other forest-based practitioners, can also enhance innovative silviculture through applied research and extension work that more directly connects to the knowledge and practices foresters need.

An important consideration for how extension can support innovative silviculture in BC is identifying the ideal short-, medium-, and long-term outcomes (Bennett 1975; University of Wisconsin 2025) and elevating underrecognized knowledges, such as that of Indigenous and local communities (Hoffman et al. 2024). While these outcomes are best developed for specific extension programs and through dialogic processes (Arnold and Cater 2016; Diaz et al. 2023), here we offer some proposed outcomes based on SIP's engagement and needs assessments (Silviculture Innovation Program 2024, 2025). Short-term outcomes could include better awareness of existing knowledge and improved access to knowledge and knowledge holders; more connections among mentors and early career professionals; and enhanced knowledge of and skills in the practices (e.g., silvicultural systems) that help manage and/or create desired values and the management objectives that guide these practices. Medium-term outcomes could include a stronger culture of support for try-

ing and failing and sharing lessons learned. It could include creating more connected, diverse, and practical communities of practice; training operators on machinery specialized to execute innovative practices; and that the application of innovative silviculture increases across BC's forested ecosystems for the stewardship of multiple values with increasing collaborations with or leadership by First Nations. Long-term outcomes could include legislative and planning frameworks that encourage innovation and more localized markets that enhance the economic viability of innovative practices, as well as increased decision-making power for First Nations across existing tenure and throughout their territories. To meet these outcomes, dedicated and purposeful inputs are needed.

Here are some ways agencies and organizations can support extension (adapted from Hoffman et al. 2024), with a particular emphasis on enhancing the inputs available for both formal extension programs and more informal extension work that people engage in:

- Recognize extension work as integral to programs and formally dedicate resources and personnel to such activities or identify and recognize individuals within organizations that are already carrying out extension. Increased recognition should result in structural changes to support work and shift the trend so that extension work is valued and no longer done off the side of one's desk.
- Make extension a core mission/value or integrate it within an organization's strategic plan.
- Provide professional development opportunities for the skills needed in extension, which could include training in facilitation, negotiation, mediation, and conflict resolution; communication with diverse audiences through accessible writing, communication, or design; and ethical practice (e.g., principles of ownership, control, access, and possession).
- Recognize, value, and foster skills such as empathy, emotional intelligence, and an openness to learning, adapting, and improvising.
- Provide time for deep engagement with material to better understand language and realities of contexts for different issues.
- Create space and support time spent connecting with professionals and experts in the field.
- Uplift underrepresented voices and highlight the importance of Indigenous and local knowledges and decision-making.

7. Conclusions

In this perspective, we illustrate the conceptual relationship between extension and innovative silviculture and its implementation (Fig. 2). Across BC, there are multiple (and sometimes competing) values that communities rely on and that foresters are increasingly expected to balance. To meet these objectives (and growing demands), foresters need a "toolbox" of options for harvesting and managing forests (Fig. 2). The broad knowledge as well as the "tool" or prescription, model, or decision-support system used will de-

pend on which values are being managed. The space between values and knowledge and tools is what requires "extension", as extension can be used to understand community values more deeply and then determine which knowledges and/or tools are suitable, applicable, and/or appropriate. In this space, extension can also guide an effective application of the tool, given the rapidly changing technologies and site-specific needs of the forest. The collective application of knowledge and tools, supported by extension, can enhance silvicultural practice to be more aligned with values and better informed by existing knowledges.

Extension in innovative silviculture, and forestry in general, can ensure through information exchange that multiple knowledge and scientific systems are bridged and provide pathways to help ensure applied research projects fill knowledge gaps for practitioners, and that forest planning and operations meaningfully identify and manage for multiple values. Extension is also critical to building on the collective knowledge of innovative silviculture by co-creating and disseminating knowledge, educating and training foresters, and providing opportunities for practitioners to engage more deeply with innovative techniques.

8. Positionality statement

Researchers involved in this work believe that effective forest stewardship requires place-based and practitioner-led solutions in partnership with and led by First Nations. As academics we intend to publish this research in an open and accessible format and contribute information to practitioners, policy, and decision-makers. K.M. Hoffman is academically trained as a fire ecologist and practitioner; G. Chow Fraser is trained as a conservation scientist; K. Copes-Gerbitz is trained as a fire ecologist and forestry social scientist and J.N. Axelson is trained in historical ecology and forest science. All authors joined this work through their mutual interest in extending knowledge in accessible formats and are all committed to decolonizing research practices. To do this, we encourage reflecting on how we can better communicate and extend knowledge to broader audiences to build inclusive extension programs in forestry across BC.

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