The Restoration Market in Northern British Columbia:

With a Focus on the Northeast Region

Full Report

May 2024

Preface and Acknowledgements

This project was funded by the B.C. Oil and Gas Research and Innovation Society and was prepared by consultants Catherine Scott-May, Paul Jeakins, and Ines Piccinino.

This is the full report that resulted from the project. A companion document, which is a summary report, was created to provide a shorter overview of the project and outcomes.

The project involved interviews of 69 people who provided input anonymously. The consultants are entirely responsible for the project design, synthesis of input, and analysis that were used to generate the project outcomes.

Abstract

Most of the demand for restoration services and products is from legally required restoration with recent commitments to cultural-ecological restoration in B.C.'s Northeast Region anticipated to increase demand. The B.C. Oil and Gas Research and Innovation Society funded this project to define the restoration economy within a northern B.C. context, develop prototypes for describing demand and supply chains for restoration, assess the strengths and vulnerabilities of the supply chains, and identify short-term actions to help optimize the restoration market. Supply chains often support demand from numerous sectors and initiatives; therefore, the project explored what may be required to develop comprehensive, integrated demand forecasts. As there is considerable uncertainty associated with demand forecasts, the project has proposed three future scenarios for restoration that may influence demand. The project has proposed a structure for describing and assessing the multiple interconnected supply chains that are required to meet demand for restoration. Finally, short-term actions are identified for addressing gaps and to support pursuing future restoration scenarios.

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1. Project Objectives

- Define the restoration economy within a northern B.C. context
- Develop prototypes for describing demand and supply chains for restoration
- Assess the strengths and vulnerabilities of the supply chains, and
- Identify short-term actions to help optimize the restoration market.

2. Project Rationale

In 2023, the Province of British Columbia (the Province) announced major commitments to cultural-ecological restoration in B.C.'s Northeast Region to address the cumulative impacts from industrial development on Treaty rights. Most restoration is legally required or policy driven. The recent commitments create unprecedented opportunities that are increasing demand for human resources, equipment, and materials, which in turn, are increasing competitive pressures on the supply chains that support restoration across northern B.C. and beyond. Currently, there is a lack of knowledge about the restoration market, which is a barrier to aligning demand and supply, increasing the resilience of supply chains, and maximizing the benefits for local communities. As a result, the B.C. Oil and Gas Research and Innovation Society (BC OGRIS) supported this project to better understand opportunities and challenges of some key components of northern B.C.'s restoration market.

3. Restoration Terms and Concepts

Current terminology is inconsistent and confusing as it is defined or modified by participants engaged in a diversity of restoration initiatives that are pursuing a range of objectives. In some cases, participants seek to clarify a niche for their initiative so definitions are intended to be unique, which can create challenges in aligning with broader interests. At the same time, there is strong support for integrated restoration planning, including scaling up from the project/site to the program/landscape scale. Hence, common terminology and concepts, which balance the need for consistency with flexibility for local priorities, could facilitate communications, collaborations, and coordination across restoration initiatives.

Restoration terms and concepts are evolving from those typically associated with ecological restoration to reflect the expanding expectations for, and practice of, cultural-ecological restoration within the Province. The evolution has implications for the restoration market. The terminology in relevant studies for Alberta (Powter et al., 2021) and the Northwest Territories (Government of Northwest Territories, 2022) were reviewed but they focused on the legal context of their respective jurisdictions and not the broad scope of restoration currently being pursued in B.C., partly due to the recent court decision Yahey v. British Columbia.

The following proposed terms and concepts have been modified from existing international principles and definitions developed by the Society for Ecological Restoration (SER) (Gann et al., 2019). SER's principles and definitions were also used in a study of the restoration economy in Western Australia (Young et al., 2023). Input from interviewees and resources they identified were used to tailor SER's definitions to reflect the northern B.C. context. The interviewees included a

cross-section of participants actively involved in restoration in northern B.C. In each case, a definition is proposed followed by a discussion on the respective input received.

Most of the proposed terms and concepts are aspirational in that they reflect what is needed, not necessarily the current approach being used in northern B.C. For sake of brevity, this report uses the term "restoration" generically to encompass the range of concepts outlined below.

3.1 Restoration

Definition: Assisting recovery of interconnected landscape scale structures and processes to support resilient ecosystems, human cultures, and ecosystem services over time.

The definition has evolved from an ecological focus on degraded, damaged, and destroyed ecosystems to reflect interest in cultural-ecological restoration, which seeks recovery of both ecosystems and human cultures as interconnected and mutually reinforcing processes (Kimmerer, 2011). Although economics is part of culture and have always been a focus for resource use and ecological restoration, the cultural-ecological restoration implies consideration of broader components of culture, including Indigenous and local cultures. One mechanism for supporting cultural restoration is the inclusion of Indigenous Traditional Ecological Knowledge and other local knowledge. The broader concept of cultural-ecological restoration has implications for forecasting demand, including what is to be achieved, how it is to be designed and implemented, as well as whom is to be engaged and will make specific decisions.

Landscapes rather than ecosystems are the geographic focus because they are culturally defined and are a social–ecological system that involves a dynamic relationship between ecosystem services and human wellbeing in changing social, economic, and environmental conditions (Gann et al., 2019).

The emphasis on ***interconnected landscape-scale structures and processes*** reflects:

- End-goals that emphasize the importance of environmentally and culturally effective restoration that revitalizes healthy relationships among the land, water, wildlife, and people. The concept supports flows or exchanges (biotic and abiotic) at a more complex level than individual ecosystems, sites, or communities (Blueberry River First Nations et al., 2021)
- General agreement on the need to scale-up restoration from the site/project to landscape/program scale
- Concern about use of a single values, including keystone species, as a focus for restoration as most stated a need to shift to system-level, multi-scale restoration plans and programs. Indigenous communities often prioritize specific species, such as moose, but also emphasize the need for a holistic approach.

The need for restoration to support ***resilience*** reflects both:

- The intrinsic relationship between restoration and climate adaptation, and
- The expansion of restoration from a focus on recovery from disturbances to include improving the resilience of at-risk landscapes, including climate refugia areas that are needed to support climate adaptation and recovery from climate events.

A focus on ***ecosystem services*** is also a mechanism for integrating cultural and ecological restoration as they define direct and indirect contributions of ecosystems to human wellbeing (Gann et al., 2019).

The inclusion of ***over time*** reflects the experience of restoration practitioners who emphasize that restoration simply takes time and may require different phases that may use different approaches.

3.2 Passive and Active Restoration

Definition: Passive restoration - acceptance of the anticipated trajectory of recovery without intentional human interventions.

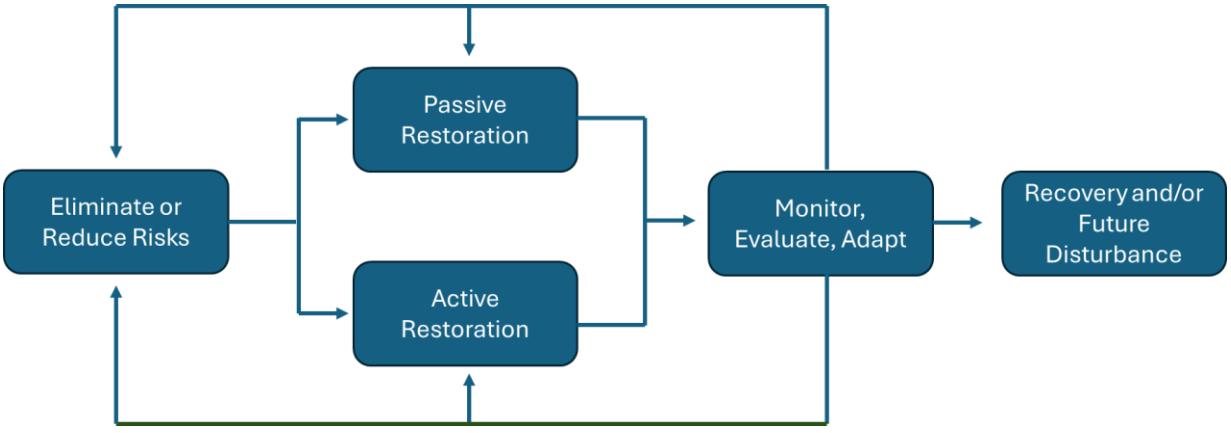
"Natural restoration" is a term that is sometimes used inter-changeably with passive restoration. Some, including within Indigenous communities, voiced concern over the use of machines and other methods that are considered to be intrusive, preferring to allow for natural restoration following minimal, if any, human intervention. Climate change, the spread of invasive species, and other human-created influences raise questions as to what constitutes natural restoration. Also, active restoration (see below) uses natural recovery processes. Therefore, passive restoration is the proposed term to describe the intent.

Definition: Active restoration - activities that are designed to:

- ***Change the trajectory of recovery, to the degree possible, towards more desirable outcomes than what is anticipated through passive restoration, and/or***
- ***Accelerate the process of recovery, to the degree possible, compared to what is anticipated through passive restoration.***

A first step may need to be the elimination or reduction of risks to create the necessary conditions for passive or active restoration (Figure 1). Examples of risks include additional disturbances, introduction of invasive weeds, erosion, and threats to safe operations of restoration crews (e.g., repairing hydroelectric lines, removing danger trees). Failure to eliminate or reduce risks may result in an inability to achieve restoration objectives and/or more costly active restoration.

Figure 1 Passive and Active Restoration



Source: Figure developed by the authors

Reliance on passive restoration may reflect a capacity for self-recovery, a phased approach with previous active restoration having proved to be effective to create the conditions for passive restoration, and/or limited funding or capacity within supply chains. Restoration practitioners are raising concerns about some previous strategies to eliminate risks, for example seeding of non-native grasses to prevent the introduction of invasive species. The non-native grasses can form a thick mat that also prevents the establishment of native shrubs and trees. Most practitioners identified a lack of support for monitoring, evaluation, and adaptation as a critical gap given the now decades of restoration experience in B.C. that offer opportunities for learning.

Other than where restoration is legally required, passive restoration is the default with active restoration requiring champions, a viable plan, and resources to implement. There can be different types, intensities, and levels of commitment to active restoration depending on the objective(s) to be achieved. Finally, a combination of passive and active restoration may be used to implement multi-phased restoration plans over time.

Clarity on the percentage of restoration that will be passive is important information for forecasting demand for human services, equipment, and materials and the anticipated pace of recovery. Some restoration practitioners have found passive restoration to be the most effective strategy for some situations and emphasize that all restoration requires long-term commitments.

3.3 Recovery

Definition: The outcomes sought or achieved from restoration.

Ecological restoration distinguishes between:

- Partial recovery, whereby some recovery has occurred but not all ecosystem attributes closely resemble those of the desired future state
- Full recovery, which is preceded by the ecosystem exhibiting self-organization that leads to the full resolution and maturity of ecosystem attributes. At the point of self-organization, the restoration phase could be considered complete and management shifts to a maintenance phase (Gann et. al., 2019).

Risks from future disturbances, such as climate events, and future land use decisions can create uncertainty whether recovery can be achieved and, therefore, the degree of risk for committing limited funds and resources to active restoration. Some suggest that wildfire recovery and supporting climate and wildfire refugia areas should be the focus for investments in restoration as achieving recovery objectives in such areas may be less risky.

There are calls to support recovery by using legal tools to protect restored areas from future uses that would undermine restoration investments, at least for a defined period of time. Such protections can be a requirement from funders with some programs requiring a 30-year commitment to no development. As a result, such funding opportunities may be limited to privately owned lands, conservation trust lands, or public lands that are unlikely to be used for industrial-scale activities (e.g., culturally significant areas) or whose use will be limited by conservation designations (e.g., ungulate winter ranges). There is interest in exploring market-based revenue streams, including monetization of carbon sequestration or ecosystem services, to support

restoration. This also requires long-term commitments to protecting investments to meet standards that may be globally defined.

In contrast, some interviewees identified the need for flexibility in the use of restored areas particularly as unplanned large disturbances, such as wildfires, can significantly change the context for landscape scale decision-making. There has been discussion about "right sizing industry" with a transition, at least within forestry, from an extensive to intensive approach, which would require realizing more value from a smaller industrial footprint. The implication is that recovery within the intensive use zones would be defined differently than the remaining landscapes. This has already happened due to technological advancements in the oil and gas sector, as the transition from conventional production to unconventional came with a much smaller surface footprint.

A broad approach to restoration requires defining recovery relative to multiple objectives and measures of success, some of which may be conflicting or require different timelines to achieve. In one case, short-term jobs and revenue from restoration have been identified as the priority and is resulting in continuation of restorative activities that have been proven to be ineffective. The broader context often involves social choice decisions as part of developing a desired future condition as the basis for defining recovery. As a result, successful recovery can result in different outcomes across different landscapes.

3.4 Desired Future Condition

Definition: A vision that describes the desired future conditions that can reasonably be expected to be achieved through restoration and other land management strategies.

For some, restoration implies a return to a former condition, but most view restoration as forward looking. SER suggests that a future vision needs to be informed by past conditions and trends, including background and projected changes, such as changes in climate, human demographics, and cultural norms. The future vision is not, however, based on immobilizing ecological communities or human cultures at some past point in time, rather the future vision is designed to help restore resilience, namely increasing the potential for native species and communities as well as human cultures to recover and continue to reassemble, adapt, and evolve (adapted from Gann et al., 2019).

Defining the desired future condition is complex and usually involves social choice and trade-off decisions. To define a desired future condition, SER recommends creating ecological reference models, which draw on multiple sources of information, including:

- Native ecosystems: An ecosystem comprising organisms that are known to have evolved locally or have recently migrated from neighboring localities due to changing environmental conditions including climate change (Gann et al., 2019).
- Traditional cultural ecosystems: Ecosystems that have developed under the joint influence of natural processes and human-imposed organization to provide composition, structure, and functioning more useful to human exploitation. In these ecosystems, traditional management practices support native biodiversity and the lack of such management can drive degradation (Gann et al., 2019).

While ecosystems that have been converted primarily to non-native species or are otherwise degraded do not function as reference models for ecological restoration, a vision for the broad economic context and associated restoration market may include generating benefits from degraded landscapes. For example, zonation may have been used to define areas of intensive use (e.g., human settlement, ongoing resource development) that offer different opportunities for restoration. As human settlements are frequently located in at-risk landscapes (e.g., low elevation, riparian areas), restoration within and adjacent to human settlements can be strategically important to achieving restoration objectives at broader scales. The concentration of human use can also create more expansive options for restoration in other zones. In contrast, some want to transition away from the zonation approach to a reduced level of use across all landscapes, with restoration used to help achieve that future vision.

Restoration alone is unlikely to realize a desired future condition. Rather it requires maximizing the cumulative benefits from restoration, conservation, and best management practices for resource use and development. With respect to restoration, multiple approaches are often required to support desired future conditions.

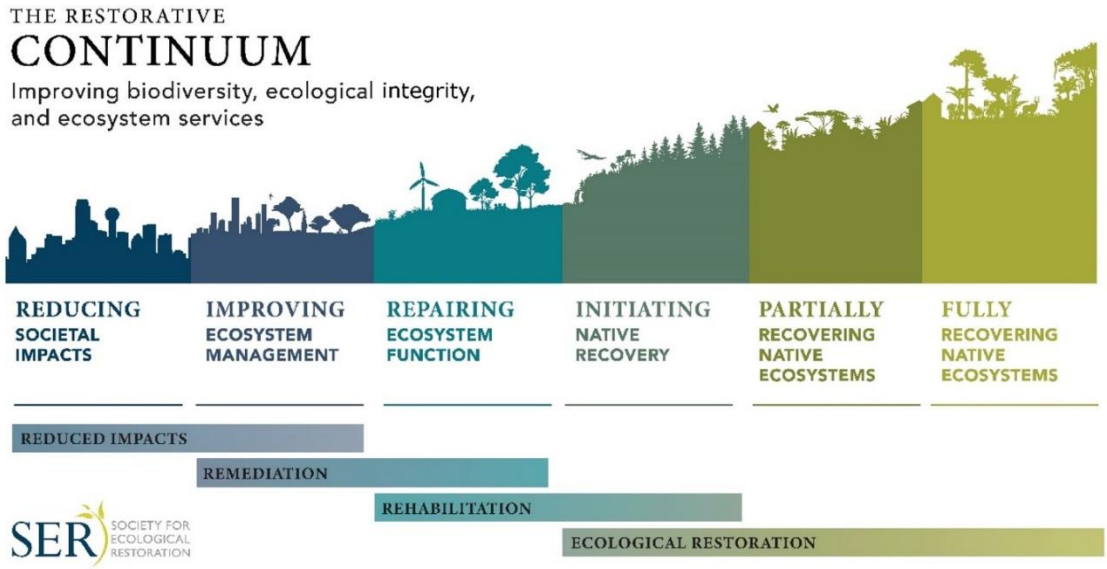
3.5 The Restorative Continuum

Definition: A means for describing the range of approaches for active restoration and the interconnections between them, which directly or indirectly assist recovery.

Confusion with terminology, including *remediation, rehabilitation, reclamation, and restoration,* led SER to develop a continuum as context for understanding how different approaches relate to each other and to help identify practices best suited to a particular context given ecological, social, and financial conditions (both opportunities and constraints) (Gann et al., 2019) (Figure 2).

The restorative continuum is useful in describing how different approaches within a given landscape may be required and taken together, can be used to achieve the highest level of recovery attainable at the landscape scale.

Figure 2 The Restorative Continuum



Within the context of ecological restoration, SER makes the following distinctions (Gann et al., 2019):

- *Remediation:* A management activity, such as the removal or detoxification of contaminates or excess nutrients from soil and water, that aims to remove sources of degradation

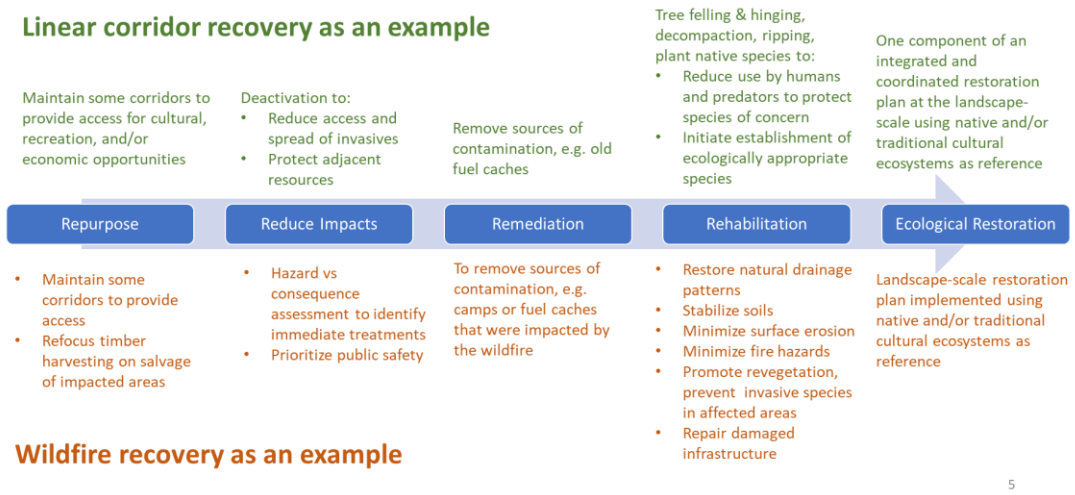
- *Rehabilitation:* Management actions that aim to reinstate a level of ecosystem functioning on degraded sites, where the goal is renewed and ongoing provision of ecosystem services rather than the biodiversity and integrity of a designated native reference ecosystem. Within the concept of rehabilitation, two other approaches have been used, including:
    - *Reclamation*: Making severely degraded land (e.g. former mine sites or wastelands) fit for cultivation or a state suitable for some human use. Also used to describe the formation of productive land from the sea.
    - *Functional Restoration*: Treatments that change the behaviours of humans or target wildlife species (e.g., blocking access or making travel difficult), often to achieve short-term objectives (e.g., reduce predator and hunting pressures on moose or caribou)

- *Ecological Restoration:* Management actions that aim to restore ecosystem attributes to closely resemble those of a designated native reference ecosystem with the ecosystem exhibiting self-organization that leads to the full resolution and maturity of ecosystem attributes.

Within the context of a restoration market, an additional distinction is proposed:

- *Repurpose*: Use of an area and/or specific impacts for a different purpose than the original and where the new use does not directly contribute to the restoration of natural processes. For example, developing a gravel pit within a harvested cut block.

Figure 3 Linear corridors and wildfire recovery as examples of the restorative continuum



Source: Figure developed by the authors

3.6 Restorative Activities

Definition: *The actions taken to achieve recovery objectives and targets*.

There are numerous types of restoration initiatives, some of which are sector-based (e.g., mine reclamation, timber reforestation), value- or species-based (e.g. caribou recovery), impact-based (e.g., road rehabilitation), reflect specific landscapes (e.g., wetlands or grasslands restoration), or are in response to climate events (e.g., recovery from wildfires, floods, landslides). When these different types of restoration initiatives are added to the different approaches to restoration, as described in restorative continuum (Figure 3), the result can be an overwhelming sense of complexity. There are, however, a limited number of actions that humans take to support restoration, which are the restorative activities and are:

- Common across most restoration initiatives and approaches. They are the "ingredients" for restoration planning with decisions made on:
    - Which restorative activities to use
    - The level of effort (intensity and scale of effort, which is guided by the recovery objectives)
    - How to combine them, including the timing, sequencing, and leveraging of each, often over different phases or time periods of recovery.

  The result is a "recipe", namely a restoration plan, program, and project that reflects the specific needs and opportunities of a given area or issue

- Interconnected and cumulatively beneficial, designed to improve outcomes from one level to the next along the restorative continuum as well as across spatial and temporal scales (Gann et al., 2019)

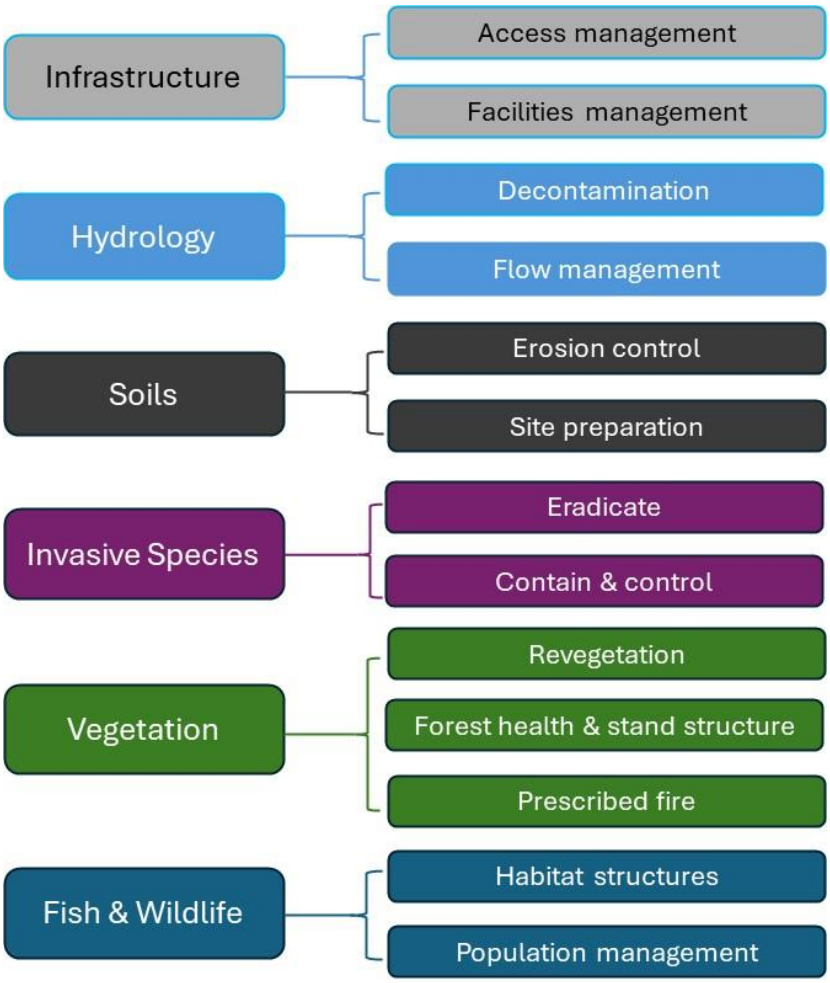
- Designed to assist natural processes of recovery that ultimately are carried out by the effects of time on physical processes and the responses and interactions of the biota throughout their life cycles. Restorative activities focus on reinstating components and conditions suitable for these processes to recommence and support recovery of ecosystem and cultural attributes, including capacity for self-organization and for resilience to future stresses (Gann et al., 2019).

Building on previous work, the project team used the interviews to test and refine a list of common restorative activities, which are anticipated to continue to evolve with further review (Figure 4). The restorative activities are often interconnected in their application, particularly through implementation of a multi-phased comprehensive restoration plan. The activities are proposed to serve a dual purpose, including:

- A consistent and common framework to facilitate communication, integration, and coordination for planning and implementing multiple restoration initiatives in a given area

- A structure for describing and assessing the strengths and vulnerabilities of the restoration supply chains that are required to support implementation of the restorative activities.

Figure 4 Restorative Activities



Source: Figure developed by the authors

4 Economic Terms and Concepts

4.1 Restoration Economy versus Restoration Market

The term restoration economy is broadly used, ill-defined, and discussions about a restoration economy in northern B.C. have often involved little focus on basic economic principles. This has left some asking if it is an economy and if so, what it means. Clarification of terminology is needed to help align efforts to maximize the benefits from restoration for local communities as well as demonstrate effectiveness in meeting provincial, national, and international targets for biodiversity, carbon, and other objectives that may support access to monetary markets for restoration.

Simply defined, an economy is the system of production, distribution, and consumption of goods and services. In the field of economics, a common distinction is between macro economics, which is concerned with how the overall economy works, and microeconomics, which is concerned with how supply and demand interact in individual markets for goods and services.

The term restoration economy gained popularity with the publication of The Restoration Economy: The Greatest New Growth Frontier: Immediate and Emerging Opportunities for Businesses, Communities and Investors by Storm Cunningham in 2002. He described a restoration economy as being the third phase of economic development resulting when restorative development is the dominate mode. The three phases include:

- New development/ adaptive conquest: a pioneering mode that launches most communities and civilizations, but can damage, degrade, or destroy irreplaceable assets if prolonged. Cunningham suggests that new development is fast becoming less profitable, desirable, and possible
- Maintenance/ conservation: this mode is always present, but seldom dominant
- Restorative development/ adaptive renewal: A dynamic, high-energy mode that restores the existing built and natural environment. Cunningham suggests restorative development is nearing dominance in construction, ecology, government, and business.

Cunningham saw restoration as the dominant phase of development once the other two reached a natural end. From that perspective, his approach is macro, but the term restoration economy has been broadly applied to refer to multiple things that are not macro in nature.

Most discussions about a restoration economy in northern B.C. focused on the challenges of scaling up restoration, for example how to secure sufficient funding, permitting issues, and a lack of skilled people. These considerations are microeconomics.

Although in theory there is a clear distinction between macroeconomics and microeconomics, there are gray areas that usually involve issues that have both individual (market level) and aggregate implications. Government policy, widespread technological change, and environmental issues are examples of the gray areas. Restoration straddles both sides of economics as it can be an economic development phase (as Cunningham described) or a series of market developments of different segments that compose the "restoration market".

This project focuses on the restoration market because it creates a pragmatic approach for:

- Aligning the interests and needs raised by interviewees
- Understanding what information about demand is needed to enable supply chains to effectively respond
- Supporting leaders and managers to understand the complexity, inter-linkages, and components of the restoration supply chain
- Identifying efficiencies that are required to scale up restoration from the project/site to the program/landscape scale
- Clarifying and assessing trade-offs required to support complex restoration objectives for an array of ecosystem services, and
- Creating incentives for adaptive management.

A focus on the restoration market is similar to how the term restoration economy is being defined in Western Australia, which is "the market consisting of a network of businesses, investors, consumers and government initiatives engaging in or driving the economic activity related to ecological restoration" (Young et al., 2023).

The terms “influences” or “context” will be used when describing the macro factors, including the gray areas, that can impact the restoration market.

4.2 Restoration Market: Definition

Definition: A system that generates and facilitates the exchange of products and services through the restoration of altered and/or at-risk assets (natural, built, and socio-cultural).

The restoration market is a complex ***system*** of interconnected factors that drive demand and impact the capacity of the restoration supply chains to respond to changes in demand. Opinions varied as to the ability to effectively manage the system given the complex context in which the market functions (e.g., climate change, consistent budgets) and the need for continual innovation in equipment, materials, and techniques. There was, however, strong agreement among interviewees on the need to better manage information about the restoration market to support decision-making by public and private sector managers and entrepreneurs.

Exploring restoration within the context of a market system that focuses on ***products and services*** is a new approach for some. There is concern with applying traditional economic approaches to restoration that may prioritize narrowly defined benefits (investment, revenue, and employment). There is, however, considerable interest in broadly defining products and services to support a diversity of ecosystem services that, in turn, support resilient ecosystems, cultures, and communities. If the products and services are broadly defined, then the microeconomic principles can support efficiencies that will help maximize the value of investments in terms of both ecological restoration and other benefits to local communities.

While a standard definition of ecological restoration involves assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed (Gann et al., 2019), societies must realize benefits from all ecosystems and so the more neutral term “***altered***” is proposed. Ecosystems are constantly changing with climate change altering trajectories even without resource development and large-scale climate events. The changes may be perceived as positive or negative. In some cases, landscapes and/or impacts may be repurposed rather than restored (e.g., an industrial road maintained for recreational purposes) or zonation has defined areas of intensive use (e.g., human settlement, ongoing resource development) as part of a large-scale land use plan. While from an ecological perspective the changes involve degradation or damage, the economic context and associated restoration market is forward looking to the desired and achievable recovery and associated benefits rather than classifying the change to the ecosystems, cultures, and/or communities.

As discussed in section 3.1, the inclusion of ***at-risk*** assets reflects the expansion of restoration from a focus on recovery following disturbances to include improving the resilience of at-risk assets. Recovery from disturbances benefits from functioning assets, including climate and wildfire refugia areas, so a restoration market recognizes the linkages.

Restoration of ***natural assets*** is a key focus for a restoration market, but pursuing broader restoration objectives may also require restoration of ***built and socio-cultural assets***, which includes (adapted from Cunningham, 2002):

- **Natural assets or ecosystem services**. In a northern B.C. context, this includes the concept of mitigating cumulative stresses and moving towards maximizing cumulative benefits (ecological, cultural, and economic), which currently involves a range of initiatives, including:
    - Value-specific restoration as a vehicle for restoring broader ecosystems and services, e.g., caribou recovery
    - Integrated cultural-ecological restoration, which may include restoring traditional cultural ecosystems where human utilization resulted in characteristics similar to natural disturbance, human-modified ecosystems that are appropriate reference models for restoration, and cultural heritage attributes
    - Offsets to create opportunities for further development. Restoration may be needed within offset areas so they can function and contribute as needed
    - Remediation and rehabilitation to continue operating in altered landscapes, e.g., post timber harvesting, oil and gas development (seismic lines, pipelines, and well pads), agriculture (range use)
    - Repurposing altered landscapes, e.g., conversion to agricultural lands, alternate uses for well pads or under hydro transmission lines.

- **Built assets**
    - Brownfields remediation and redevelopment
    - Infrastructure resilience/renewal/replacement
    - Cultural and historic structure restoration, including cabins, trails, spiritual sites

- **Socio-cultural assets**
    - Treaty rights
    - Education
    - Community services/security
    - Public institutions that support natural resource planning and decision-making

This project has focused on the restoration of natural assets and associated education and training.

4.3 Restoration Supply Chain Ecosystem: Definition

Supply chain definition: A network of individuals, organizations, resources, activities, and technologies that are involved in the creation and exchange of products and services.

Supply chain ecosystem definition: Multiple inter-connected supply chains that are required to meet demand with the potential for strengths and vulnerabilities to have cascading effects on the entire system.

Studies that have described restoration supply chains (Powter et al., 2021; Arbib et al., 2023, Young et al., 2023) were reviewed and the experience of the project team used to develop a proposed approach for defining restoration supply chains. The focus was on supporting practical analysis and identification of pragmatic opportunities to address key gaps. The proposed approach was tested with interviewees and modified based on input from a cross-section of participants in the

supply chains. The result is two types of supply chains that, together, comprise the restoration supply chain ecosystem:

1. **Enabling activities**: planning and decision-support processes (services) to create restoration plans and programs (products). These activities interpret macro scale drivers (e.g., factors such as climate change that are beyond the control of the restoration market but can impact it) and integrate them with micro scale drivers (e.g., local restoration priorities) to create products that forecast demand for the restorative activities supply chains.

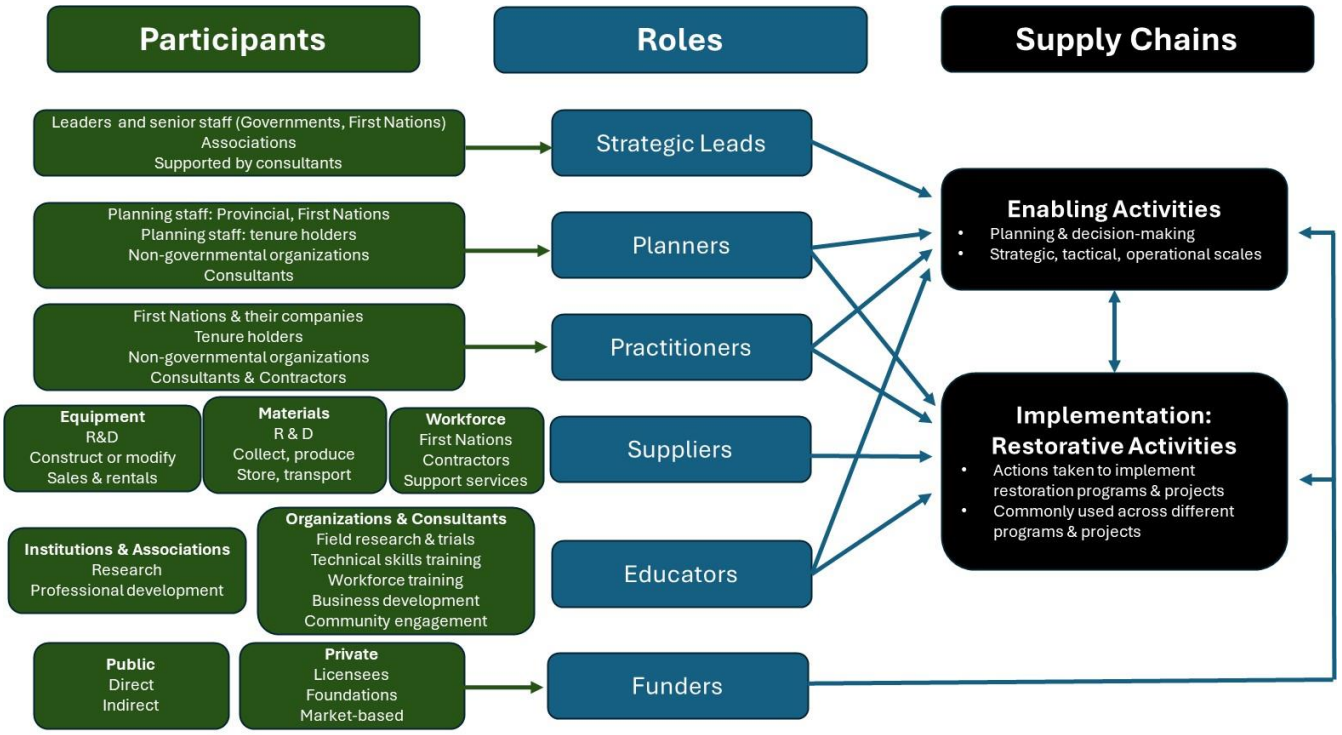
2. **Implementation of restorative activities**: the restorative activities that are common across most restoration initiatives (section 3.6) are the basis for describing the associated supply chains that support on-the-ground implementation. These are the focus of what is commonly referred to as restoration supply chains, including the people, equipment, and materials needed to complete specific tasks that, taken together, result in implementation of on-the-ground activities.

In other studies, enabling activities may be embedded within the concept of a restoration supply chain but they are not typically described as a separate type of supply chain. When funds are provided for restoration, there is often an expectation for immediate implementation of tangible, on-the-ground activities (restorative activities). Planning can be viewed negatively, unnecessarily complicated, and time consuming. Describing the supply chain ecosystem as including two interconnected types of supply chains seeks to clarify that funders are "buying" tangible products from the enabling services supply chains that are essential for defining demand. The products (restoration plans, programs, project prescriptions), enable restorative activities to be "purchased" from the associated supply chains. To optimize the restoration market and provide good value to funders, the supply chain ecosystem, including both types of supply chains, must provide efficient services and produce tangible, effective products.

4.3.1 Roles and Participants in the Restoration Supply Chain Ecosystem

Six key roles and associated categories of participants were identified as part of the restoration supply chains (Figure 5). Initial roles and categories of participants were defined based on the experience and knowledge of the project team and refined through project implementation.

Figure 5 Roles and Participants in the Restoration Supply Chains



Source: Figure developed by the authors

4.4 Demand Forecasts: Overview

Participants in the supply chains need to understand the current and likely future demand for their services and products so they can determine if changes to their operations may be needed. As it can take between 5-15 years for some components of the restoration supply chains to increase or modify their capacity, forecasting future demand is important.

A restoration demand forecast uses the best available information to communicate anticipated demand. While demand has typically considered the ***amount*** of restoration planning and restorative activities that may be required, there can also be change in demand for the ***complexity*** of what restoration is to achieve (e.g., to support a broader range of objectives) and how it is to be implemented (e.g., greater integration and coordination across initiatives). Changes in demand for the complexity of restoration are more difficult to quantify and have not always considered the impacts on the supply chains.

To date, demand forecasts tend to be sector-specific, yet demand can impact supply chains that support multiple sectors; hence, optimizing the restoration market would benefit from a comprehensive, integrated approach to demand forecasting. While the restoration supply chains function at multiple, interconnected scales, many of the socio-economic objectives for restoration are at local and regional scales. Therefore, this project explored what may be required to create integrated demand forecasts at a regional scale.

Optimizing the restoration market would benefit from reducing demand fluctuations and increasing the resiliency of the supply chains. Although there are some long-term contracts that create

stability, demand for restoration generally fluctuates in response to many interconnected drivers. At any given point in time, each driver may be an upward pressure, thus contributing to a potential increase in demand, or a downward pressure, which contributes to a potential decrease in demand. A more detailed discussion on demand drivers is provided in section 8.4.

Participants in the restoration supply chains stated that they need better information about potential changes in demand with five years of reasonable certainty to justify hiring and training new staff, new investments in equipment, and/or changes in the production of materials. As a result, this project explored what may be required to improve demand forecasts for restoration and how the information might be presented to support decision-making by participants in the supply chains.

4.5 Risks: When Demand and Supply are not Aligned

If demand for active restoration exceeds the capacity of the supply chains, economic theory predicts prices (the costs of planning for, and implementation of, restorative activities) will increase, which could result in:

- For non-legal obligations, less restoration being implemented relative to the available funding and resources
- Innovation in best management practices for resource development and/or restoration practices, which could increase efficiencies and effectiveness while reducing overall demand for restoration
- An increase in reliance on passive restoration if the "buyers" are unable to afford the new prices, for example in less active restoration associated with wildfire recovery or legacy issues that are not driven by legal obligations (e.g., seismic lines, some roads). In some cases, passive restoration can be both appropriate and effective to support ecological restoration, recognizing that restoration takes time. Passive restoration, however, may not support economic development goals; for example, short-term employment and contracting opportunities as well as the longer-term need to expand future land use options as quickly as possible
- Increased legacy issues and liabilities in the short- and longer-terms.

If the capacity of the supply chains exceeds demand even temporarily, then prices will go down and could result in:

- Investments in training, equipment modifications and/or purchases, and production capacity being lost as workers and contractors migrate to other opportunities and may be unavailable if subsequent demand for restoration increases
- Job loss and business failures, with the scale dependent on the circumstances.

5 Project Scope

Restoration supply chains are often siloed to align with resource development sectors or other drivers of demand. Many of the products and services are, however, transferable; therefore, assessing the strengths and vulnerabilities of the restoration supply chains must consider the demands across sectors and multiple drivers.

The project has explored what is required to develop demand forecasts and assess supply chains at a regional scale. Participants in the supply chains identified this level of specificity as required to determine if and how they need to change their operations to meet changes in demand. The Northeast Region was selected as the primary focus for the project given the level of activity and recent commitments, which has created a restoration market that is larger than other parts of B.C. The selection of the Northeast Region led to a focus on impacts that are of primary interest in that region, including those associated with oil and gas, forestry, and wildfires. Where possible, the project considered the issues and implications for the restoration market across B.C.'s north area, which includes the Omineca and Skeena natural resource regions.

As a commonly expressed interest was to grow the economic opportunities associated with restoration, partly by scaling up restoration from the site/project to the landscape/program scale, the project focused on potential impacts on demand and the supply chains from such scaling up.

Given the limitations of available data and uncertainties, the project developed prototypes, including for defining demand within the context of the current situation and two possible demand scenarios over the next 10 years. Prototypes were also developed for defining and assessing the strengths and vulnerabilities of the supply chain ecosystem to respond to changes in demand.

6 Project Methodology

The project team reviewed related studies and participated in forums that were discussing the restoration economy in B.C. to ensure this project would be complementary to and build on efforts to date. Publicly available quantitative data from government sources, including the Ministry of Forests (FOR) and the BC Energy Regulator (BCER), were used to develop prototypes for demand forecasts. Reviews of relevant studies and interviews were used to gather qualitative data to:

- Augment the quantitative data about demand
- As the basis for assessing the strengths and vulnerabilities of the restoration supply chain ecosystem, and
- Identify short-term actions to help optimize the restoration market.

6.1 Related Initiatives

Interest in restoration has resulted in numerous studies on the scale of the economic opportunities, including in Alberta (Powter et al., 2021), the Northwest Territories (Government of Northwest Territories, 2022), Western Australia (Young et al., 2023), and two for B.C. that have not yet been published. The project team also participated in a restoration conference in Vancouver in October 2023 that included presentations on the economic context for restoration in B.C.

In January 2024, an interagency planning committee comprised of provincial government agencies, the BCER, and Environment and Climate Change Canada hosted a workshop on growing the restoration economy in B.C. A member of the project team participated in the workshop, which identified opportunities and challenges that were grouped into four pathways for growing a restoration economy (Fuse Consulting Ltd., 2024), including:

- Building capacity and training
- Reducing regulatory and policy barriers
- Achieving co-benefits and resiliency
- Monitoring outcomes.

Interest in supply chains have resulted in focused studies, including on the national seed supply chain (Mouck et al., 2023 and Spearing et al., 2023), a labour market strategy for the silviculture industry (Catalyst Research Group, 2022), and an overview of remediation undertaken by the natural gas sector (iTOTEM Analytics. 2023). Associations, such as the BC OGRIS, Western Forestry Contractors Association, the Forest Nursery Association, the B.C. Seed Orchard Association, and the National Tree Seed Centre are pursuing some of the supply chain issues and, in some cases, are creating forums and hosting conferences to support discussion.

FOR has recently created the Reforestation Service Supply Chain Committee that is seeking to support B.C.'s involvement with the federal 2 Billion Tree Program and address other opportunities and challenges in the supply chain. Finally, companies in the supply chain are expanding, entering into formal partnerships, and/or creating networks to increase their capacity and resilience to respond to changes in demand.

As these efforts indicate, there is interest in a restoration market, including concerns regarding supply chains. This project has sought to build on previous efforts and support ongoing initiatives by exploring development of integrated demand forecasts at a regional scale and an approach for assessing the strengths and vulnerabilities across the complex interconnected supply chains that make up the restoration supply chain ecosystem.

6.2 Quantitative Data Sources and Analysis

Best available quantitative data for impacts from oil and gas development from BCER, included:

- Wells – number of sites for both dormant and orphan wells
- Pipelines – number of kilometers
- Seismic lines – number of kilometers.

Best available quantitative data for impacts from forestry activities from FOR included:

- Harvesting trends for Skeena and Omineca with little activity in the Northeast Region
- Site preparation, planting, and brushing for all three regions with some cost information.

There was no quantitative data available about wildfire recovery that could be used.

To develop an integrated demand forecast across different sector impacts, a common measure of demand was needed; hence, cost estimates for restoration of the impacts from oil and gas and forestry were developed. Developing cost estimates required making assumptions.

Additional quantitative data for forecasting demand included publicly available information about funds committed to restoration or to programs that have restoration as one of their focal areas. Assumptions were made about:

- How much funding from provincial scale programs may be spent in the Northeast Region
- The timeframe for spending funds that will be used over a period of time.

The assumptions and detailed methodologies used to develop prototypes for current demand (base case) are outlined in section 9.1.

Studies on restoration supply chains include quantitative data collected through surveys (Government of Northwest Territories, 2022, Powter et al., 2021, Powter et al., undated, Spearing et al., 2023, Young et al., 2023). Canadian data is at the national or provincial scale, which provided context for this project's focus on the regional restoration market in Northeast B.C. Also, some authors noted that survey response was low, so their results are best considered to be indications of, rather than definitive statements on, the issues.

6.3 Qualitative Data Collection through Interviews

Sixty-nine online interviews were conducted with a cross section of participants in the restoration supply chains to gather qualitative input on the project objectives. The interviews averaged one-hour in length. The interviews included 17 strategic leads, 10 planners, 19 practitioners, 12 suppliers, 7 educators, and 4 funders outside of provincial government agencies. Consultants conducted the interviews using a general guide with conversations reflecting the unique knowledge and experience of each interviewee. The input was given in confidence and this report reflects a synthesis of the input. Language has been modified, as necessary, to integrate similar comments or ideas. It is recognized that statements made by multiple interviewees are one indication of significance, however insightful perspectives offered by a single interviewee are also reflected in this report.

7 The Restoration Market in Northern British Columbia

7.1 Goals

Proposed short-term goal: To optimize the restoration market through a focus on efficiency, innovation, and effectiveness.

While there is interest in growing the restoration market, many inefficiencies and missed opportunities have been identified in how the restoration market currently functions. Therefore, it is proposed that a pragmatic short-term goal is to optimize the restoration market, which could create the conditions necessary for future growth.

Interviewees identified numerous goals that can be supported by restoration, and which relate to both macro and microeconomics.

7.1.1 Restoration Goals and the Macro Economy

Restoration is seen as one mechanism for pursuing broad land and resource management goals. When stated, the broad goals and supporting objectives and targets can then guide development of restoration objectives and targets, which in turn can support integrated restoration across multiple interconnected scales. The broad goals that were identified by interviewees relate to the macroeconomic context for the restoration market and include:

1. Improve ecological, cultural, and community resilience

   A focus on resilience is in response to the uncertainties created by climate change, global markets, and other factors that are largely beyond the control of local communities or even provincial and federal governments. Restoration is one mechanism for improving resilience. To do so, restoration would benefit from tactical-level objectives and targets for landscapes that have been altered and/or are at-risk, which are nested within broader resilience goals at the strategic scale.

2. Improve management of cumulative effects

   Cumulative effects management includes both minimizing the cumulative disturbances from resource use, development, and climate change as well as maximizing the cumulative benefits from the three pillars of restoration, conservation, and best management practices for resource use and development. To be effective, planners and practitioners spoke of the need to:

   - Scale up restoration from the project/site to the program/landscape scale with objectives and targets used to align efforts at the strategic, tactical, and operational scales
   - Improve integration and coordination across restoration initiatives at multiple, interconnected scales as well as across the three pillars of cumulative benefits.

3. Support reconciliation

   Restoration is viewed as an important component of reconciliation. It is widely considered to be a positive response to shared concerns that can offer opportunities to:

   - Identify common ground and support relationship-building
   - Explore a two-eyed seeing or walking on two legs approach to bring indigenous knowledge into balance with western science (Blueberry River First Nations et al., 2021) (Hoyle et al., 2021)
   - Explore principles, structures, and processes for co-management
   - Expand lessons learned to other natural resource and land use decision-making.

   To effectively contribute to reconciliation, however, depends on the clarity of the reconciliation goals, as restoration includes trade-offs and social choice decisions that must be guided by agreement on broader goals.

7.1.2 Economic Development Goals and the Microeconomy

There is broad interest in using restoration as a focus for economic development, which the Province defines as "programs, policies, or activities that seek to improve the economic well-being and quality of life for a community" (2023). Optimizing the restoration market includes pursuing numerous economic development goals, including those identified by interviewees, some of which can be contradictory, and which reflect two main themes:

1. Short-term employment and contracting opportunities

    - Prioritize meaningful and culturally appropriate opportunities for Indigenous communities, members, and companies

    - Prioritize opportunities for local communities, companies, and residents

    - Support transitions to:

        - Replace loss of opportunities in the natural resource development sector

          Forestry is considered to be in decline and some want to see reductions in other industrial sectors with lost jobs replaced through restoration initiatives. Others anticipate that a restoration market will only support a partial replacement of losses associated with a downturn in the natural resource sector.

        - Reduce dependency on and/or the future amount of resource development

          Some have suggested that wages within the restoration market need to be equivalent to those in resource development as their objective is to create viable employment alternatives for community members. Hence, this goal is entwined with the goal of reducing or perhaps eliminating resource development from a defined geographic area and aligns with the view that a restoration market is separate from natural resource development (section 7.3.1).

        - Stable, year-round, and long-term opportunities thus replacing the boom/bust cycle of resource development and limited, seasonal employment associated with many restoration initiatives.

          Suppliers within the restoration supply chain identified the need to develop well-paying, consistent, and year-round employment opportunities to attract and retain skilled workers.

2. Longer-term economic benefits

    - Expand opportunities for future land use decisions

      Active restoration seeks to not only achieve a defined desired future condition, but to accelerate the pace of restoration, to the degree possible. Thus, compared to passive restoration, active restoration seeks to not only expand opportunities for how natural resources may be used in the future, but also allow for such decisions to be made sooner. For some, this includes expanding future opportunities for industrial-scale resource development. Others do not support this as a goal, instead restoration is

primarily to support broad ecosystem services and an economic system that emphasizes non-industrial or smaller scale uses of natural resources.

- Become a centre of excellence for restoration that will:

    - Facilitate investments in research, restoration practices, and best management practices for resource use and development

    - Build capacity to not only support restoration in northern B.C., but also participate in restoration markets in other jurisdictions, including provincially, nationally, and internationally. The broader opportunities can help recruit and retain skilled people.

7.2 Cultural Influences

The economic context for restoration is tied to cultural transitions as the cultural norms and institutions were created during the earlier macroeconomic phases of new development and conservation (section 4.1). The commitment to reconciliation with Indigenous communities is part of the cultural shift that many anticipate will support the transition to a restorative development phase for the economy in northern B.C.

The Indigenous economies of northern B.C. have always been rooted in the use and stewardship of vast territories and a wide trade network. Traditional stewardship included restoration, for example cultural burns. Today, the opportunities associated with restoration are a key focus for economic development strategies for most Indigenous communities. Indigenous perspectives and principles, including the use of traditional knowledge, are being used to design on-the-ground restorative activities and how they can be pursued to maximize the benefits, including economic benefits, for communities. Integrating Indigenous perspectives and principles into a restoration market is part of a larger cultural shift that is being driven by the *Declaration on the Rights of Indigenous Peoples Act*.

There are cultural differences across northern B.C. that reflect differences in ecosystems, dominant economic drivers, Indigenous communities and their relationship with governments (Treaty rights in the Northeast Region and parts of Skeena Region with Indigenous rights elsewhere), and demographics. In Skeena Region, restoration is a less frequently used term but there is strong interest in restoration associated with fisheries, including fish passage and restoring the impacts of land-based activities that could negatively impact fish and other food species. In Omineca, there are two distinct ecosystems that require different approaches with Highway 16 creating a dividing line. Forestry, the dominate driver for landscape change, is undergoing a major transformation with a need to focus on broader restoration compared to traditional reforestation. The Northeast is a more complex mix of industrial activities that is dominated by oil and gas, which has a different operating culture than other sectors that dominate in Omenica and Skeena. As a result of the Yahey decision, the Northeast is experiencing system-level changes that are seeking to transform not only what constitutes restoration but how it will be designed and implemented.

The context for the restoration market in northern B.C. includes a growing human population. B.C.'s population is anticipated to increase by 49% by 2046 with the growth concentrated in the lower mainland and southwest region (B.C. Stats, 2024). The current number of births in B.C. has

been lower than the number of deaths since 2021 so growth has been and is anticipated to continue to be driven almost entirely by migration, most of which will be international. Hence, restoration in northern B.C. will unfold within an increasingly urban dominated economy, population, and culture, which creates uncertainties as to how restoration will fit relative to broad provincial priorities and budgets in the future.

One of the lingering outcomes of the COVID-19 pandemic is a cultural shift that favours working from, or at least close to, home as people changed their lifestyles, including employment, during travel restrictions. Some employers reported that workers are now more reticent to take work that requires significant travel. Conversely, given housing and other costs of living, seasonal workers require longer seasons and more stable work and to meet that demand, employers often must pursue opportunities that require travel.

7.3 Relationship with Other Markets

7.3.1 Externalities from the Natural Resource Sector

The natural resource sector seeks to optimize the production of goods and services from resource use and development while stewarding the natural resources on which it depends. There are multiple natural resource markets that operate as part of the sector (e.g., oil and gas, forestry, mining, agriculture).

B.C.'s legislative framework defines the legal obligations for tenure holders for restoration. Broad societal expectations for restoration, which have and will continue to change, are not always fully reflected in existing legal requirements. For example, there are legacy impacts, which are defined as disturbances that do not involve a regulatory obligation to conduct restoration and contribute to overall cumulative stresses on ecosystems, cultures, and communities (Petroleum and Natural Gas Restoration Management Committee, 2023). From an economic perspective, legacy impacts are externalities, which are the consequence of resource use that affects other parties without being reflected in the cost of the goods or services involved.

Scale is often a factor in defining externalities, for example when the greater share of benefits is experienced at a regional, provincial, or larger scale yet the stresses and risks are disproportionately experienced at the local community scale. There is also a linkage between scale and whether the benefit directly addresses a stressor. For example, a direct benefit from resource development is revenue to the provincial government, which is then used to support restoration and the provision of government services across the province, thus resulting in indirect benefits back to the region and local communities. The indirect benefits may be dispersed across a wide geographic area and range of priority issues that are indirectly connected to resource development. Without a direct connection to addressing the specific stressors, the benefits may be viewed as inadequate with externalities remaining.

There is a lack of agreement on the philosophical relationship between a restoration market and the natural resource sector, which has implications for how to best support a restoration market to reduce externalities. Views ranged from the restoration market is a:

- ***Quasi-separate system***. In this view, restoration is incremental to, and may not include the legal requirements for remediation or rehabilitation that licensees and permit holders are required to undertake. A key driver is the recent Yahey decision on the cumulative impacts from resource development on Treaty Rights and commitments to reconciliation. Some anticipate it will build support for a higher level of recovery, including full ecological restoration (section 3.5).

  The proposed structure includes creating trusts or other forms of secure long-term funding for restoration, which would be funded by governments and market-based sources. The goal is to grow the restoration market, which could reduce future reliance on natural resource development with jobs and opportunities in the restoration market replacing at least some of those involved with natural resource development. Some interviewees voiced concern about this approach as in their experience, separate funding structures can be ineffective as they can contribute to fragmented, siloed responses when an integrated, coordinated approach is required. The level of effort required to create independent structures can also be a distraction, at least in the short-term.

  This approach is not entirely separate from natural resource development because one purpose for supporting Treaty Rights and reconciliation is to provide certainty for investments in resource use and development, including by Indigenous communities. Also, currently, authorizations for restorative activities are provided by a governmental system that was designed to support resource development, which fosters an ongoing relationship.

- ***Different and/or better system*.** In this view, restorative development is the dominate mode. It creates a paradigm shift with the capacity for, and effectiveness of restoration as a determining factor for future resource development opportunities, rather than restoration being a response to resource development.

  Discussions on this approach lacked details as to what would be required to achieve it. Some hope that modernized land use planning and tactical planning, such as Forest Landscape Plans, will support the shift with others concerned that such planning is too narrowly focused. There may also need to be changes in strategic priorities and governance structures to lead the required change management.

- **An agent of change from within the natural resource sector.** In this view, the restoration market is embedded within the larger natural resource sector and, as such, can be a driver for understanding and reducing externalities. The management of natural resources is the responsibility of the Province, which increasingly collaborates with First Nations to create a legislative framework that assigns responsibilities for restoration to tenure and permit holders. This view assumes that the Province will modify the legislative framework based on lessons learned from the implementation of restoration initiatives to reduce externalities. In doing so, those who are given access to publicly owned natural resources assume responsibilities for a greater portion of the full costs of development to minimize externalities. This view is supported by those who emphasize the importance of engaging

industry in restoration as they have critical capacity and, if there are clear restoration objectives and standards, the motivation to efficiently achieve results.

Full cost accounting is dependent on establishing clear legal standards for recovery to guide industry. While there is general agreement that standards for industry-led restoration have and will continue to evolve, there is concern that the process to change standards is too slow and industry will never have the mandate for, or motivation to achieve the full range of multi value goals. Moving towards greater full cost accounting can also be challenging if current and anticipated future resource development will not generate sufficient revenue to address legacy impacts, especially given that climate change and climate events can increase the costs of restoration. Thus, the restoration market may need to be managed within the broad, macroeconomic system rather than assume proponents operating at a local level can absorb all associated costs.

7.3.2 Relationship with Related Concepts

A comprehensive and coordinated approach to optimizing the restoration market would benefit from clarifying its relationships with related concepts. While outside the scope of this project, it is important to recognize there are related concepts, which could be complementary or synergistic. Table 1 compares the different terms.

Table 1 Comparison of Restoration Economy, Restoration Market and Other Commonly Used Terms

Aspect	Restoration Economy	Restoration Market	Circular Economy	Green Economy	Bio-fuel Market	Nature-Based Solutions	Full-Cost Accounting
Primary Focus	A mode (phase) of development. Restoration of natural, built, and socio-cultural assets	The marketplace where goods and services related to restoration are generated and exchanged	Efficient use of resources and reduction of waste in production and consumption	Sustainability and reduced environmental impact across various economic sectors	Use biomass to produce consumer goods and industrial products	Utilizing natural processes and ecosystems to address environmental challenges	Accounting method to include the full environmental and social costs of activities
Goals	Realize benefits from restoring or repurposing altered and at-risk landscapes to support resilience	Foster a thriving industry around restoration initiatives	Minimize resource depletion, waste generation, and environmental impact	Promote sustainable development and reduced environmental impact	Shift the forest sector to a high-value, waste-free circular economy to mitigate climate change	Mitigate and adapt to environmental issues using natural mechanisms	Transparently assess the total costs of activities, including externalities
Approach	Maximize the cumulative benefits from individual restoration initiatives	Improve effectiveness and efficiency; research & development to support innovation	Rethinking the entire lifecycle of products and materials to minimize waste	Broad range of practices and technologies to reduce resource consumption and pollution	Use residual material from conventional forestry or non-timber forest products	Utilization of nature's processes and ecosystem services	Analytical tool and framework for cost assessment and decision-making
Economic Drivers	Job creation and workforce transition, expand future land use options	Government regulations and policies; public and private funding; innovation; collaboration	Reduced resource costs, increased resource efficiency, new markets and business models	Development of clean energy industries, energy savings, green job creation, reduced healthcare costs	Reductions in Allowable Annual Cut, wildfire risk reduction	Environmental benefits, cost savings, and resilience to climate change	Informed decision-making, reduced external costs, sustainability assessment
Examples	Policies and market-based incentives to support a restoration market	Supply chains for human resources, equipment and materials meet demand	Designing products for easy disassembly, recycling, waste reduction in production	Adoption of renewable energy, energy-efficient buildings, electric vehicles, sustainable agriculture	Cross laminated timber products, wood biomass heating systems for remote communities	Green infrastructure, natural flood management, urban green spaces	Assessing the true cost of production, accounting for environmental impacts

7.4 Scale of the Restoration Market

Attempts have been made to measure demand for restoration in B.C., generally at the provincial scale. Methodologies and assumptions diverge considerably, thus providing a variety of results:

- An unpublished study (Powter et al., undated) estimates the total potential remediation and restoration workload in B.C. as of 2019 to be $2.795 billion in total liabilities and growing. The study was based on a survey of 32 respondents. The full report and data were unavailable prior to writing this report.

- Smart Prosperity Institute estimated at least $132 billion will be needed over the long-term for all restoration required in B.C. (Restoration Conference 2023, October 2023, Vancouver, B.C.). The full report and data were unavailable prior to writing this report.

- The total costs for boreal caribou habitat restoration in B.C., has been estimated to be between $900 million and $1.39 billion (Anielski, 2019).

  Understandably, the study had to use many assumptions, for example that restoration of legacy seismic lines cost on average $10,000 per kilometer. In 2020 with funding from the federal COVID-19 Economic Response Plan and the Province of B.C., restoration of approximately 154 kms of legacy linear features in the Northeast Region was completed with costs ranging from $26,000/km to $114,000 km, which did not include planning and monitoring costs. As capacity grows and efficiencies are identified, costs may decrease.

Attempts to measure demand for restoration in other Canadian jurisdictions have also been made, with similar challenges of differing methodologies and assumptions and include:

- The remediation and restoration workload in Alberta includes an estimate as of June 2019 of $30.8 billion for abandonment and reclamation of coal and oil sands mines (Powter et al., 2021).

- A study in the Northwest Territories (NWT) estimated that $4.8 billion of work is needed over the next 30 years with 90% of spending likely to occur in the next 15 years. The annual spend is estimated to be roughly $291 million per year for the next 15 years, generating approximately $151 million per year in Gross Domestic Product (GDP) to the NWT in that timeframe (Government of Northwest Territories, 2022).

- At the global scale, the Kunming-Montreal Global Biodiversity Framework targets include restoration of 30% of degraded ecosystems by 2030. The damages from climate change, land degradation, and biodiversity loss are estimated to be costing 10% of GDP annually, which in theory is the annual value of restoration if damages could be reversed. B.C.'s GDP as of 2020 was $288 billion.

For context, the scale of the natural resource sector in B.C. is estimated at $15.3 billion annually in current dollars as of 2020, which is 5.3% of B.C.'s GDP (Source: B.C. Stats). Although it is not

possible to separate from the totals, this estimate includes restoration activities undertaken by service sector providers, licensees, and permit holds within the natural resource sector.

Over the last few decades, B.C. has introduced multiple legal obligations to restore, which has resulted in legal obligations accounting for the majority of the current restoration initiatives. Legal obligations do not include legacy issues or externalities, which could be an additional factor in estimating the potential scale of demand for restoration. Liabilities can be quantified using estimated costs for remediation, rehabilitation, or ecological restoration. A more fulsome assessment could also include additional restoration costs should a failure occur (e.g., contamination of an adjacent water body) and associated lost opportunity costs (e.g., fishing closures within the contaminated water body). Increasingly, the provincial government considers liabilities relative to Indigenous and Treaty rights, so quantifying liabilities is becoming more complex as a broader range of ecosystem services is considered. Assessments of liabilities can be useful in comparing the costs and benefits of pro-active restoration to emergency responses should a failure occur.

Multiple sources provide estimates of public liabilities in B.C., based on different methodologies and approaches:

- Public liabilities for remediation of contaminated sites in B.C., outside of the oil and gas sector, were suggested to be at least $500 million (Personal communication, Ministry of Environment and Climate Change, 2023).

- A Globe and Mail investigation suggested the shortfall in payments from industry for mine reclamation ranges from $400 million to $753 million depending on how the liabilities are calculated.

- In the Northeast Region, orphan wells occur when the associated oil and gas company is declared bankrupt or can't be found. Orphan wells make up just over 1% of all oil and gas wells in B.C. The total liabilities associated with orphan wells are estimated to be $92.15 million for 2023/24, according to the BCER Financial Plan. BCER determined the liability based on costs to meet standards that reflect an obligation to ensure public and environmental safety. The liability for known orphan sites is estimated using expected abandonment and restoration costs for these specific sites, under expected conditions based on known characteristics of each site. Full reclamation costs for orphan sites are estimated to be in the range of $112,000 to $176,000 per site.

- The costs of remediating legacy seismic lines within boreal caribou habitat have been estimated to be $1.39 billion at $10,000 per kilometer (Anielski, 2019), but as noted above, recent seismic restoration efforts in the Northeast Region have involved higher costs.

- Forestry road engineers expressed concern over increasing public liabilities associated with resource roads but did not provide a total cost estimate. It is estimated that there are

200,000-300,000 road crossings over fish bearing streams and rivers, some of which lack clear legal responsibility for maintaining fish passage.

- The Forest Practices Board of B.C. reported that the indirect costs from wildfire, such as loss of timber that supplies mills and supports jobs, damage to watersheds and drinking water, and negative impacts on the tourism industry, are estimated to be 2 to 30 times higher than the direct costs to suppress wildfire. The 2023 wildfire season, for example, had direct suppression costs of approximately $800 million, and based on that multiplier, the indirect costs could have been up to $24 billion. Additionally, B.C.'s forests have released more carbon than they store due to the emissions associated with mountain pine beetles and severe wildfire seasons. In 2017, 2018, and 2021, annual direct B.C. wildfire emissions averaged three times the annual emissions from all other sectors in B.C. combined.

There was no indication of an ongoing effort to improve calculations of liabilities, including a cumulative effects assessment across different sectors or types of impacts, or a rigorous review of methodologies to support improved demand forecasts for restoration.

Generalized information about the potential scale of demand for restoration can be useful in strategic-level decision-making for defining the relative priority of restoration compared to other needs, for example housing and health care, and for allocating resources across the range of natural resource stewardship activities. The information does not, however, assess actual commitments to restoration and is, therefore, less useful to most decision-makers in the restoration supply chains who need more specific data on demand at the regional and more local scales.

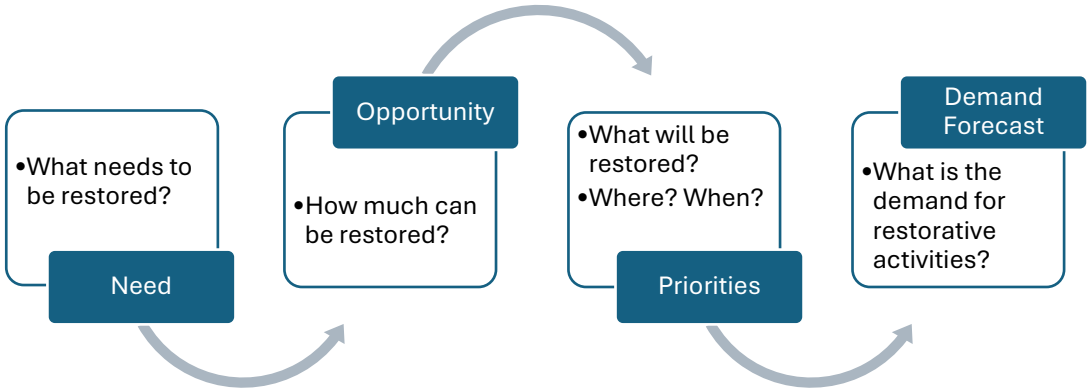
8 The Process of Forecasting Demand

Current demand forecasting reflects the silos associated with resource development, the distinctions between remediation, rehabilitation, and ecological restoration, and that multiple, unconnected restoration initiatives are pursued in response to the multi value needs defined through policy and cultural planning. Supply chains, however, often support demand from numerous sectors and initiatives. Therefore, a comprehensive, integrated demand forecast would provide the information needed to maximize the cumulative benefits from investments in restoration as it will promote efficiencies, innovation, and effectiveness across the range of restoration initiatives.

Development of a comprehensive demand forecast for restoration was outside the scope of this project, rather the focus has been to develop prototypes for generating the type of information that participants in the supply chains have stated they need. The prototypes can then be reviewed to determine if and how improvements could be made. Input from interviewees, reviews of related initiatives, and economic theory guided development of the prototypes. Interviewees also identified ongoing work that could improve demand forecasts, including the use of Artificial Intelligence (A.I.) that could increase the complexity of data analyses and develop real-time forecasts.

Ideally, demand forecasts for implementation of on-the-ground restorative activities involve real-time assessments of need, opportunities, and priorities, including the associated drivers of change, at multiple interconnected scales (Figure 6).

Figure 6 Process for Forecasting Demand for Restorative Activities



8.1 Needs

Ideally, a needs assessment considers the cumulative disturbances or stressors, including their known significance relative to stated objectives or targets for a range of ecosystem services, some of which are defined through legal obligations. The assessment must also consider factors that can be used to adjust or net down the assessment of total risks to identify candidates for investments in active restoration. Currently, there is no agreed upon methodology for developing an integrated needs assessment. The Province has been developing its capacity to undertake other types of cumulative effects assessments so there may be opportunities to build on lessons learned.

8.1.1 Total footprint

Disturbances that may require restoration typically involve a calculation of the total footprint from resource use and development as well as large scale climate events. The quality of currently available data is considered lacking by planners across sectors, First Nations, and government agencies and has resulted, for example, in one First Nation purchasing data from a private company in Alberta. Efforts are underway to improve data collection across the province using LiDAR. One interviewee suggested that new satellites will soon be launched and are anticipated to greatly improve data collection. An additional challenge is that private ownership of data about public lands and resources can be a barrier to integrated and coordinated restoration. The siloed nature of resource development, which to some extent is mirrored in the restoration supply chains, can also lead to inefficiencies in data collection, analyses, and management.

An alternate view, including from those who work internationally, is that sufficient data exists, is far better than available data in other jurisdictions, particularly developing countries that are implementing large-scale restoration programs, and should not prevent the advancement of restoration in B.C. For some interviewees, the challenges include not only the amount or quality of data, but lack of knowledge as to what data exists and how to access it, as well as how to use it to inform decision-making.

Some feel that now is the right time for a focused discussion on emerging technologies and how they can best be used to improve data collection and analysis that will help generate comprehensive, integrated demand forecasts for restoration. The discussion could lead to a comprehensive strategy with corresponding partnerships to support implementation.

8.1.2 Resilience

Projected risks from climate change, including species shifts and events such as large-scale wildfires and flooding, are major stressors. Opinions vary on whether restoration should include restoring resilience as well as recovery from resource use and development and climate events, partly because the latter's needs often exceed opportunities to restore so expanding the concept of restoration adds further challenges. Climate change and associated large-scale events are, however, key context for restoration planning, including the risks to investments if the restored area could be negatively impacted by wildfire or flooding.

The B.C. Wildfire Services uses the Provincial Strategic Threat Analysis to assess risks. The Forest Practices Board of B.C. reported that the 2021 analysis indicates 45 percent (39 million hectares) of public land in B.C. is at high or extreme threat of wildfire, and 28 percent is at moderate threat. The build up of fuels is creating concern about the intensity and extent of wildfires. First fires can be stand replacing, but an even greater threat can be second fires, which are being experienced within shorter fire intervals. The initial fire can leave many standing dead trees that eventually fall to become ladder fuels and when combined with dense regeneration, the conditions support a second fire that can cause a shift in ecosystems with trees and some ecosystem services unlikely to re-establish for a long time.

Hence, an assessment of resilience needs to consider multiple related risks over time. Of particular concern for restoration are risks to climate and wildfire refugia areas. Such areas are needed to support not only climate adaptation and migration, but also to be sources for re-establishing native flora and fauna following disturbance events. In a survey of people involved in Canada's national seed supply chain, over 50% of respondents stated they rely on wild or naturally restored areas to manage their production (Spearing et al., 2023). Hence, restoring the resilience of refugia areas can be a key strategy for comprehensive, landscape-scale restoration planning. Climate and wildfire refugia areas have been mapped for the province and work is ongoing to create tools that will make the information publicly available. For the Northeast Region in particular, wetlands are key determinants for which areas may function as refugia. Other provinces have assessed the vulnerability of wetlands given projected changes in climate. It was suggested that such an assessment has not yet been completed for B.C. and could be a logical next step for continued work on identifying future climate and wildfire refugia areas.

8.1.3 Net Down Adjustments

The need for restoration may be less than indicated through an initial assessment of total footprint and risks to landscape resilience . A needs assessment must, therefore, include calculating net down adjustments with the result being the total areas/impacts that are likely to benefit from investments in active restoration. There are numerous ecological and socio-cultural factors that could result in a net down adjustment, such as:

1. Effectiveness of passive and previous active restoration to create a positive recovery trajectory

   While the analysis is preliminary and limited, there are indications that up to one-third of untreated legacy seismic lines may already be on a positive recovery trajectory. Over time, passive restoration has at least initiated recovery. In some cases, active restoration at this point would not improve the recovery trajectory, for example due to the negative impacts of operating machines over areas that are starting to recover. In forestry, the Province reports that 20% of harvested areas recover through "natural regeneration". Assessing the effectiveness of passive restoration within different contexts is one of the net down calculations.

   Previous restorative activities may have created a positive trajectory for recovery so while full recovery has not been achieved, at this point and going forward passive restoration is the most cost-effective approach. Alternatively, some practitioners voiced concern about reliance on some practices, including seeding of non-native grasses that form thick mats and prevent the establishment of native shrubs and trees even after 20-30 years. The lack of long-term monitoring is a key gap with some practitioners returning to previous sites out of personal interest but without support for a structured assessment. Better understanding of the effectiveness of past restoration efforts is key to calculating net downs to identify good candidate areas and/or impacts for investments in restoration.

   Machine learning (a branch of A.I.) is being used to stratify areas and/or impacts that may be good candidates for passive and active restoration, including exploring a range of determining factors such as site index, aspect, moisture, and nutrient regimes. At a minimum, such modeling can support strategically designed and less costly field monitoring and verification programs that can use a sampling approach. A few consultants are exploring the use of machine learning, but as this is an emerging practice, it would likely benefit from a focused review of current knowledge and practice, emerging trends, and strategies for its use in developing integrated, real time demand forecasts.

2. Potential future disturbances

   Tenure holders may identify potential future use as a reason for not initiating incremental restoration that is beyond basic legal obligations with stated timelines. For example, maintaining a road in anticipation of future activities in the area. Uncertainties about future activities and, for the oil and gas sector, competitiveness that leads to a lack of transparency about future plans may result in a conservative approach that favours options for future use and development when considering net down adjustments.

   The cumulative effects across multiple sectors that operate under different legislation and within different cultures make forecasting future use of altered landscapes challenging. The recent experience of rehabilitated roads within caribou habitat being re-opened for use is an example of the difficulty of ensuring, outside of protected areas, that investments in

restoration will not be undermined through future resource use or development. As noted in section 3.3, some funding organizations require a 30-year commitment for no development in a restored area and the Province is exploring potential legal tools to protect investments in restoration. This can limit investments in restoration outside of protected areas or result in more conservative decision-making on possible candidates for restoration. Some interviewees suggested that redevelopment within restored areas may be appropriate if the result is a net gain. For example, if the result focuses development in areas that have already been altered rather than undisturbed areas, and if the new development will pay the costs of further restoration.

Interviewees identified that risks to completed restoration projects from wildfire are also a concern. A social choice could be made to net down areas outside of climate and wildfire refugia areas that are at highest risk from wildfire. Alternatively, considering the risks from wildfire could be a subsequent step when identifying priorities (section 0).

3. Repurposing areas and/or specific impacts

There may be interest in re-purposing rather than restoring some areas or impacts. Maintaining access using linear corridors that were created for one industrial activity to support a different industrial or community use is a common example. Identifying candidates for road restoration can be a costly process as defining local interests may require engagement of individuals with vested interests not just communities. Scaling up restoration to the program/landscape scale will benefit from considering net downs at the larger scale, for example assessing options across a road network rather than individual roads with an understanding of the associated budget for road maintenance and liabilities to support discussions on trade-offs across the network.

A project in Alberta explored how to address barriers to using aging oil and gas infrastructure and sites for new development, including hydrogen, solar, wind, lithium, geothermal or carbon capture and storage projects.

There may also be opportunities to repurpose within the context of restoration, with timber harvesting or other development practices serving as tools to support restoration objectives. Identifying economically viable strategies to reduce forest ingrowth has been a focus for decades in dry forest and grassland ecosystems. Timber harvesting for non-lumber markets, such as posts and biofuels, are used to make stand tending activities economically feasible. One practitioner has suggested reframing the restoration challenge for areas with a concentration of legacy seismic lines that are not regenerating through passive restoration by overlaying a timber harvesting cutblock. The question to be explored is if leveraging and mobilizing the equipment and skilled people needed for harvesting and reforestation might improve the cost-effectiveness of pursuing additional restorative activities to support broader landscape-scale restoration objectives.

8.2 Opportunities

Identifying areas or impacts that need to be restored is an important first step, but there must also be opportunities to implement restorative activities. Opportunities are created by the set of circumstances and decisions, including available budgets, that taken together, determine the type, level, and amount of investment in active restoration. If need exceeds opportunities, then the scope of the opportunities will also determine the extent to which passive restoration will determine the recovery trajectory.

There are clearly identified opportunities, such as legally required activities, as well as programs that have a greater degree of flexibility in determining what opportunities will be pursued. For the latter, differing governance structures and funding mechanisms are important factors in the resulting opportunities.

In terms of governance, initiatives that are intentionally designed to foster integration and collaboration across needs and sectors are more likely to create opportunities that reflect an understanding of the cumulative effects on supply chains. Initiatives that are more narrowly defined or pursuing a strongly independent approach can create demand that may exasperate challenges for the restoration supply chains, unless there is active coordination between initiatives to support efficiencies, innovation, and effectiveness. Interviewees commonly reported frustration in tracking opportunities created by the ever-changing initiatives that are often address a narrowly defined need for a limited period of time.

In terms of different funding structures for legal and non-legal restoration, each create opportunities and challenges, including:

- Non-legal, short-term, one-time opportunities that may be administered by temporary committees or existing organizations, which may have a broader mandate than just restoration. Short-term commitments create pulses or fluctuations in demand. The priorities and administrative capacity of the selected organization or committee are key determinants for how demand on the supply chains materializes, for both planning and on-the-ground activities. Funders and other decision-makers may have limited understanding of the significant demands that short-term opportunities create for planning and permitting, rather the expectation is that opportunities will be focused on implementation of on-the-ground restoration

- Ongoing, but uncertain opportunities, including organizations that regularly receive funds from government agencies and/or other sources, but without certainty that funding will continue or the amount that will be received each year. To support longer-term opportunities, organizations may deter spending until they accumulate sufficient funding for multi-year initiatives. Alternatively, they may commit to a phased approach to multi-year projects based on anticipated future funds. The latter involves risks if subsequent funding is not available to both supply chain participants that build workplans around anticipated future demand and the project proponent.

- Secure, longer-term opportunities that create more stable demand are strongly desired by many participants in the restoration supply chain ecosystem. Efforts to establish stable

long-term funds can still be subject to changing priorities of governments or other decision-makers. Hence, designated trusts that are not subject to short decision-making cycles were often cited as valuable to align demand and supply. Others voiced concern, based on previous experience, as to the cost-effectiveness of such approaches as they can contribute to a siloed, fractured response as longer-term funds and trusts may be administered by organizations that prioritize their independence. Significant resources may be required to facilitate partnerships and collaborations.

- Opportunities to leverage legal obligations to improve efficiency and effectiveness is an important strategy given that legally required restoration constitutes the majority of investments. This can depend on:

    - Decision-making by individual companies as they seek to minimize costs through economies of scale. For example, in an area where an oil and gas company had a combination of time dependent restoration obligations and activities that will require investments sometime into the future, it decided to undertake all restorative activities in the area in the short-term as it was more cost-effective over the longer-term.
    - The degree to which the regulatory and policy framework incentivize partnerships because industry proponents are usually ineligible for funding to support incremental restoration that is beyond their legal obligations, but they deem to be of value to their interests. As such, industry needs to partner, for example with First Nations or community groups. If such funding is secured, then at the operational level coordination of the timing and sequencing across all the activities can result in greater cumulative benefits from each individual effort.

The following is an overview of the currently available opportunities that were known to the interviewees.

8.2.1 Legal Requirements for Restoration and Supporting Guidelines

Legally required restoration and supporting guidelines are the most significant driver for on-the-ground implementation of restorative activities. Recovery standards exist for industrial activities, but there is a trend for an increase in standards, at least in terms of complexity, to support a broader range of objectives and movement along the restorative continuum towards fuller ecosystem restoration at the landscape scale. When standards are formally changed by governments, then there are clear signals to the supply chains. The pace of change may be challenging for the supply chains to respond to as some shifts in production of materials, such as developing capacity for different nursery stock or developing seed orchards can take time, the latter taking up to 15 years. Industry proponents may also negotiate individual agreements with First Nations or changes for one industrial sector may be slow to impact standards for others, so the lack of clarity can challenge the supply chains to effectively respond.

Within the oil and gas sector, in March 2024 BCER, in collaboration with Treaty 8 First Nations, released an Ecologically Suitable Species Guideline (ESSG) that outlines expectations for industry

to meet the intent of Section 19 of the Environmental Protection Management Regulation (EPMR) as part of the Certificate of Restoration (COR) Part 2 application process. ESSG provides guidance to practitioners when evaluating reclamation options for site preparation and revegetation techniques that will support a minimum threshold of established ecologically suitable species. As the ESSG is not a prescriptive manual for planning and implementing restoration, it may result in a short-term decrease in demand as companies will take some time to define how to respond.

Within a forestry context, support for climate adaptation, wildlife habitat enhancement, or other objectives are resulting in changes to stocking standards. Also, attaining a free-growing stand for timber production implies no further intervention, but achieving broader restoration objectives may require additional interventions, such as stand tending activities. The Province, First Nations, industry, and academics are all engaged in these issues.

As discussed, increased standards may have short-term downward pressures on demand but be an upward pressure for both the amount and complexity of restoration over time. There may, however, be a threshold whereby an incremental increase in restoration standards or supporting guidelines decreases demand for restoration because industry may determine that:

- Operational costs, including for restoration, have become too high and the market will not support passing on the increases to consumers, so operations are slowed or cease temporarily or permanently. If there is less resource development, then demand for restoration is reduced over the longer-term

- It is more cost-effective to pro-actively change resource development practices that will reduce the need for increasingly costly restoration, thus reducing the demand for restoration over the longer-term. Such changes can also occur due to technological advances without additional pressures from increasing standards. For example, oil and gas production in B.C. has almost fully transitioned from conventional development (individual wells, triggering individual pipelines and individual roads supporting them, with high risk of not being productive) to unconventional development (pads with multiple wells serviced by one road/pipeline, enormous productivity and almost 100% chance of being successful).

8.2.2 Policy and Legal Decisions

Legal decisions, such as Yahey v. British Columbia, and social choice decisions by governments can result in structures, processes, and designated funds that create strategic-level opportunities for restoration. The decisions most frequently identified by interviewees included:

- Creation of the Blueberry River Restoration Society ($200 million plus $35 million provided directly to the Blueberry River First Nations)
- Dedicated restoration funds for other Treaty 8 Nations ($50 million)
- Boreal Caribou Protection and Recovery Plan ($47 million over the period of 2017-2022)

These decisions create new opportunities for restoration, but the level of effort required to launch such large-scale initiatives may require redirecting resources that may decrease capacity to support other programs, including other restoration programs. These initiatives result in an immediate increase in demand for strategic planning, followed by tactical and operational planning

and finally implementation of restorative activities. Large-scale initiatives may involve iterative planning across strategic, tactical, and operational scales. Hence, the pace and outcomes of planning determine whether the increased opportunities are experienced as a short-term shock to the restorative activities supply chains or a measured and managed increase in demand over a longer time. Many are looking to recent commitments to restoration in the Northeast Region to demonstrate success and generate lessons learned for how to best create or expand strategic-level opportunities in other regions.

8.2.3 Permitting and Consultation

The regulatory framework has been created to support sector specific resource use and development. It was suggested that restoration has been "bolted on" to the existing framework. One consequence is that permitting requirements for restoration have not been designed to incentivize linkages between restoration and multi-value objectives. Instead, the current situation is considered burdensome and costly, which can be a disincentive to improving effectiveness through more integration and coordination, encouraging innovation in restoration practices, or supporting efficiencies within the restoration market. The current permitting and consultation requirements are, generally, a downward pressure on demand as they can reduce overall opportunities beyond minimum legal obligations. Conversely, improvements in the regulatory framework are likely to create significant opportunities and increased demand for restoration.

Interviewees reported that the B.C. regulatory and permitting requirements are more complex, challenging, and expensive compared to, for example, Alberta. Increased costs over the past 20 years are partly, and in some cases largely seen to result from regulatory and permitting issues.

Permitting is tied to requirements to engage or consult with a range of interests. The challenges and costs are being experienced widely as industry, First Nations, government agencies, and non-governmental organizations (NGOs) can be project proponents and, therefore, required to consult. Some NGOs identified consultations with multiple First Nations as a deterrent to pursuing projects and some First Nations want a streamlined approach to their need to engage multiple companies operating in their territories.

There have been efforts to streamline permitting, for example in the Northeast Region BCER now has authority to issue some of the permits that were previously required from FOR. This is intended to enhance BCER's ability to offer a single window regulatory approach. Some First Nations have suggested the process is not easier or faster, but the change is recent and collaborative efforts are underway to support implementing the changes. FOR staff noted that their involvement may continue to be needed for complex permit applications that impact a range of values and users.

In addition to streamlining the existing permitting processes, many identified a need to reduce the regulatory burden, some of which is viewed as unnecessary. For example, requiring a permit to salvage plants that are disturbed during site preparation activities so they can be replaced during revegetation activities. Another example was numerous interviewees identified that the planting window for when specific species can be planted is too rigid as their field experience suggests greater flexibility would be beneficial.

Finally, optimizing the restoration market would benefit from a regulatory framework and permitting processes that facilitate scaling up to comprehensive, integrated restoration

landscape-scale plans. Such plans could include multiple interconnected restoration programs and projects to address a diversity of sector driven impacts and non-legal opportunities, which would require authorization under numerous Acts or regulations. A system that could authorize such plans and programs, rather than the individual projects that embedded within them, would be more efficient and help generate clearer demand forecasts.

8.2.4 Tri-partite Nature Agreement

In 2023, the Government of Canada, the Province (Ministry of Water, Land and Resource Stewardship (WLRS)), and the First Nations Leadership Council signed an agreement to establish a framework to achieve a more integrated and collaborative landscape-based approach to ecosystem health and biodiversity conservation. Habitat enhancement and restoration as well as species at risk protection and recovery are some of the objectives that the agreement will support.

The federal and provincial governments have committed up to $500 million each over the duration of the agreement (to March 2030), including some previously announced commitments. In addition to restoration funds for Treaty 8 First Nations and the Boreal Caribou Protection and Recovery Plan (as discussed in section 8.2.2), the announcement included:

- The 2 Billion Trees Program (Canada wide $3.2 billion over 10 years by 2031, with $80 million in joint Canada-BC funding for the 2023 and 2024 treeplanting seasons to launch the program in BC)
- Nature Smart Climate Solutions Fund that supports natural climate solutions, for example wetlands restoration
- A commitment to work with First Nations throughout B.C. and other partners to restore or enhance at least 140,000 hectares of wildlife habitat by 2024/25 beyond regulatory requirements
- B.C.'s Watershed Security Fund ($100 million in 2023 building on $30 million in 2022 and $27 million in a previous initiative), although restoration is not a primary focus
- Conservation Financing Mechanism to support conservation and restoration. An initial mechanism is a partnership between the Province and the B.C. Parks Foundation, in collaboration with First Nations, to improve biodiversity and climate security with restoration as one potential strategy, but not the main focus ($150 million to be leveraged by the Foundation to a total of $300 million)

The Nature Agreement brings together numerous initiatives, which helps clarify the total scale of opportunities across the different programs. The supply chains, however, require more detail about the priorities and restorative activities that each program will support, including where the work will happen. Another commitment made through the agreement is to develop a long-term restoration framework to support an ongoing restoration program in collaboration with First Nations, industry land managers, and others. Depending on how it is developed, the framework could help clarify demand and support optimization of the restoration market.

8.2.5 Provincial Agency Programs

FOR has established programs that create opportunities for restoration. Resourcing of the programs can fluctuate with overall declines in budgets since inception, which can result in a corresponding reduction in demand for restoration unless other sources of funding become available. Maintaining the required long-term support for restoration is recognized as a systemic challenge, hence FOR recently changed their funding structure. The previous Forest Land-Based Investment Program allocated $70.83 million in 2021-22 to support restoration and related stewardship activities. It used an annual internal application process to fund provincial programs. It has been replaced by predictable funding for FOR programs, although future governments could change the funding approach. Managers of the programs leverage the core funding through partnerships with other FOR programs, other agencies, and external partners, including the federal government. The programs that are related to restoration in northern BC and were identified by interviewees included:

1. Forest Investment Program. It was recently created to allocate $90+ million per year for across the province for non-legal silviculture and wildfire restoration needs. The focus Is on wildfire recovery, including habitat restoration post large-scale wildfire events. For the 2023-34 fiscal year, it is anticipated that approximately $70 million will be allocated to on-the-ground activities with approximately $4 million allocated to the Peace District for reforestation with other allocations yet to be made at the time of writing this report.

2. Provincial Ecosystem Restoration Program. Its resources have declined from an initial budget of $2 million to an annual core budget of $165,000, which in the past year was leveraged to a total of $800,000. In recent years, the program funding has been used to support external partners, including the Society for Ecosystem Restoration Northern B.C. (SERNBC). Responsibilities for some of the initiatives launched through the program have been assumed by other agencies or programs, for example risk reduction in wildland-urban interface areas.

   Invasive Plant Management. The program is led by FOR whereas Invasive Fauna Management is managed within WLRS. Invasive plant management now receives an annual allocation of $650,000. Prevention and management of invasive species can be necessary to reduce or eliminate risks to help create the required conditions for restoration (passive and active) and can be a key component for successful implementation of subsequent restoration programs and projects. The program's top priority is to prevent the establishment and expansion of new invasive species in B.C. (i.e. provincial early detection and rapid response species), which has been consuming a greater percentage of the budget over time given increasing climate-driven changes (disturbances, events, and ecosystem shifts). FOR's total invasive plant program budget has fluctuated from $300,000 to $1 million from 2008-2024, with the portion of the FOR operational budget allocated to the Northeast Region ranging from 5-23%. FOR also provides funding, when available, from fiscal year end savings through transfer agreements with regional districts. For the Northeast Region, transfers have ranged from $30,000 - $265,000 over the past 15 years

depending on the type of activities being pursued (planning/ coordination versus on-the-ground activities).

In addition to FOR core funding, the Ministry of Transportation and Infrastructure has provided relatively consistent funding over time in the range of $150-200,000. The Ministry of Environment and Climate Change Strategy (B.C. Parks and Rec Sites and Trails) also fund invasive plant management as do non-provincial government funders including industry and various NGOs.

3. Fish Passage Program. It was initiated in 2008 with a budget of $5-7 million and now receives $685,000. The program is directed by the Fish Passage Technical Working Group. Leveraging the core funding is key as the replacement of one bridge can exceed $1 million and culvert replacements can be hundreds of thousands. Restoration of fish passage is a particular focus in Skeena Region.

8.2.6 Response to Wildfires

There is ongoing discussion about use of wildfire risk reduction activities to pro-actively restore resilience within at-risk landscapes and, therefore, reduce demand for wildfire recovery. In June 2023, The Forest Practices Board of B.C. reported that provincial funding to reduce risks from wildfires has been directed almost exclusively to public and private lands within the wildland-urban interface (WUI) with $72 million spent to treat 26,000 hectares since 2018. According to FOR's 2023-2026 Service Plan, provincial risk reduction and wildfire management activities will continue to be directed primarily to the WUI.

Funders and planners, including some First Nations, have voiced concern about allocating limited restoration funding to wildfire risk reduction. For others, wildfire risk reduction to restore landscape resilience needs to be a core focus, including to protect investments in on-the-ground restorative activities that could be negatively impacted by wildfire.

As the wildfire season expands in duration and intensity, urgent demand to support wildfire suppression can consume significant capacity within the restoration supply chains as there can be overlapping demands for human resources and equipment. Also, the risks associated with active wildfires to human safety, including smoke that can be experienced a long distance from the originating wildfire, can create a sudden decrease in demand as on-the-ground implementation is put on hold. Thus, the restoration season and associated opportunities can become compressed.

Large scale wildfires are serving as vehicles for expanding the concept of wildfire recovery to reflect broader restoration principles, for example the general principles as well as a guide for access management that were developed to support recovery from the Elephant Hill fire in the Thompson-Okanagan Region in 2017. Following the large-scale wildfires in 2017 and 2018, the B.C. Wildfire Service (BCWS) expanded its capacity to support wildfire recovery through staffing and funding of a dedicated group within the organization. FOR is also actively supporting wildfire recovery planning.

While the Donnie Creek wildfire continued to burn in the Northeast Region, discussions were initiated between the Province and Treaty 8 First Nations about how wildfire recovery could support a range of objectives, including helping to restore Treaty 8 First Nations' values and cultural

practices. To do so, wildfire recovery is being discussed within the context of (Unpublished meeting summary, Ministry of Forests, 2023):

- Integrating with ongoing conservation and restoration programs to support comprehensive landscape-level restoration
- Enabling and assisting reciprocal restoration that supports natural ecosystem healing and community healing
- Exploring how Indigenous natural laws and the provincial regulatory framework can be used to support recovery
- Taking a two-eye seeing for braiding Indigenous knowledge with western science to support planning, shared decision-making, and adaptive management
- Evolving traditional silvicultural practices to support broader restoration objectives
- Identifying priorities for restoration of natural, built, and socio-cultural assets.

Funding for recovery of large-scale wildfires is an ongoing challenge. The Province is responsible for rehabilitation of fire guards. The Province's Wildfire Land-Based Recovery Program reported that of the 5,133 km of fire guard built in 2023, approximately 1,208 km was rehabilitated by late winter 2024. Following fireguard rehabilitation, wildfire recovery becomes broader with responsibilities potentially spread across various entities, including forest licensees and the Province who may both have silvicultural obligations. As a result, there is a lack of clarity as to the extent of the opportunity for restoration associated with large-scale wildfires.

In most cases, the need created by wildfire impacts will continue to be greater than associated restoration opportunities. Passive restoration will likely be used for a significant portion of burned areas. Suppliers, particularly those who have supported the now declining forestry sector, are hopeful that there will be demand for their products and services from wildfire recovery. While wildfires will continue to create uncertainties for the supply chains, strategic-level policies and decisions as to the level of investments to be made in both wildfire risk reduction and wildfire recovery would help define the anticipate scale of opportunity for participants in the supply chains.

8.2.7 Energy Sector Programs

1. BCER administers the Orphan Site Reclamation Fund (OSRF) as a means for industry to pay for restoration of orphaned oil and gas sites and related costs. Revenue for the OSRF is derived from government transfers, orphan site restoration levies, interest, and security. The OSRF has assets of $13,295,000 (BCER Financial Information Act Report for year ended March 31, 2023) to pay for costs associated with orphan sites, which is in line with BCER's estimate of spending up to $15 million/year to fully restore existing orphan wells within a 10-year period.

2. The Petroleum and Natural Gas Legacy Sites Restoration Program was created in 2020 with $5 million from the federal COVID-19 Economic Response Plan and $1.5 million from the Province of B.C. A Memorandum of Understanding was developed involving provincial agencies and industry associations to administer funding for the restoration of legacy petroleum and natural gas activities in northeast B.C. The intention was to work collaboratively with Treaty 8 First Nations and use the program as a proof of concept that providing a fund for legacy site restoration would successfully advance restoration efforts

in areas and manners identified as important to Treaty 8 First Nations. The program was intended as a short-term initiative; funding from the Province has subsequently been allocated directly to Treaty 8 First Nations so they can continue to pursue their restoration priorities as noted in section 8.2.2.

3. The B.C. Hydro Fish and Wildlife Compensation Program approved $8.7 million for 81 projects in 2024-25, with 24 of the projects being in the north (Peace Region) for a total value of $1,863,099. Most of the projects will be undertaken in the Omineca Region.

8.2.8 Non-Governmental Funders

Funding organizations have been created in response to specific concerns. The funders include registered societies as well as formal partnerships that are not incorporated. The organizations usually operate with a degree of independence, including developing their strategic priorities and criteria for allocating their funds. In doing so, they create opportunities for restoration that may be responsive to local interests through an application-driven processes. While aware of the interest in and need to scale-up restoration from the project/site to the program/landscape scale, most funding organizations lack capacity to significantly support such a shift. Instead, they stated interest in supporting pilot projects whose outcomes could be scaled up with support from governments and industry. Some organizations prioritize communication and collaboration with other funders as the funding siloes can be a barrier to implementing comprehensive, integrated restoration plans and programs.

While the scale of restoration initiatives supported by non-government funders is small compared to the level of activity associated with legal requirements implemented by industry, the projects can be strategically important as they may explore innovative practices and what is required to achieve broader restoration objectives. There is concern, however, that the full value of such projects is not being realized given the lack of an integrated and comprehensive system for monitoring and evaluating project outcomes so they can inform decision-making and improve restoration practices, including for legally required restoration.

Funders receive their funding from provincial and/or federal governments, dedicated revenue sources such as conservation surcharges on provincial licenses, fundraising initiatives by the respective organizations that can target large donors, international trusts or markets, and as compensation for impacts from industrial activities. While there are many non-governmental funders, two that were mentioned by interviewees included:

- Habitat Conservation Trust Fund (HCTF), which allocates approximately $1 million annually for restoration and enhancement projects, in addition to $2-3 million for broader stewardship projects. Funding is project driven at a provincial scale so funding for projects in the Northeast Region has varied from $100,000 - $800,000 over the last six years with an average of $200,000. Previously (more than five years ago), there were more prescribed fire project applications and so the amount allocated to restoration was higher.

- Forest Enhancement Society of B.C. funds wildfire risk reduction projects and since 2017 has provided $5.5 million to a partnership with HCTF to fund wildlife habitat improvement projects.

8.2.9 The Global Context

The global context, including technology disruptions and global goals regarding climate change and biodiversity loss, could impact demand for restoration in northern B.C. The timing and extent of change are uncertain.

Technology disruptions at the global scale are important context for immediate and longer-term opportunities for restoration. A study on the use of existing technologies to address climate change suggested that eight technologies are leading disruptions in the energy, transportation, and food sectors (Arbib et al., 2021). It is suggested that market forces could be leveraged to support achieving climate targets and create opportunities for restoration because the technologies required are either already commercially available and competitive today or can be deployed to market before 2025. The authors caution that technology alone is not enough as societal choices matter and so there is a high degree of uncertainty as to how and when technology disruptions may impact demand for restoration.

Concerns regarding climate change and biodiversity loss are resulting in the creation of global goals and networks, which can influence federal and provincial policies as well as global market responses that, in turn, could create opportunities for restoration. The Paris Agreement of 2015, United Nations Decade of Ecosystem Restoration (2021-20230), Glasglow Climate Pact, and Kunming-Montreal Global Biodiversity Framework have set targets and create momentum that could result in opportunities for restoration in B.C.

For example, the Taskforce on Nature-related Financial Disclosures (TNFD) was formed in June 2021 in response to increasing recognition for the need to factor nature into financial and business decisions. A set of disclosure recommendations and guidance has been developed that encourage and enable business and finance to assess, report, and act on their nature-related dependencies, impacts, risks, and opportunities. Companies that are signatory to the TNFD will disclose nature-related risks and their management. The idea is that targeted ecological restoration would contribute to reducing the risk profile of companies and could help open-up or maintain access to financial lending, robust insurance and asset management services, and enable high quality and timely valuation, risk, and credit analysis which form the key foundations for economic stability and growth. The aim is to support a shift in global financial flows that align with the Kunming-Montreal Global Biodiversity Framework.

In Canada, the Institute for Sustainable Finance and Chartered Professional Accountants of Canada are co-convenors for the TNFD to facilitate the private sector's role in helping to meet Canadian and global biodiversity targets. Building on the Taskforce on Climate-related Financial Disclosures and the TNFD global frameworks, the finance sector is potentially a significant driver of change with access to financial capital increasingly being influenced by Environment, Social, Governance (ESG) performance. The specifics of how and when this might impact demand for restoration in northern B.C. is unclear.

8.3 Priorities

The need for restoration generally exceeds the myriad of opportunities so it is necessary to identify priorities that will maximize the benefits from investments in restoration. There are many types of governance organizations setting priorities at a variety of planning levels, which are creating inefficiencies in the prioritization process and unclear signals for restoration supply chains. Even for priorities that are clearly defined, for example through legal obligations for industry-led restoration, the need to manage cumulative effects requires a more comprehensive and integrated approach to setting priorities across industry sectors and with efforts that are not industry-led.

For non-legal restoration, funding organizations undertake internal planning processes to define their priorities and establish criteria for allocating funds. The funders can become de facto decision-makers for restoration as applicants may revise their priorities to conform to available opportunities. The challenge is partly due to scale whereby funders may define criteria at a large spatial scale whereas applicants are addressing local concerns and opportunities.

Hence, demand for restoration reflects the complex and dynamic priorities of funders, program/project proponents, and organizations that are both. Establishing priorities transforms the needs and opportunities into a clearer demand forecast and generates information that is essential to the restoration supply chain ecosystem. As a result, optimizing the restoration market would benefit from a nested set of priorities across multiple scales so that the interconnections are defined, synergies identified, and incompatibilities acknowledged and addressed. Planning processes, including Forest Landscape Plans (FLPs), wildfire recovery and boreal caribou recovery, are exploring how to assess needs, opportunities, and trade-offs to identify tactical-level priorities. Some interviewees suggested that creating a common framework to support such planning processes would improve the efficiency and effectiveness of the prioritization process.

8.4 Demand Drivers

Demand forecasts consider the inter-connected drivers of need, opportunity, and priorities that, taken together, can impact the overall pace and intensity of changes in demand on the restoration supply chains. As there is considerable uncertainty associated with demand forecasting, it is proposed to consider four categories for the relationship between drivers and their significance. Table 1 outlines the theoretical concept of describing the probability of occurrence and the significance of impact that drivers could have on demand for services and products provided by the restoration supply chains.

Table 1: Probability and Significance Concept

1. High Probability & High Impact	2. Lower Probability & High Impact

• These drivers are already creating some change in demand or are highly likely to do so without any new intentional interventions
• May need strategic actions to:
  ○ Maximize the cumulative benefits
  ○ Minimize undesirable risks
• Impacts on demand are at multiple scales:
  ○ Strategic, tactical, operational
  ○ Local, regional, provincial
  ○ Short and longer-terms
 	
Management Responses
• Identify leadership & accountabilities
• Identify/establish processes, align resources to
  ○ Plan and implement responses and/or support other processes to do so
  ○ Communicate to supply chains
  ○ Monitor, evaluate and integrate into decision-making
	• These drivers have the potential to significantly impact demand (increase or decrease) but are less likely to do so without new intentional interventions
	• Could result from significant and unexpected shocks to the system or changes in the context for restoration
	• Likely would require a shift in priorities and strategic investments to maximize the cumulative benefits and/or minimize risks
	• Impacts on demand would be at multiple scales
	
	Management Responses
	• Monitor for early detection of change through a diversity of ongoing processes, e.g., issues being explored through pilots and independent initiatives
	• Create issue tracking protocols and relationships across a network of participants and with leadership and processes established for #1 to co-develop responses as need and opportunities arise

3. High Probability & Focused Impact	**4. Lower Probability & Focused Impact**
• As per #1 above but scale of impact is more focused, at least in the short-term • May be potential for scale of impact to increase Management Responses • Support leads of processes that are resulting in the focused impacts, including creating clear issue tracking protocols and relationships with leadership and processes established for #1 • Identify and communicate potential cumulative impacts on demand to support and supply chains at multiple scales	• Unlikely to impact demand without intentional interventions, but if they do, impacts are anticipated to be focused, at least in the short-term • The lowest priority at the strategic level, but may be significant at a local level Management Responses • Support existing organizations/ processes/ key positions to track and monitor • Create clear communications and reporting relationships with leadership and processes established for #1 to periodically review trends • Use a cost-benefit analysis to evaluate possible responses at the strategic level

Source: Table developed by the authors

Table 2 synthesizes input from this project combined with outcomes from related initiatives to propose a current assessment of key drivers for restoration with a particular focus on the Northeast Region.

Table 2: Current Understanding of Restoration Drivers in the Northeast Region

Blue are drivers that are anticipated to increase demand
Red are drivers that are anticipated to decrease demand

1. High Probability & High Impact	2. Lower Probability & High Impact
a. Increase in standards from • Legal decisions (e.g., Yahey) • Negotiated agreements with multiple First Nations (e.g., BCER ESSG) • Outcomes of ongoing processes (e.g., changes to stocking standards) b. Increase in large-scale climate events c. Permitting, including both upward and downward pressures on demand: • Efforts to streamline permitting processes • Lack of needed change • Increases in some permitting requirements d. Less resource development due to: • Increasing conservation (e.g., 30 by 30) • Lack of clarity on social choice issues • Fragmented decision-making • Lower demand for resources due to changes in technology, consumption patterns, etc. e. Increased restoration costs in the short-term if demand exceeds supply	a. Create a consistent framework for incorporating restoration into strategic and tactical scale planning across sectors/initiatives that are designed to increase the clarity of demand forecasts b. Facilitate the use of emerging technologies and A.I. • Modeling to support identification and prioritization of candidate impacts/areas for active restoration and post-treatment monitoring • Increased efficiencies, innovation, and decreased costs for integrated, coordinated restoration c. Improve incentives for industry proponents to assume responsibility for broader restoration objectives (e.g., stumpage, pricing, restoration as a commodity) d. Create a clear process and accountability for incorporating lessons learned into decision-making to improve: • Restoration practices • Best Management Practices for resource development to reduce need for future restoration
3. High Probability & Focused Impact	**4. Lower Probability & Focused Impact**
a. Development proponents negotiate individual agreements with one or more First Nations for increased standards b. Short-term ("pulse") funding continues to • Support worker transition/ job creation • Address legacy impacts • Support pilots but not scaling up • Support projects but not long-term programs c. Restrictions on safe access for restoration crews from large-scale climate events (wildfires, smoke, floods, landslides)	a. Restoration trusts to address legacy and incremental issues and effective governance to administer them b. Increased restoration costs result in innovation in resource development, less impacts, and reduction in future demand c. Market-based opportunities, including: • Convergence at global and national scales on sustainability platforms but likely a limited amount of funding coming to a developed country like Canada • B.C.'s Conservation Funding Strategy to access non-governmental funding

Source: Table developed by the authors

9 Restoration Demand Scenarios

As discussed in section 6.2, to develop an integrated demand forecast across different types of impacts, a common measure of demand was required. Hence, best available information was used to develop cost estimates for restoration of the impacts from oil and gas and forestry development activities. Information about wildfires and road liabilities that could be used to develop similar cost estimates was unavailable. Developing cost estimates required making assumptions, which introduce uncertainties into the demand forecast. The assumptions and assessments of certainty are identified to support improvements on the prototypes.

Given the inherent uncertainties in restoration demand forecasting, considering possible scenarios may be useful. The scenarios, together with the drivers of demand (section 8.4), provide a structure for individuals and collaborative groups within the supply chains to track uncertainties and pro-actively consider options to respond to likely changes in future demand. The drivers of demand are fluid, which will result in the scenarios evolving over time. Hence, tracking changes could support participants in the supply chain ecosystem to determine the magnitude of change and, therefore, the type of required response, ranging from minor modifications, adaptations, to transformations in their operations.

The proposed scenarios include a prototype for describing the base case, including current needs and opportunities. There are significant information gaps, so the prototypes use best available data about anticipated restoration needs resulting from oil and gas and forestry activities as well as identified opportunities in the Northeast Region. Currently, there is insufficient data to develop a prototype for priorities, but how different scenarios could be used to support the prioritization process is discussed.

The current scenario includes many pulses or fluctuations in demand that create challenges for the supply chains. While fluctuations cannot be eliminated, reducing the severity of the pulses will help optimize the restoration market. Therefore, two additional scenarios are proposed based on input from interviewees about how the drivers of demand and management responses to them could shape future demand. The scenarios are discussed in terms of the likelihood that they might reduce fluctuations and help stabilize demand for restoration services and products, the amount of work likely required to pursue the scenarios, and the opportunities and challenges for doing so. The intention is to support a discussion on the value of the proposed approach, including the prototypes and scenarios.

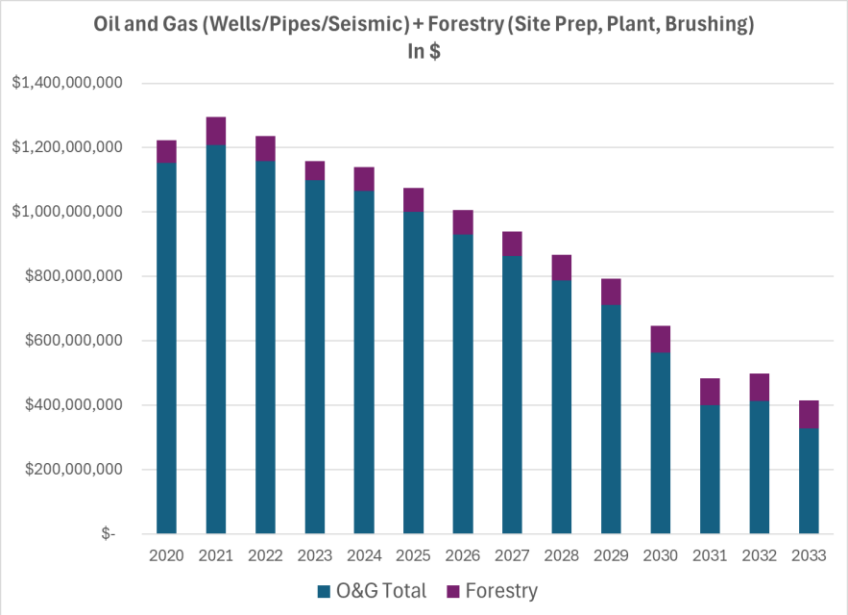
9.1 Current Scenario or Base Case

Regardless of the inherent uncertainties, the base case prototypes for need and opportunity support understanding of the general shape of the demand curve and comparative needs across different types of impact. As further work improves the base case, including to define priorities, then it will support participants in the supply chain ecosystem to adapt to changes in demand and help governments design effective policies, including to guide evolution of the current situation towards a desired future scenario.

9.1.1 Current Needs

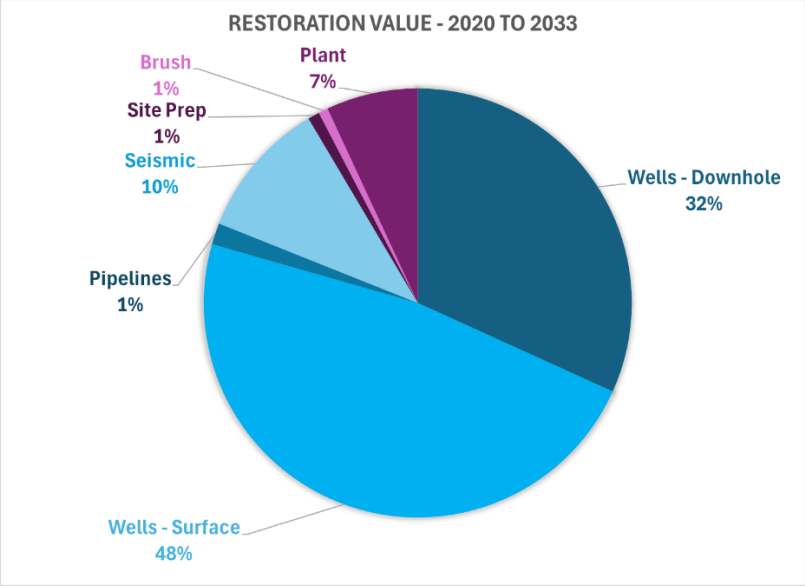
Best available data has been used and interpreted to depict the current needs related to oil and gas activities, including wells, pipelines, and seismic, as well as forestry activities, including site preparation, planting, and brushing (Figure 7).

Figure 7 Estimated Total Restoration Needs from Oil and Gas and Forestry Activities in the Northeast Region



Source: Figure developed by the authors

Figure 8 Estimated Total for Specific Restoration Needs from Oil and Gas and Forestry in Northeast Region



Source: Figure developed by the authors

Roads: Needs

The restoration of roads constructed and used by the oil and gas and forestry sectors was identified as a priority issue by many interviewees. The lack of data, however, precluded the inclusion of roads into this assessment of needs, which is a challenge that was shared by another study on the costs of restoration in northern B.C. (Anielski, 2019).

Oil and Gas Base Case: Needs

Two categories of activities are included in the base case:

1. Legal requirements

- Dormant wells: as per the BCER Dormancy and Shutdown Regulation, there are mandatory timelines for the restoration of inactive sites. The base case includes BCER information until 2035 and builds a scenario for 2036-2050 based on past activity.

- Orphan sites: the scenario assumes that the existing stock of orphan wells is restored as per the BCER commitment of a ten-year period to full restoration. No additional orphan sites are included, as those are indirectly covered under dormant wells (i.e., the likelihood of a productive well becoming orphan is low and all inactive wells are already contemplated in the stock of dormant wells).

- Pipelines: recent changes to the Dormancy and Shutdown Regulation have established timelines for the restoration of pipelines. Estimating how many kilometres per year will be affected by the new timelines is difficult as many elements could play into the assumptions. For example, certain areas might become inactive as a whole, while smaller areas might still require pipeline services even with marginal production.

2. Legacy issues

- Seismic lines: although there's no legal obligation to restore seismic lines, the Province has provided funding to Treaty 8 First Nations who may use some or all of it to restore seismic lines.

Highlights from this base case exercise include:

- The 2019-2050 accumulated cost of restoring dormant wells, orphan sites, pipelines. and seismic lines is estimated at $19.5 billion

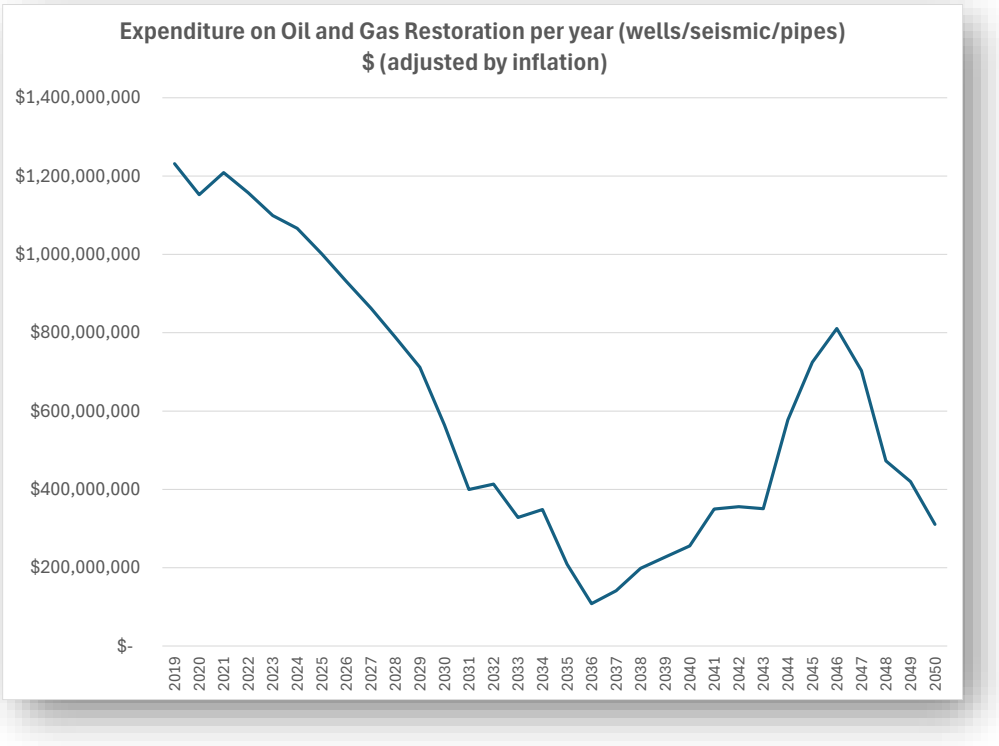
- 74% of the total need corresponds to the restoration of dormant wells

- Of the total anticipated costs for restoring wells, 40% is estimated to involve downhole activities, which involve specialized skills and specific participants in the restorative activities supply chains. 60% is estimated to involve surface restoration, which involves restorative activities that may be common with other restoration initiatives, including

forestry's site preparation and planting and, therefore, are part of the cumulative demand on the restorative activities supply chains

- As shown in Figure 9, the shape of the forecasted need for restoration related to oil and gas activities shows an average cost of restoration of $610 million per year, with a peak that might have been reached already in 2019-2021 surpassing the $1.2 billion per year, a valley around 2036 expected to be in the $100 million range, and a second peak (triggered by the restoration of wells from the 2005-2008 vintage which was a high-drilling activity period) around 2047 in the $800 million range. Legacy seismic restoration is included in Figure 9 based on a total estimated cost of $1.45 billion with expenditures averaged over the time period.

Figure 9 Estimated Total Restoration Needs for Oil and Gas



Source: Figure developed by the authors

Table 3 Assumptions and Assessment of Certainties for Oil and Gas Base Case

H – high level of certainty, M – moderate, L – low level of certainty

	Rating Until 2035	2036 and beyond	Comments
Wells (Dormants + Orphan)			
Number of wells	H	M	Type A and B are known. Type C are estimated making assumptions on speed of development
Hectares (has) per well	H	M	Converted number of sites to has based on 1.44 ha per well as per BCER. Fairly accurate short term, but could change substantially once restoration of unconventional wells becomes the norm
Dormancy timelines	H	M	Type A and B are known. Type C are estimated making assumptions on speed of development
Restoration timelines	H	M	As per dormancy timelines, plus additional uncertainty on pace producers will address their wells as they become dormant (within legally required timelines)
Downhole vs surface restoration	M	M	Assumes 40% downhole compared to 60% surface restoration as per BCER estimates (personal communication)
Cost of restoration	H	M	Used an average of $150,000/ ha. Fairly certain in the short term. Adjusted by inflation but speculative in the medium/long term
Pipelines			
Kilometres of pipe	M	L	Short term assumption is based on expected levels of activity. Longer term is highly speculative as it is difficult to predict which pipelines will become 'unnecessary' as areas stop producing.
Cost of restoration	L	L	Speculative. Used $60,000/km (Anielski, 2019)
Seismic Lines			
Kilometres of seismic	M	M	2D seismic is not used anymore, so it wasn't necessary to forecast. The main uncertainty is how much has already regenerated and to what level
Cost of restoration	L	L	Speculative. Used $10,000/km (Powter et al., 2021; Anielski, 2019) but costs from recent projects ranged from $26,000/km to $114,000 km, which did not include planning and monitoring costs

Source: Table developed by the authors

Forestry Base Case: Needed

Two categories of activities are included in the base case:

1. Reforestation activities (site preparation, planting, brushing) used to meet legal requirements for establishing free growing stands by licensees and BC Timber Sales

2. Reforestation activities that are the responsibility of, or funded by, the Province. These consist of non-legal silviculture and wildfire restoration needs funded through the Forest Investment Program and section 108 of the *Forest and Range Practices Act*, which allows for the Province to fund extra expenses or waive obligations of a licensee, including related to reforestation.

Highlights from this base case exercise include:

- Reforestation activities associated with timber harvesting are likely less than the 9% shown in Figure 8. As outlined in Table 4, the need for site preparation, planting, and brushing associated with forestry is likely overestimated.

- Surface restoration associated with wells is approximately 46% of the total combined needs, which also creates demand for site preparation and planting. Hence, surface restoration and reforestation contribute to the cumulative demand on the same supply chains. Data on wildfire recovery was unavailable but will also create demand for these restorative activities.

Table 4 Assumptions and Assessment of Certainties for Forestry Base Case

	Rating until 2026	2027 and beyond	Comments
Cutblocks			
Harvested area (ha)	H	L	Harvested area is a key indicator of demand for site preparation, planting, and brushing. Allowable annual cut levels, as determined by the Province, are an indicator of harvest level, but can differ from the actual area harvested for a given year. All three northern regions (Skeena, Omineca, and Northeast) have experienced a decline in harvest levels. While this trend may continue, there is no clear data as to how much and when. Hence, reforestation activities resulting from timber harvesting has assumed a consistent future level of reforestation activities, which is likely overestimating demand.
Site preparation	H	L	While site preparation is tied to harvested area, demand is site specific.
Planting	H	L	The assumption is that at least 80% of harvested areas will be replanted as the Province stated that 20% of harvested areas recover through "natural regeneration". Demand for planting is tied to harvested area, so it will decrease but there will be a lag in terms of timing.
Brushing	H	L	While brushing is tied to harvested area, demand is site specific.
Free growing timelines	H	M	A stand of healthy trees of a commercially valuable species, the growth of which is not impeded by competition from plants, shrubs or other trees must be established post-harvest within timelines set out in prescribed plans.
Restoration timelines	H	M	Reforestation activities generally start within two years of harvest. Wildfire or other natural events can impact the ability of companies to undertake or maintain restoration activities.
Cost of restoration	H	M	Data from FOR for 2020 – 2023 for Natural Resource Districts in the north was used to create cost ranges for each activity in each of the regions.

Source: Table developed by the authors

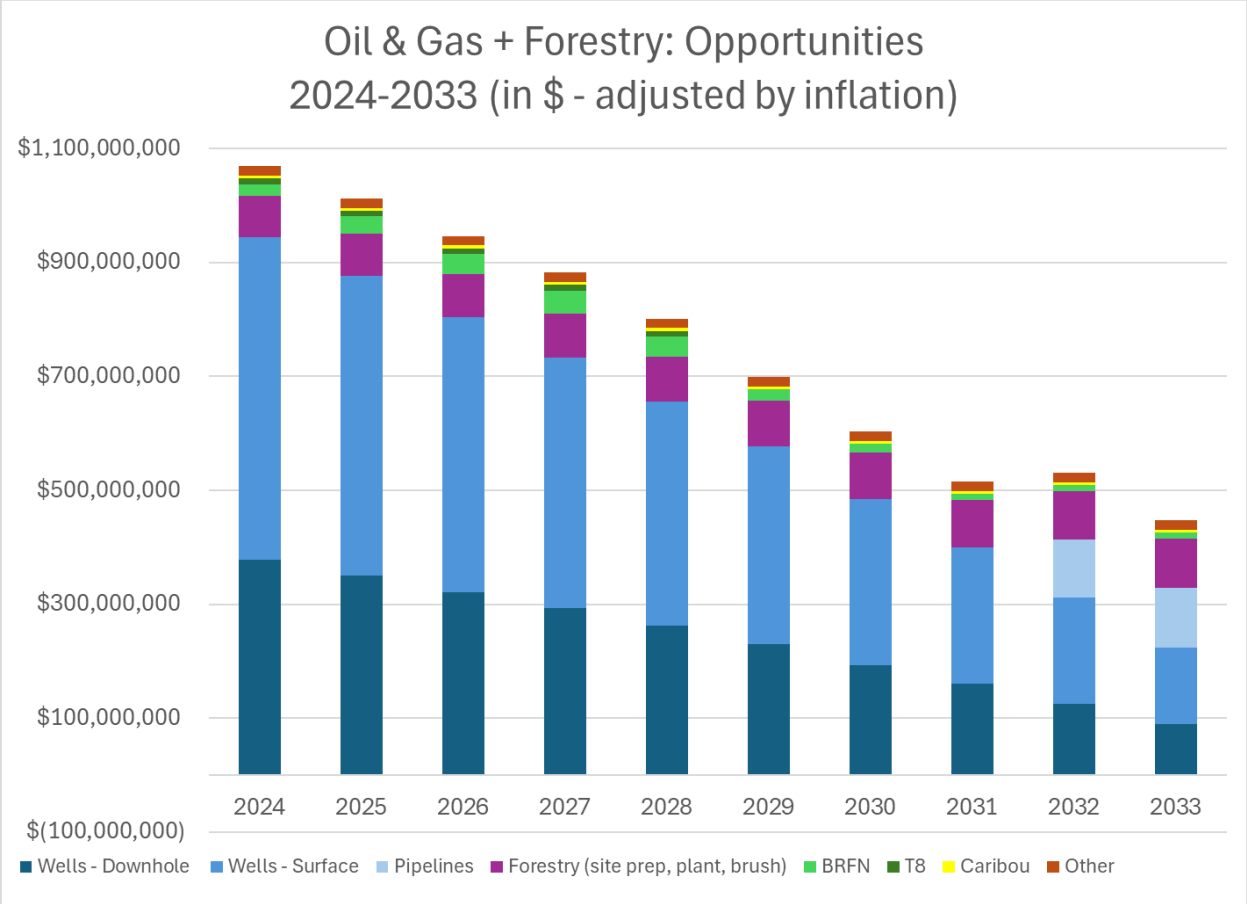
9.1.2 Current Opportunities

Current opportunities for restoration combine the forecasts for legal obligations with the best available information about "pulse" funding that results from:

- One-time or short-term commitments
- Fluctuations in how programs allocate funding, for example based on an application process or desire to balance opportunities across geographic areas, issues, etc.
- Responses to emergencies, such as wildfires.

Assumptions have been made as to the potential amount and time horizons for spending of pulse funding. The initial demand for enabling activities, including planning and permitting, can take 3+ years followed by multi-year implementation of restorative activities.

Figure 10 Estimated Opportunities for Restoration in the Northeast Region



Source: Figure developed by the authors

Highlights from this base case exercise include, as discussed throughout this report, the majority of demand for restoration is a result of legal obligations and in the Northeast Region for those associated with oil and gas activities. While there are greater uncertainties associated with the non-oil and gas demand projections, the relative significance to overall demand remains valid.

Table 5 Assumptions and Assessment of Certainties for Restoration Opportunities in Northeast B.C.

H - high degree of certainty, M – moderate, L - low

	Rating Until 2033	Comments
Legal obligations: wells and pipelines	L to H	As per Table 3. Restoration of seismic is not included in Figure 10 as it is not legally required. The current opportunity for seismic restoration is dependent on if and to what extent it will be supported by restoration funding provided to Blueberry River First Nations (BRFN), other Treaty 8 First Nations, Boreal Caribou Recovery, and other existing programs, which are included in Figure 10
Legal obligations: forestry	L to H	As per Table 4
Funds allocated to support restoration of BRFN Treaty Rights	M	Includes $200 million to be administered by the Blueberry River Restoration Society and an estimated $25 million remaining of $35 million provided directly to BRFN. The amounts may have increased due to interest or decreased due to expenditures. Assumes spending the funds over a 10-year period peaking in 2027. Allocation of funds over time is speculative
Funds allocated to other Treaty 8 First Nations for restoration	M	Total of $50 million, which may have increased due to interest. Assumes consistent spending of $10 million over 5 years. Allocation of funds over time is speculative
Boreal Caribou Recovery	L	Assumes spending $5 million/year based on averaging previous expenditures between 2017-2022. Amount and allocation over time are speculative
Other	L	Assumes 1/8 of provincial scale program funds will be allocated to Northeast Region (there are a total of 8 regions) with consistent allocations for the next 10 years from the following programs: • $40m/yr for the 2B Tree Program (BC signed a 2-yr agreement for $80m) • $90m/yr Forest Inventory Program (non-legal silviculture and wildfire restoration needs • $165k/yr provincial Ecosystem Restoration Program • $850k/yr provincial FOR Invasive Weed Program plus MOTI • $685k/yr provincial Fish Passage Program • $785k/yr provincial Forest Enhancement Society • $1m/yr provincial Habitat Conservation Trust Program For a total of $132,485,000/yr, which would mean $16,560,625/yr for the Northeast Region. Amounts and allocations over time are speculative

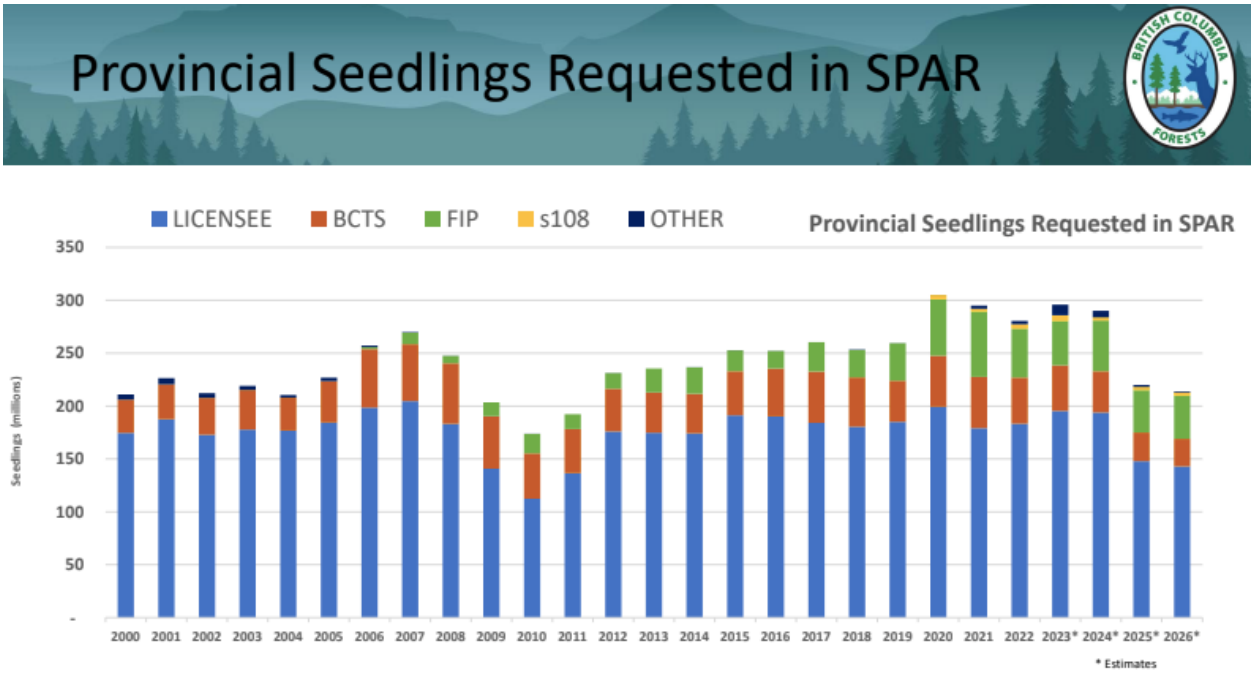
Source: Table developed by the authors

9.1.3 Priorities

Needs often exceed opportunities, so funders and other decision-makers define priorities for making best use of the available opportunities relative to needs. Therefore, while needs and opportunities provide important context, the restorative activities supply chains require more detailed information about priorities to determine what, if any, changes to their operations may be required to help align supply and demand.

Planning processes, including FLPs, wildfire recovery and boreal caribou recovery, are exploring needs, opportunities, and trade-offs to identify tactical-level priorities. The outcomes of such planning can then be used to develop prescriptions for restoration programs and projects. Taken together, the tactical-level priorities and operational-level prescriptions articulate demand that participants in the restorative activities supply chains can interpret in terms of human resources, equipment, and materials.

There are existing systems for tracking and communicating demand related to components of the restoration supply chain ecosystem. For example, FOR's Seed Planning and Registry (SPAR) is an online tree seed registry that supports reforestation, forest and ecosystem rehabilitation, and wildfire recovery. SPAR tracks demand for seedlings by species, funding source, time of year to be planted, and geographically by Natural Resource District. It is also designed around Climate Based Seed Transfer (CBST) to help forests adapt to climate change. SPAR guides users through the selection of suitable seedlots using the transfer rules found in the Chief Forester's Standards for Seed Use. SPAR is used by the forestry sector to order commercial tree species and does not currently track demand from other restoration proponents or for the broader range of native tree and shrubs that are used in other types of restoration.



Source: Ministry of Forests

There are also new initiatives that could help improve demand forecasting depending on how they are designed and implemented, such as WLRS's effort to create a spatial restoration tracker for at least some restoration initiatives.

Optimization of the restoration market would benefit from comprehensive, integrated planning and tracking tools that reflect an understanding of the supply chain ecosystem. This could result in priorities across resource sectors and restoration initiatives being articulated in ways that help participants in the restorative activities supply chains understand demand for human resources, equipment, and materials.

9.2 Wildfire Resiliency and Recovery Scenario

A scenario that focuses on wildfire is proposed because of the:

- Increase in the number, size, and intensity of wildfires that potentially increases demand for restoration
- Potential for wildfires to negatively impact previous restorative activities, which undermines investments in restoration (e.g., revegetation projects burn and so the landscape experiences a set back in successional processes)
- Need to restore resilience through risk reduction activities, particularly in climate and wildfire refugia areas that are needed to support restoration of adjacent areas.

Wildfire Risk Reduction

In June 2023, The Forest Practices Board of B.C. released a report that advocates for broad-scale implementation of Landscape Fire Management (LFM) to restore landscape and community resilience beyond the current focus in the Wildland Urban Interface (WUI). Treatments would include a combination of wildfire risk reduction, restoration, and climate change adaptation strategies to reduce the risk of catastrophic wildfires. Treatments are proposed to include manual or mechanical removal of woody debris (fuel) from previously burned or harvested areas, prescribed burning after harvesting, forest thinning and prescribed burning, and managed wildfires.

Currently, provincial government agencies, First Nations, local governments, industry, and funding organizations are involved in planning risk reduction activities in the WUI, with industry partners and contractors providing services and equipment. A commitment to broad scale implementation of LFM would intensify short-term demand for restoration but the treatments could be designed to moderate longer-term demand fluctuations, including by reducing the future pulse demands from catastrophic wildfire.

To implement LFM at scale, the Forest Practices Board identifies that supportive policies, a sustainable funding model that is not vulnerable to election cycles, and public acceptance will be required. It is suggested that funding models consider:

- Changes to the appraisal system that do not currently recognize the costs of treatments on public lands
- Development of a bio-economy that makes use of the large volumes of available low-grade biomass, which can make some of the treatments cost-effective
- Government funding for alternative energy using bio-mass

- Direct government funding for treatments.

Implementing broad scale LFM would require transformative changes at the strategic and tactical scales and so it is unlikely in the short-term. A focused approach may be possible in the short-term with lessons learned used to consider how to expand LFM if the required policies and funding models are developed. Opportunities in the short-term might include prioritizing:

- Seeking synergies with implementation of other restoration, conservation, or resource development activities to leverage equipment and human resources to reduce costs, create longer seasons for seasonal employees, and more consistent demand on the supply chains
- Use of LFM to help protect investments in other restoration initiatives that could be undermined if subjected to a wildfire with LFM being incorporated into restoration program and project budgets. This would increase costs and could reduce overall demand for restoration, but it could improve effectiveness
- LFM treatment areas, for example a focus on climate and wildfire refugia areas. This would increase the effectiveness of treatments to support broader and longer-term restoration needs
- The type, intensity, and location of LFM activities that align demand with the capacity of the supply chains to avoid inflating short-term prices as well as guiding investments in capacity building.

Wildfire Recovery

Although wildfires are unpredictable and, therefore, create spikes in demand for restoration, wildfire recovery can be designed to create more predictable demands on supply chains. This could include consistency in the types of products that result from planning processes, their content and structure, and the timing of their release relative to defined stages of wildfire suppression. Feedback from participants in the supply chains could inform the evolution of the products so they effectively communicate demand to supply chains in a timely manner.

The United States and Australia are using multi-expert rapid response reviews to identify initial post-fire priorities and cost estimates. The reviews can support multiple government agencies, First Nations, industry, and funders identify clearer priorities and design a more holistic approach to multi-value restoration and longer-term management. BCWS and FOR are engaging with First Nations on multi-value plans, for example for the Donnie Creek fire, but without benefit of the multi-expert rapid response review.

Strategic level policies, objectives, and criteria for wildfire recovery would also help clarify priorities for restoration services and products, including:

- To guide the extent to which passive restoration will be a primary strategy, including where and over what timeframe(s)
- How wildfire recovery fits relative to broader restoration objectives. For example, recovery of large-scale wildfires could become the priority for investments in comprehensive, integrated restoration planning compared to areas with high wildfire risks that have not burned or been treated to reduce risks. Restoration outside of large-scale wildfire recovery

areas might be limited to legal obligations and risk reduction activities. These are social choice decisions that would send clearer signals about demand to the restoration supply chain ecosystem.

There is growing expertise regarding large-scale wildfire recovery, both in B.C. and other jurisdictions that can inform the evolution of wildfire recovery. This, combined with the likelihood of increased large-scale wildfires, makes some form of a wildfire-focused scenario for restoration likely. The Province is adapting by expanding capacity within the BCWS, using a collaborative wildfire recovery planning process for the Donnie Creek wildfire, and exploring the concept of a rapid response team of experts. There is often concern, however, about the roles for outside experts in regional and local planning processes but more localized collaborative processes can be challenging to complete within tight timelines.

In terms of defining strategic direction that will help improve demand forecasts, responding to the immediate issues created by large wildfires is the priority. The interest in a more holistic, longer-term response would benefit from an overarching restoration framework that could help clarify the role of wildfire recovery within the context of broader restoration goals.

9.3 Comprehensive, Integrated Restoration and Economic Development Scenario

A third possible scenario would focus on comprehensive, integrated planning for both restoration and economic development to generate better information about demand and enable the supply chains to effectively respond. Optimizing the restoration market would benefit from an economic development approach that is developed and implemented in parallel with restoration planning. Both types of planning consider needs, opportunities, and priorities through their respective lenses, but are not always co-developed and formally linked at multiple scales. The proposed structure of enabling services and common restorative activities is applicable to both types of planning and can serve as a common foundation. Treating restoration as a market, which seeks to align demand (as defined through restoration planning) with the capacity of the supply chains (supported by economic development planning), is a means to facilitate integration between the planning processes.

Implementing strategic-level restoration and economic development plans and objectives would likely be accomplished through multiple processes at the regional/sub-regional (tactical) and local (operational) scales. It is challenging and costly to facilitate the necessary integration and coordination across multiple processes. One suggestion identified at a forum on B.C.'s restoration economy is to create restoration tenures with clear responsibilities and accountabilities for comprehensive, integrated restoration that would be supported by dedicated funds. This idea was raised in the early 2000's to support restoration following mountain pine beetle infestations but was not formally explored.

Another approach is to create a market system that prioritizes efficiency, innovation, and effectiveness by turning restoration into a commodity that can be traded or sold. For example, a company that is responsible for the original impacts but is no longer operating in the area may not be best positioned to complete the restoration work so they could trade or put on the market the restoration opportunity along with required funding. The concept goes beyond contracting the work

to a third party to including responsibility for realizing efficiencies and innovation through timing, sequencing, and leveraging with other activities being undertaken in the given area.

Regardless of whether restoration tenures or transforming restoration into a market commodity are pursued, there was widespread agreement among the interviewees on the need for a consistent approach to incorporating comprehensive, integrated restoration into ongoing planning and where necessary, to develop restoration-specific plans, which would be supported by complementary economic development strategies.

Economic Development Planning

Optimizing the restoration market would benefit from a strategic-level economic development plan, which could be refined through implementation at the regional and local scales. The strategic-level plan could explore:

- Appropriate roles for governments, including First Nations, in addressing key gaps, including what would benefit from direct government leadership, public-private partnerships, and competitive market-based responses

- Incorporation of a broad range of ecosystem services into analyses at the tactical level and decision-making at the strategic level

- Policy changes to create incentives for restoration, including as they relate to taxation, transforming restoration into a market commodity to be traded or sold, etc.

- Modernizing and streamlining permitting to improve cost-effectiveness, increase certainty for implementation, and maximize the ecological and social benefits from investments in restoration

- Reporting requirements to articulate how restoration initiatives in B.C. are contributing to global targets and frameworks and associated federal and provincial policies. This is needed to facilitate greater involvement of the private sector in restoration to help align financial flows with climate and biodiversity targets

- Strategies to support alignment of demand forecasts and supply chains, for example:
    - Co-management & reconciliation strategy within the context of a restoration market and associated First Nations goals
    - A.I. & technology strategy
    - Education & training strategy
    - Funding & partnerships strategy
    - Procurement strategy, including development of a registry of supply chain participants and facilitation of collaborative purchases to create sufficient demand for specialty services and products (e.g., native plants).

Comprehensive, Integrated Restoration Planning

There was widespread agreement amongst interviewees that development of landscape-level restoration plans is key to optimizing the restoration market. Planning at this scale provides participants in the restorative activities supply chains with important context, including future trends and if and how partnerships may be required to support efficiencies, innovation, and effectiveness. The outcomes from tactical, landscape-level plans complement the detailed forecasts for immediate demand that result from operational planning and permitting. To be effective, tactical and operational planning benefits from strategic-level direction, hence optimizing the supply chain involves planning at multiple, interconnected scales.

While there are opportunities to integrate restoration into ongoing land and resource planning initiatives at the strategic and tactical levels, efforts to do so would benefit from a framework for comprehensive, integrated restoration planning that balances consistency with flexibility for local priorities. Such a framework could help streamline and improve efficiencies in planning and could include:

- Common terminology, concepts, principles, strategic-level objectives, and tools for restoration to reduce duplication of effort and support effective communication and collaboration across sectors and planning processes

- The use of emerging technologies, including A.I., to analyze needs and trade-offs and define priorities within the context of available opportunities. While field verification may still be required, analyses can help design efficient field verification programs that use a sampling approach

- Guidelines for common restorative activities that could define consistent principles and strategies that could help select the suite of restorative activities and the levels of intensity or investment for each (e.g., high, moderate, low). This could help identify and reconcile the interdependencies of selected activities across the landscape. For example, one initiative may choose a low level of investment in invasive species control that could undermine investments by another initiative on revegetation or wildlife habitat enhancement

- Guidance for how plans and restoration programs can be consistently structured to facilitate communication and coordination (priorities, timing, sequencing, and leveraging) across programs and their respective projects to maximize the benefits from each individual effort

- Integrated monitoring for both implementation and effectiveness. When outcomes do not meet the desired objective, there is a tendency to pursue higher standards. If, however, the issue has been how programs and projects were implemented, for example there was insufficient integration and coordination to maximize the benefits of the individual efforts, then higher standards may not achieve better outcomes. Changing standards takes time and is costly, so there needs to be confidence that such efforts will result in the intended outcomes

- An intentionally designed system to use lessons learned to inform decision-making to:

    1. Improve integrated restoration planning, permitting, and practices

    Many restorative activities are commonly used to support restoration of a diversity of impacts, but the siloed nature of resource development and associated restoration can be a barrier to adaptive management. Integrated restoration planning, authorizations, implementation, monitoring, and evaluation offer opportunities to learn faster, which has the potential to change demand for specific restorative activities (both amount and complexity)

    2. Inform the evolution of best management practices for resource use and development, which might reduce demand for future restoration and/or improve restoration outcomes

    Practitioners offered examples, such as protecting existing vegetation and pro-actively reducing soil decompaction by laying protective materials on the ground prior to the use of equipment. While this strategy is labour intensive, it was an overall cost-effective method as it significantly reduced the need for subsequent restoration and improved the outcomes.

To fully implement this scenario, a transformative level of change in governance may be needed to support the required integration and coordination. The two complementary approaches, restoration and economic development planning, require mobilizing and aligning broad expertise and resources. There are, however, numerous existing initiatives that are seeking to improve integration and coordination across some of the restoration supply chain ecosystem, which offer a foundation for exploring incremental improvements in integration and coordination.

The need to respond to the Yahey decision and the scale of the restoration market in the Northeast Region make the region a logical, albeit complex, focus for building and testing products to support comprehensive, integrated restoration and economic development planning. If intentionally designed to do so, products and lessons learned could be applied more broadly to benefit other regions in the province and in recognition that the supply chain ecosystem operates at a scale that is broader than the Northeast Region.

10 The Restoration Supply Chain Ecosystem: Description

10.1 Enabling Activities Supply Chains

The enabling activities supply chains operate at three inter-connected scales: strategic, tactical, and operational (Figure 7), which reflects the general approach to natural resource planning and decision-making. The enabling activities supply chains are the mechanisms for integrating comprehensive, integrated restoration into broader planning and decision-making, which is necessary to maximize the benefits from restoration in terms of both landscape and community resilience. If explicitly designed to do so, the services and resultant products could:

- Define demand for restorative activities, including priorities that will make best use of available opportunities and maximize the benefits from investments in restoration, and

- Generate clear demand forecasts that will align demand and supply and, therefore, help optimize the restoration market.

Figure 11 Enabling Activities Supply Chains

Source: Figure developed by the authors

10.2 Restorative Activities Supply Chains

The experience of the project team combined with input from interviewees and reviews of studies in other jurisdictions (Powter et al., 2021, Young et al., 2023) were used to generate proposed supply chains for each restorative activity (section 3.6). Each supply chain is presented as distinct with efforts made to avoid duplication, but as restorative activities are frequently used in combination, it is important to consider the linkages across the restorative activities supply chain ecosystem.

Figure 12 Restoration Infrastructure Supply Chain

	Restorative Activity	Supply Chains			
Infrastructure	Access management	Construction			
		Controls			
		Decommissioning			
	Facilities management	Established	Maintenance for safe access and operations		
			Decommission		
		Temporary	Camps		
			Storage	Equipment	
				Materials	Chemicals, including fuel
					Non-chemical

Source: Figure developed by the authors

Figure 13 Hydrology Supply Chains

	Restorative Activity	Supply Chains			
Hydrology	Decontamination	Point source	Extraction	Treat onsite	
				Transportation	Treat offsite
			Containment		
			Blending, mixing, dilution		
		Insitu	Chemical		
			Biological		
			Thermal		
			Technology		
			Dilution and dispersion		
	Flows	In-stream structures	Engineered structures	Create	
				Remove	
			Natural system design		
		Culverts	Install or improve		
			Remove		
		Prescribed flooding			

Source: Figure developed by the authors

Figure 14 Soils Supply Chains

	Restorative Activity	Supply Chains			
Soils	Movement	Manage nutrient and gravel cycling			
		Erosion prevention and control	Engineered structures		
			Natural system design		
	Site preparation for revegetation (passive/natural and/or active)	Soil replacement			
		Decontamination	Extraction	Onsite treatment	
				Transportation	Offsite treatment
			Containment		
			Blending, mixing, dilution		
		Decompaction			
		Contouring, mounding			
		Amendments			

Source: Figure developed by the authors

Figure 15 Invasive Species Supply Chains

	Restorative Activity	Supply Chains	
Invasive Species	Eradicate	Plants	Manual
			Mechanical
			Chemical
		Fauna	Manual
			Mechanical
	Contain & Control	Plants	Manual
			Mechanical
			Chemical
			Biocontrols
		Fauna	Manual
			Mechanical

Source: Figure developed by the authors

Figure 16 Vegetation Supply Chains

	Restorative Activity	Supply Chains					
Vegetation	Revegetation	Seed Collection	Wild/unmanaged populations	Processing	Certification	Storage	Distribution
			Managed areas				
		Propagation	Conifer seedlings	Storage	Distribution		
			Deciduous seedlings				
			Shrubs				
			Seed				
			Seed balls, pucks				
		Planting	Manual				
			Mechanical				
			Technology				
		Seeding	Manual				
			Mechanical				
			Technology				
		Irrigation					
	Forest health and stand structure	Mechanical, manual	Danger tree removal				
			Coarse woody debris removal				
			Salvage harvesting				
			Thinning				
			Brushing				
			Pruning				
		Chemical	Manual				
			Mechanical				
	Prescribed fire	Manual ignition					
		Mechanical ignition					

Source: Figure developed by the authors

Figure 17 Fish and Wildlife Supply Chains

	Restorative Activity	Supply Chains	
Fish and Wildlife	Habitat structures	Terrestrial	Openings (inblock, fields)
			Linnear corridors
		Aquatic	Instream
			Lacustrine
			Wetlands
			Riparian
	Population management	Harvest regulations	
		Predator-prey dynamics	Predator control
			Maternal protections
		Reintroduction & assisted migration	Translocation
			Captive breeding

Source: Figure developed by the authors

11 Assessment of the Restoration Supply Chain Ecosystem: Purpose

An assessment of the supply chain ecosystem is intended to support participants across the supply chain ecosystem to:

- Understand the strengths and vulnerabilities of the system to meet current demand and the resilience to respond to changes in demand
- Clarify their specific strengths (opportunities) and vulnerabilities (risks)
- Identify individual actions and collaborations for responding to the opportunities and risks.

Markets are increasingly using A.I. to manage supply chains. A.I. powered supply chains is one of five global innovation clusters selected as a focus for investments by the federal government. Exploring possible A.I. applications was beyond the scope of this project, rather the focus has been to propose a basic, pragmatic approach that participants in the supply chains could use to support their individual decision-making and identify collaborations that may be useful to address more complex risks and opportunities. To build on the outcomes of this project, a next step could be to explore technologies that would support more complex analyses and generate real-time demand forecasts and assessments of the supply chain ecosystem.

12 Assessment Methodology

Assessment of the supply chain ecosystem requires consideration of:

- Capacity to support current and potential future demand in terms of both:
  - Amount of restoration – expand or contract based on changing demand
  - Complexity and innovation required, for example restoring to achieve broader objectives, scaling up to the program/landscape scale, and greater integration and coordination across initiatives to maximize the benefits from individual efforts

- Resiliency to adapt to sudden changes from within the supply chain ecosystem and external shocks, such as wildfires that might prevent planting and require storing seedlings for an extra year or two

- Challenges and opportunities that are common across a supply chain and/or the supply chain ecosystem compared to unique challenges and opportunities.

Existing data on supply chains has been collected through surveys (Powter et al., undated, Spearing et al., 2023, Young et al., 2023,) which were sometimes conducted in combination with interviews. As the scope of the projects were provincial or national, the resulting data provides broad context for understanding the restoration market in Northeast Region. As the surveys had a low return rate, this project used online interviews with participants; hence, input on the strengths and vulnerabilities of the supply chains is based on the knowledge of interviewees. The intention was to build on previous efforts and explore the regional-scale restoration market and associated supply chain ecosystem for Northeast Region. Taken together, the input provides an indication of the strengths and vulnerabilities of the supply chains and overall supply chain ecosystem to meet current demand and potential changes in future demand in the Northeast Region.

There are complex interactions within and across the supply chains, which makes assessing vulnerabilities and strengths challenging. Therefore, a vulnerability/ strength matrix has been developed as a prototype for a basic assessment of the restoration supply chain ecosystem (Figure 18). The matrix uses a ranking from 1-9 depending on the significance of the vulnerability and scale of impact. Taking action to address a vulnerability can transform it into a strength with a similar scale of impact. For example, a vulnerability that creates risks for the entire restoration supply chain ecosystem could be transformed into a strength that benefits the entire ecosystem.

Table 6 Vulnerability and Strength Matrix for Supply Chains Assessment

	High Vulnerability or Strength	Moderate Vulnerability or Strength	Low Vulnerability or Strength
Supply chain ecosystem impact	9	7	4
Supply chain impact	8	5	2
Individual impact	6	3	1

Source: Table developed by the authors

Matrix Category	Basic Description
Low vulnerability	Can be managed within the existing system and business operations
Moderate vulnerability	Involves adaptation that can likely be achieved within the existing system and business operations
High vulnerability	Involves a transformative level of change to systems and business operations
Individual impact	Impacts one organization or a cluster of organizations at one point on a supply chain
Supply chain impact	Implications along a supply chain
Supply chain ecosystem impact	Ripple or cascading impacts across multiple supply chains

Source: Table developed by the authors

Rank	Discussion on Vulnerabilities and Potential Responses
9	Multiple risks across multiple supply chains that involve systemic macro and mico economics scale challenges Increases in demand pressures result in significant and widespread lost opportunities. Decreases in demand could result in major restructuring with loss of jobs and workers, etc. Or transformations may redefine the risk, for example new technologies, consolidation with larger companies purchasing smaller ones, a new government regulation May require new formal processes or revising mandates for existing processes. Likely need to use a triage approach to stratify risks that can be addressed in the short, medium, and longer terms
8	Risks are entrenched challenges and likely macro in scale. May require decisions from parties that are external to the supply chain, overcoming historic challenges, and can take time to resolve Changes in demand could cause this risk to flip to an ecosystem level impact or transformations may redefine the risk
7	Risks are spread across multiple supply chains, some of which can be addressed by participants in the supply chains, but some may require decisions from external parties Changes in demand result in lost opportunities, job loss, etc. that may be focused in a region or suppliers serving a single sector. Or transformations may redefine the risk Processes and leadership exist to support the required coordination, but need the mandates and resources to do so

Rank	Discussion on Vulnerabilities and Potential Responses
6	Risks experienced by a cluster at a point along a supply chain that involves diverse organizations (e.g., from different sectors that are working within different legislation, cultures) While solutions can result from collaborations, the cluster may be dealing with more macro issues, participants may lack familiarity with each other, require formal partnerships or agreements, and so is less responsive. If there is a sudden change in demand, the situation could flip to a supply chain level risk
5	Numerous risks are dispersed across the supply chain, which can be mitigated if there are effective and coordinated responses Will benefit from respected leadership within the supply chain, established relationships, and previous successful collaborations If the response is quick and effective, unlikely to destabilize the supply chain whereas slow, ineffective response increases risks
4	A small number of risks will likely spread from one supply chain to others. The issues are micro in scale, well understood, solutions are dependent on decisions made by the supply chain participants, and processes and leadership exist to support the required coordination
3	Risks experienced by a small cluster at a point along a supply chain that involves similar organizations (e.g., not dispersed across a supply chain) Issues are generally micro scale where solutions can result from collaborations. May be based on relationships, can be informal, highly flexible
2	A small number of minor risks are dispersed across the supply chain. Issues are mostly micro scale with solutions dependent on decisions by the supply chain participants Unlikely to destabilize the supply chain. Monitor to determine if coordination of multiple individual responses will be required
1	Risk experienced by an Individual organization that can respond for example a business expands or contracts, a government agency creates an internal working group, or a First Nation creates a restoration business

Source: Table developed by the authors

13 Common Vulnerabilities and Strengths across the Supply Chain Ecosystem

13.1 Communication and Coordination

Vulnerabilities

There are missed opportunities to optimize the restoration market because participants in the supply chain may be:

- Unfamiliar with restoration terms and concepts; the structure and components of the restoration supply chain ecosystem; and/or how the restoration market functions. Such knowledge is a critical foundation for communication and coordination across related initiatives to help optimize the restoration market
- Unaware of how the macro-scale forces are impacting demand and the supply chain ecosystem in real time as tracking and interpreting the drivers of change is complex
- Supporting only one sector (e.g., oil and natural gas or forestry) when their products or services could be transferable across different types of restoration initiatives, and/or
- Unaware of the strengths or vulnerabilities within the supply chain ecosystem that could impact them, including demand for their products or services and opportunities to collaborate to respond to changing demand.

Strengths

Participants across the supply chain ecosystem recognize the importance of improved communication and coordination. Many participants have created, or are members of, formal associations and committees or informal networks. The forums are using improved communication and coordination to help solve specific challenges and maximize the benefits from identified opportunities for their members. The multiple existing forums can be a foundation for a more strategic approach to communication and coordination across the restoration supply chain ecosystem.

13.2 Human Resources

Vulnerabilities

Human resources were consistently identified as a key limiting factor for meeting current demand and a barrier to growing the restoration market in the Northeast Region. Some local companies are no longer trying to recruit as their efforts have been unsuccessful, rather their existing capacity is defining their participation in the restoration market.

Macro-level factors are impacting the ability to recruit and retain workers, including:

- Competition from other markets for workers with transferable skills, including sometimes higher wages in other markets
- High cost of housing and limited availability for those who might relocate for work
- Travel restrictions and greater work-from-home opportunities during the COVID-19 pandemic has resulted in a longer-term shift with many workers less willing to travel

- Patterns and inertia created by the history of restoration, which has typically offered seasonal employment or short-term contracts. The cost of living is making temporary employment less appealing in a competitive market for employers
- An increasingly urban economy, culture, and workforce, which does not recognize the attributes of the Northeast Region that many locals value, and so negatively impacts recruitment that requires relocation.

The restoration market operates at multiple scales. Both formal and informal networks are being used to support integration across the multiple scales to support participants in the supply chains to adapt to emerging challenges and opportunities. The identified human resource challenges and opportunities that are associated with the various scales of the restoration market include:

1. **The local market**, which tends to focus on ***generalists*** with transferable skills, for example machine operators who have worked in resource development who could be trained to work within the restoration market or field technicians who can be trained for a diverse range of activities. The local market seeks to maximize the close-to-home employment and contracting opportunities at a community level, for example individual Treaty 8 First Nations or municipalities within the Northeast Region.

   In terms of optimizing the existing local capacity, relationships can impact, positively or negatively, the opportunities for local people and businesses. In addition to impacting employment and contracting opportunities, relationships can promote or restrict the flow of information and shared experience, which is needed to advance the skills of local people and businesses in the practice of restoration.

   In terms of growing local human resources, training is a key strategy. First Nations are providing training for their members. This includes support to participate in existing programs offered by educational institutions and designing culturally appropriate opportunities. The latter may involve a partnership with an educational institution or contracting a subject matter expert to deliver training that is tailored to members. While funding for training is often available, aligning the training with meaningful opportunities to apply the skills to gain needed experience can be challenging and can lead to individuals being “certified but not qualified". Funds that are dedicated to restoration are aligning training with opportunities to apply the skills, with one recent example being the Petroleum and Natural Gas Legacy Sites Restoration Program.

   As identified in a labour market strategy for the silviculture industry (Catalyst Research Group, 2022), training is a key tool to help workers diversify their skills. This could expand the field season and support longer-term employment opportunities, which could enhance worker retention at all scales of the labour market.

2. **The regional Northeast restoration market** is comprised of ***mostly generalists but can support some specialists*** for which there is sufficient demand, for example in the technical downhole work associated with the restoration of wells.

   The regional supply of skilled people and contractors has been described as small, which is both a challenge to meet demand but also is easier to support communication and

coordination to help optimize how existing capacity is used. There are collaborations and mechanisms for information sharing, such as the Treaty 8 Restoration Committee and regional conferences or gatherings on related topics. Provincial government agencies, including BCER and FOR, have vested interests in the success of the regional market to support restoration in the oil and gas sector as well as forestry and wildfire recovery. Hence, staff facilitate collaborations at the regional scale.

Northern Lights College staff in Fort St. John are aware that restoration offers opportunities for the regional workforce but are unclear how they can support the market. As the Dean explained, Northern Health identified the need for 94 nurses, which allowed the Board of Directors to authorize a partnership with the University of Northern British Columbia to deliver a nursing program in Fort St. John. The College is similarly interested in learning what the restoration market needs, how many, and by when. In short, the education and training supply chain needs a clearer demand forecast and support to interpret it for their internal decision-making processes.

Other strategies used to grow the capacity of the regional market is for large organizations, such as provincial agencies, industry tenure holders, and consulting firms to offer flexible employment opportunities, including the ability to be based outside of the region. As a result, the restoration market is dependent on the availability of accommodation, food, rental vehicles, and other services for staff that need to travel into the region, which has been an issue in the region and can add to the cost of restoration services and products.

3. **The broader restoration market** includes the Province of BC, Alberta, and could be extended to the Northwest Territories and the Yukon given proximity and shared interests in restoration within boreal forests. Some components of the supply chains, for example tree planters, recruit from across Canada. It is recognized that Northeast residents can resent outsiders taking employment and contracting opportunities; the demand forecast, however, suggests that demand exceeds local supply for at least some components of the supply chain ecosystem. Therefore, the challenge is to determine how to engage the broader restoration market to optimize the supply chain ecosystem dynamics so that the benefits at the local and regional scales are maximized. The broader restoration market includes:

    - ***Semi-specialists*** that do some of the activities that local generalists can do (for example restoration planning and tree planting) but have economies of scale that can support scaling up restoration. For restorative activities, this includes the capacity and experience to operate multiple crews and equipment to fulfill large contracts. Partnerships between locals and external larger companies exist with more being explored to ensure that the objective of maximizing benefits at the local scale is achieved within the context of contracts that are too big for local companies to unilaterally fulfill.

      Given some of the macro influences that are impacting the cost of living, many seasonal workers need longer seasons and may be seeking year-round and more stable employment opportunities. As a result, companies operating within the larger market are, not unlike

those at the local level, looking to cross train employees and diversify their operations to extend their seasons. At a broad restoration market scale, strategies to recruit and retain workers include a focus on youth and underrepresented groups, employing foreign workers, providing mental health supports, collaborating with the education and training sector to facilitate student transitions into the workforce, and providing more on-the-job training. Government staff identified the need to be creative, for example hiring students out of high school and supporting them through a combination of formal education and on-the-job experience that would lead to full-time employment.

- ***Specialists*** in both technical and professional realms who are subject matter experts that do not exist within the regional market as there may be insufficient demand at that scale or they may be unwilling to commit to a focus on the Northeast Region. Specialists need to be strategically engaged to support the local and regional markets. The boreal forest ecosystem and dominance of the oil and gas sector makes the Northeast Region different from other parts of B.C. and it was suggested that experiences in Alberta's boreal forests are not always directly transferable to Northeast B.C. Hence, locals voiced concern about the value of outside experts. At the same time, there is insufficient capacity within the Northeast Region, so engagement of external specialists needs to be strategically designed so they can effectively contribute their knowledge and skills and complement local and regional strengths.

13.3 Education and Training

While human resources are a common challenge, participants across the supply chain ecosystem identified education and training as a common opportunity to, at least in part, address some of the challenges. This project involved interviews of a cross section of participants in the education and training supply chain to assess the current situation.

Based on input from interviewees, five areas of education and training have been identified:

1. Professional Education and Research

   In B.C. there are post-secondary programs that are specific to restoration. The B.C. Institute of Technology (BCIT) offers a BSc in restoration. At the graduate level, a joint MSc involving BCIT and Simon Fraser University has ended and BCIT will offer its own course-based MSc. The University of Victoria offers thesis-based MSc and PhD opportunities through its School of Environmental Studies and is considering offering a course-based MSc. While the BCIT and UVIC programs mostly attract students from outside of northern BC, some of the graduates are working in northern B.C., including in the Northeast Region.

   Many professionals working in restoration have degrees in biology, ecology, forestry, engineering, or other relevant subject matter areas. Post-graduate certificate programs in restoration are available for those who have a related degree but want more in-depth understanding of restoration. Through its Continuing Education Department, UVIC offers diplomas and certificates through its Restoration of Natural Systems Program. Between 200-

300 students are enrolled at any given time with most taking individual courses rather than pursuing a diploma or certificate.

Another post-graduate program is the international SER's Certified Ecological Restoration Practitioner (CERP) program. In addition to offering professional development training, SER is seeking to set standards for restoration professionals that could be recognized like a Registered Professional Biologist (RPBio), Agrologist, Forester, or Engineer.

There is concern that the trend towards requiring designated professionals, the current most required designation being an RPBio, will limit the contributions of other knowledge holders, including Indigenous peoples. Scaling up restoration will likely continue this trend of greater reliance on designated professionals, including as one response to reducing the regulatory burden. A stated reason for UVIC's consideration of creating a course-based MSc in restoration is to support Indigenous and other ways of knowing into the curriculum to recognize the leadership role that Indigenous communities are and likely will continue to take in restoration.

In addition to UVIC, other universities support restoration-related research, including opportunities for MSc and PhD candidates, through programs in related fields. Industry proponents and consultants design and lead restoration operational trials or other studies. While this leads to some studies being published, many are not which can create challenges in accessing the studies and data, using results that have not been formally peer-reviewed, and advancing the practice of restoration through knowledge transfer. One organization is using A.I. to make their studies more accessible, networks such as SER and the Treaty 8 Restoration Committee facilitate information sharing, and interest has been expressed in creating a community of practice for northern B.C. While information sharing is important, there is still need for credible peer reviewed research that can be integrated with Indigenous and other local knowledge to support decision-making.

2. Technical Training

Technical training through educational institutions is frequently delivered by qualified consultants who are engaged by the institution. For example, the University of Northern B.C.'s Continuing Education Program offers a Land Reclamation Certificate, which is an entry level program that targets students who are new to land reclamation and may not have a post-secondary level understanding of ecosystem ecology. Royal Roads responds to identified training needs by engaging qualified consultants to offer training that is tailored to a particular group.

Universities can also bridge professional and technical training through engaging local technicians, including members of Indigenous communities, in field trials that are associated with research by MSc or PhD students and their supervisors.

Consultants are also being directly engaged by First Nations or companies to deliver tailored technical training. Businesses with niche knowledge may offer training either because they do not perceive the outcomes will be undesirable competition or because they have entered into a partnership and the training is anticipated to be mutually beneficial.

First Nations are training their members in both technical skills, such as field assessments and monitoring, and as part of the workforce to support project implementation, for example tree planting. Members are being supported to participate in formal programs offered by educational institutions as well as culturally appropriate training that has been specifically designed, which can involve a partnership between a First Nation and an educational institution or a First Nation may hire a subject matter expert to deliver training that is tailored to the members.

The current approach to technical training is focused on building capacity to meet the current understand of demand. Scaling up restoration, including increasing the complexity of programs and projects, may need a different approach. Local colleges are interested in offering more technical training but require clearer information about demand. Colleges and universities across B.C. have regular gatherings for continuing education programs and different types of sciences. It was suggested that a presentation on demand for technical training to support the restoration market could be discussed through these joint forums.

3. Workforce

Workforce training at the local scale seeks to build generalists through training that is tailored to the needs of the workers and to align with known employment opportunities. At the larger scale, the restoration workforce tends to align with the siloes for resource development. Diminishing opportunities in some sectors, such as forestry however, are resulting in contractors exploring what skills and experiences are transferable to other opportunities and could expand their season, including to create year-round employment to support workforce retention. Workforce training appears to also being pursued along sector lines with potential missed opportunities to increase efficiencies through collaboration on developing transferable skills.

A significant portion of the workforce is transient as it often involves young people, including students, or others who consider the work to be a temporary means to support their longer-term goals. The turnover increases costs and challenges the ability to scale up restoration, including the ability to increase the complexity of programs and projects. One response has been to focus on training for supervisors using a train-the-trainer approach.

4. Business Development

Established consulting companies are incorporating restoration as an area of expertise into their broader business models and there are a few companies and individual consultants that focus on restoration. Saulteau First Nations started Aski Reclamation LP and other First Nations are developing capacity for restoration planning and program/project management within their Nations' governance structures. Additionally, First Nations are supporting members to access employment and business opportunities associated with the restoration market, hence the economic development component of their organizations is involved with restoration and are seeking to access business development training and supports. The lack of clear demand forecasts inhibits delivery of effective business development training and can create tension as local community members are frustrated by the lack of visible progress following large funding commitments by the Province. Business development training is

typically provided by different organizations or consultants than for skills associated with restorative activities. Developing a shared understanding of the restoration market by both restoration and economic development professionals could help design strategies for optimizing the market and maximizing benefits for local communities.

5. Community-level Education and Engagement

   Planners and practitioners reported that community-level education and engagement results in mutual learnings that are critical for developing and implementing restoration programs and projects. Interviewees noted community-level education and engagement requires:

   - Using a two-eyed seeing or walking on two legs approach that integrates science, traditional Indigenous, and other local knowledge into planning and decision-making

   - Designing trade-off assessments to consider:
     - A broad range of ecosystem services
     - Priorities at multiple scales. For example, assessing options for reducing access in terms of both individual roads that may be a local priority compared to trade-offs across the larger network that those roads are part of

   - Developing agreements on behaviour changes to support:
     - Pro-active risk reduction activities, for example to help prevent the introduction of invasive weed species
     - Successful restorative activities, such as access restrictions for a recently restored area.

   Many organizations and consultants have experience in community education and engagement, including to support restoration projects. Scaling up restoration to the program/landscape scale and the need for greater integration and coordination across restoration programs and projects will likely increase both the range of participants to be engaged and the complexities of the discussions. Therefore, those leading community-level education and engagement processes would benefit from common terminology, a consistent framework for restoration, and support to become conversant with them. Currently, there is no clear education or training pathway to support these needs.

14 Assessment of Enabling Activities Supply Chains

An assessment of the enabling activities supply chains considers the:

- Vulnerabilities that could challenge providing effective services and generating the necessary products
- Likelihood that ongoing efforts may address gaps and transform a vulnerability into a strength.

Given that the enabling activities supply chains create products that define demand for restorative activities, the likely scale of impact of a vulnerability or strength is across the supply chain

ecosystem. A vulnerability within the enabling activities supply chain can have cascading risks but strengths can create benefits that also ripple across the supply chain ecosystem.

The purpose of an assessment is to support leadership within the enabling activities supply chains to understand the vulnerabilities, strengths, and their significance to inform decisions on how best to capitalize on opportunities to reduce risks and maximize the benefits from investments in restoration.

The following rankings are subjective interpretations by the project team based on input from interviewees about the current capacity of the enabling supply chains to produce the required products at the strategic, tactical, and operational scales.

A summary of the input received is below. It reflects the knowledge and experience of the individuals interviewed and should, therefore, be considered an indication rather than a comprehensive assessment of vulnerabilities and strengths. The rankings are intended to support further discussion.

Table 7 Ranking of Enabling Supply Chains

Enabling Supply Chain Products	Ranking		
	Strategic	Tactical	Operational
Restoration policies and strategies to support efficiencies			
• Strategic level restoration objectives, targets, definitions of success	7	7	7
• Define relationships between restoration and major policy initiatives	7	7	7
• Decision-making support for restoration: formalized system for evaluating lessons learned and integrating into decision-making	7	7	7
Integrated demand forecasts			
• Across sectors/impacts at multiple, connected scales	9	9	7
• In real-time	7	7	7
Comprehensive, integrated restoration plans			
• Framework to support scaling up restoration and incorporating it into planning processes	9	9	9
• Landscape level plans		9	7
Regulatory framework to support efficiencies across sectors/ impacts			
• Modernized framework that rationalizes the use of available tools under existing Acts and regulations as well as addresses gaps to support a comprehensive, integrated approach to restoration	9	7	9
• Streamlined processes, including to support approvals of comprehensive, integrated landscape-level plans and programs, which can include multiple, nested projects that may be impacted by multiple Acts and regulations	9	7	9

Enabling Supply Chain Products	Ranking		
	Strategic	Tactical	Operational
Economic development policies to help optimize the restoration market			
• Taxation policies that incentivize restoration	7	7	
• Socio-economic assessment methodology that incorporates a broad range of ecosystem services	7	7	
• Clear roles and responsibilities to optimize the allocation of resources and increase effectiveness, including which opportunities are best: o Led by governments, including First Nations o Pursued through public-private partnerships o Managed through the private sector market	7	7	4
• Framework for reporting that will link restoration to global targets and frameworks and associated federal and provincial policies to help align financial flows with restoration opportunities	4	4	4
Strategies to support alignment of demand forecasts and supply chains			
• Co-management & reconciliation strategy within the context of a restoration market and associated First Nations goals	7	7	7
• A.I. & technology strategy	7	7	7
• Education & training strategy	7	7	7
• Funding & partnerships strategy	8	8	7

Source: Table developed by the authors

14.1 Strategic Level Supply Chain

Most strategic leads within the natural resource sector have some level of understanding of many of the vulnerabilities and are working within their mandates and available resources to pursue opportunities to reduce the risks. Examples include:

- Collaborations, including regional multi-agency committees and a provincial scale committee to explore challenges within the reforestation supply chain
- Exploring how major policy initiatives, such as caribou recovery and old growth, can be vehicles to explore broad restoration objectives
- If and how protecting restored areas from further development might support longer-term goals, although there is a lack of consensus as to the value of developing legal tools to do so.

The provincial Ministry of Jobs, Economic Development and Innovation (JEDI) seeks to respond to the stated interests of communities, including those that want to become more involved with the economic benefits associated with restoration. The local-scale goals and objectives, however, are being pursued without benefit of a strategic-level approach to economic development.

14.1.1 Mandates

While efforts to address gaps in the restoration supply chain ecosystem by individual people and single organizations are important, they are unable to address the systemic gaps and inefficiencies across the restoration supply chain ecosystem. In some cases, individual efforts may address a specific challenge but further entrench inefficiencies at a broader scale.

Currently, support for a comprehensive, integrated approach to restoration and optimizing the restoration market is not explicitly identified in the mandate letters of the provincial natural resource management agencies or JEDI. Rather individual restoration initiatives, including legally required activities, are pursued to support the diverse mandates as outlined in the letters. This has led to inefficiencies and missed opportunities to maximize the cumulative benefits of individual restoration initiatives. The priorities and allocation of resources for provincial government staff are guided by the mandate letters. Clear mandates for comprehensive, integrated restoration across provincial government agencies could facilitate:

- Identification of a team of champions with clear and direct accountabilities

- Creation of linkages between:
    - Multiple objectives for restoration that define its contribution to landscape and community resilience
    - Broad restoration objectives and the range of priorities that are defined through legal and policy direction
    - Restoration planning and economic development planning
    - Budgets across agencies and programs

- Maximizing the cumulative benefits from investments made in restoration by improving efficiencies, innovation, and effectiveness across the supply chain ecosystem.

First Nations' involvement in restoration is rooted in traditional stewardship practices with mandates reflected in Treaty and Aboriginal Rights as well as commitments to reconciliation and co-management. The need to consider restoration at scales larger than individual First Nations territories and the impacts from and on macro-level economic drivers creates an important continuing role for the Province. Hence, the mandates for provincial government staff affect the success of other participants in the restoration market.

14.1.2 Champions

Many First Nations have consistently been champions for restoration with legal decisions, such as Yahey v British Columbia, as well as commitments to reconciliation and co-management having strengthened their position to be effective champions. As the concepts of reconciliation and co-management are evolving, many participants spoke of a cautious, time-consuming approach that seeks to support First Nations to define their values, needs, and visions. The role of champion can not be completely assumed by First Nations as complementary champions are needed within governments, industry, NGOs, and other local communities to optimize the restoration market.

Champions for restoration exist at various levels throughout the provincial natural resource agencies and federal government. As noted above, the lack of clear mandates for provincial

government staff hinders the mobilization of a team of identified champions from across all relevant agencies, which could increase the effectiveness of individual efforts. Some industry associations are exploring how they can champion optimization of a restoration market and maximize the benefits for their members. To do so, some associations are exploring how to establish relationships with groups they have not traditionally worked with.

Influencers, including NGOs and educational institutions, are organizing forums and supporting research to advance restoration in B.C. Finally, consultants have important knowledge and experience to support the strategic-level supply chain. Influencers and consultants are, however, limited to a supporting role at the strategic level within the enabling activities supply chain.

14.1.3 Allocation of Resources

In the Northeast Region, the amount of legally required restoration combined with the creation of dedicated restoration funds have created a restoration market that is sufficiently large that investments in improving enabling services and products are likely to be cost-effective over time. If intentionally designed to do so, the lessons learned and resultant products could benefit other parts of B.C. and other jurisdictions. There have been numerous discussions on the need for strategically designed collaborations to leverage resources to develop mutually beneficial products. Such efforts could lead to the development of clear strategies and workplans.

14.2 Tactical Level Supply Chain

Planners and practitioners at the tactical level are leading efforts to integrate and apply strategic-level direction that relate to multiple objectives. This often includes assessing trade-offs at the landscape scale to support refinement of the strategic-level direction. The resulting tactical-level products then support operational-level decision-making. Examples of ongoing tactical-level efforts include:

- Exploring a more holistic approach to wildfire recovery for the Donnie Creek fire
- Building understanding of, and capacity for tactical, landscape-level planning through FLPs although the processes tend to be forestry-centric and restoration is a level two focus
- Undertaking landscape-level restoration planning through boreal caribou recovery
- Defining changes to stocking standards given climate change and the need to support a broad range of values and objectives.

Lack of products from the strategic-level supply chain can result in participants at the tactical-level “muddling through”. Participants in the tactical-level supply chains tend to have a clear view of the gaps and in absence of other options, may take the initiative to address the gap to the best of their ability and within the confines of their mandates and resources. While significant gains can be realized at the tactical level, there is also potential to further entrench inefficiencies in the restoration market through one-off efforts.

14.3 Operational-level Supply Chain

Creative problem-solving is used at the operational level to work within the system to enable the implementation of restoration projects. Examples include:

- Streamlined permitting, for example by expanding the range of authorizations made by BCER
- Collaborations between planners and decision-makers to identify creative uses of available regulatory tools, such as Special Use Permits, to create opportunities for restoration
- External parties are learning about the regulatory framework so they can propose innovative approaches. For example, an Indigenous-owned consulting company proposed a permitting solution to address a unique challenge that has sparked a legal review to confirm support. While this will delay implementation until the subsequent field season, there is potential to set precedents and apply lessons learned more broadly into the future.

If the needed strategic and tactical-level products are unavailable, then the scale of problem-solving that can be accomplished by participants in the operational-level supply chain will generally be for restoration projects, not landscape-scale restoration plans and programs.

15 Assessment of Restorative Activities Supply Chains

The following rankings are subjective interpretations by the project team based on the outcomes of relevant studies and input received from interviewees, which are summarized below. The input reflects the knowledge and experience of the individuals interviewed and, therefore, the rankings are an indication rather than a comprehensive assessment of vulnerabilities and strengths. The rankings are proposed to support further discussion. No rankings are offered where there was insufficient input from interviewees.

Table 8 Ranking of Restorative Activities Supply Chains

Category	Restorative Activity	Human Resources	Equipment/ Infrastructure	Materials
Infrastructure	Access management			
	Facilities management			
Hydrology	Decontamination			
	Flows	3	3	3
Soils	Erosion control	5	5	
	Site preparation	8	5	
Invasive species	Eradicate	3		
	Contain and control	3		
Vegetation	Revegetation	8	7	9
	Forest health and stand structure	5	5	
	Prescribed fire			
Fish and Wildlife	Habitat structures	3		
	Population management			

Source: Table developed by the authors

For each restorative activity, general comments on demand are offered as context for considering the relative significance of strengths and vulnerabilities for the respective supply chain and the supply chain ecosystem as a whole. The comments about demand reflect available information about needs and opportunities as well as input from interviewees.

Infrastructure: Access management

Demand: Accessing remote restoration sites can involve creating new roads or trails, re-opening previously decommissioned roads, or creating landing areas for helicopters.

There can also be demand for access controls or decommissioning existing access as:

- part of initial risk reduction strategies to create the necessary conditions for passive or active restoration
- a component of implementing a comprehensive, integrated restoration plan or program over time.

Particularly in northern B.C., climate and terrain can limit access and concentrate restorative activities into relatively narrow windows of opportunity during the winter and spring/summer/fall field seasons.

Strengths	Vulnerabilities
• There is considerable experience with all forms of access management, including through Boreal Caribou Recovery • Restoration practitioners are identifying opportunities to pro-actively reduce the impacts access that can reduce costs and increase the effectiveness of subsequent restorative activities • Entrepreneurs are designing modified equipment that enables an expanded season for access in boreal forest ecosystems to support restoration	• Building agreements to cost-effectively create, control, and/or decommission access remains a complex and costly process • Some types of access, such as seismic lines, are legacy issues so will not be addressed unless special funds and mechanisms are created to do so. It is uncertain how Treaty 8 First Nations will allocate the funding provided to them for restoration, but there is an assumption that allocation of the funds may increase demand for legacy seismic restoration

Source: Table developed by the authors

Infrastructure: Facilities management

Demand: Restoration can require decommissioning of existing infrastructure, such as down hole work to restore abandoned wells. Restoration following large scale climate events, such as wildfire and flooding, may also require maintenance of existing infrastructure for safety and/or to restore operations as part of initial risk reduction and a pre-condition for initiating active restoration.

Some activities, such as treeplanting, may require establishing temporary work camps and on-site storage facilities for specialized equipment or materials. While these needs are often met by the company that is providing the service, for example the treeplanting contractor, large-scale projects in remote locations can create demand that a limited number of companies can meet.

Strengths	Vulnerabilities
• Governments, First Nations, and industry will mobilize to respond to emergencies	• Responses to emergencies can reduce available capacity to respond to demand for other restorative activities
• The need for decommissioning existing infrastructure is generally known	• Demand for decommissioning orphaned wells exceeds the capacity of the supply chain in Northeast Region. Hence, there is a dependency on capacity in Alberta, but availability is subject to demand in Alberta and relative prices • Currently, the lack of capacity is a barrier to meeting some targets for well pad remediation, for example in the Blueberry River Implementation Agreement • Need alone does not define demand. If additional opportunities are created and priorities are defined (for example for abandoned mines), then supply chains may need 1-5 years to build sufficient capacity
• Contractors are motivated to find cost-effective solutions and have experience with working in remote locations	• Since the COVID-19 pandemic, there has been a longer-term decrease in the availability of workers willing to work from remote camps, particularly for temporary work

Source: Table developed by the authors

Hydrological Flows	
Demand: Legally required restoration seeks to support hydrological flows. Additional restoration of hydrologic flows, including but not limited to wetlands, is a priority for at least some First Nations and non-profit organizations. Demand is, however, dependent on the opportunities created by funding and other resources.	
Strengths	**Vulnerabilities**
One organization reported having sufficient internal capacity and anticipate that the supply chain can provide the required machines, operators, and materials to meet demand in terms of opportunity. It was noted, however, opportunity is significantly less than need	It is uncertain how Treaty 8 First Nations will allocate the funding provided to them for restoration and, therefore, if there will be an increase in demand for restoration of hydrological flows. If so, it is uncertain if the supply chains could meet the increased demand

Source: Table developed by the authors

<table>
<tr><th colspan="2">Soils: Erosion Control and Site Preparation</th></tr>
<tr><td colspan="2">Demand: Erosion control and site preparation supports a broad range of restoration, including both passive and active, the full restorative continuum (remediation, rehabilitation, restoration), and impacts that have resulted from different resource development sectors. As a result, the supply chain needs to respond to a diversity of demand drivers.
Improved demand forecasts are needed to articulate the scale of demand for specific restorative activities. Available FOR data indicates that site preparation constitutes approximately 5% of all silviculture expenditures, but site preparation is also needed to support oil and gas activities, which comprise a greater portion of the demand for restoration in the Northeast Region.

Erosion control is often part of initial risk reduction to create the conditions necessary for either passive or active restoration. An example is the initial rehabilitation of wildfire breaks that are created during suppression activities, which is resulting in increasing demand for erosion control activities.</td></tr>
<tr><th>Strengths</th><th>Vulnerabilities</th></tr>
<tr><td>BC Wildfire Service anticipate being able to secure required equipment and operators for rehabilitating fireguards to prevent erosion and other wildfire suppression rehabilitation priorities as they contract suppliers in advance</td><td>Emergency level needs for addressing immediate risks are being met. Where a multi-agency plan has not been prioritized, however, there can be a time lag between the end of initial risk reduction and the start of restoration. FOR staff are being asked for assistance for help with broader recovery of older burn areas, which increases costs. It would likely require targeted funds, which would create a pulse or spike in demand that could be challenging for supply chains to respond to.</td></tr>
<tr><td>Regulations and the funding structure have created predictable demand for some restoration, for example well pad remediation
The predictable demand creates opportunities for investments in training and capacity building</td><td>There is limited capacity for well decommissioning and remediation, hence there is a dependency on companies from Alberta
As it is difficult to attract workers to the Northeast, training and capacity building may not fully address the gap so there are ongoing risks to meeting targets</td></tr>
<tr><td>Practitioners report a growing body of experience, including in Alberta and other jurisdictions, that can be shared to support advancements in erosion control and site preparation that will improve restoration outcomes and cost-effectiveness</td><td>Suppliers can be siloed so sharing lessons learned across sectors and jurisdictions may need active facilitation and coordination</td></tr>
<tr><td>Innovations are occurring in terms of designing and modifying equipment for use in restorative activities in the Northeast to reduce the impacts of</td><td>Innovations are generally at the project and local level. Scaling up requires increased certainty about future demand and public-private partnerships, for example through business development support to interested First Nations</td></tr>
</table>

machinery moving across the landscape and to expand the field season	
	• There is strong interest in use of natural system design, but some biologists and ecologists prefer to focus on conservation and preservation rather than contribute to restoration that may be used to create opportunities for future resource development • Several engineering programs are incorporating natural system or biomimicry design into their curriculums, which could expand the capacity for designing such activities

Source: Table developed by the authors

Invasive Species	
Demand: Specialists suggest that the threat from invasives is growing, in terms of: • Lost economic opportunities as invasives negatively impact the productivity of aquatic and terrestrial ecosystems • Increasing costs for prevention, eradication, control, and containment activities of an ever-growing number of invasive species, and • Limiting options for restoration as invasive species can be a key determinant for the recovery trajectory. There is particular concern about aquatic invasives given the difficulty of managing them once they have entered an ecosystem. Need alone, however, does not define demand. Requirements for invasive species management are outlined in several Acts and regulations, which creates some predictable level of demand. Invasive species management can also be a primary focus or a supporting activity in applications to many funding organizations, hence there are also fluctuations in demand for the services.	
Strengths	**Vulnerabilities**
• Some invasive weed eradication, containment, and control activities are not highly technical, hence training can be provided to a wide range of field crews • Invasive species activities can be used to expand field seasons and provide more consistent employment	Unlike other regions in the province, there isn't a Northeast Regional committee that facilitates building capacity and partnerships to address invasive weeds. Previously, an adhoc group and regular collaborations between provincial government agencies supported a more strategic, cost-effective approach to invasive weed activities. Those mechanisms have been impacted by reduced budgets and staffing to programs that led such efforts. Currently, funding, which may not be specifically for invasive species but can be used for that purpose, is dispersed across multiple organizations, including First Nations.

Source: Table developed by the authors

<table>
<tr><th colspan="2">Vegetation</th></tr>
<tr><td colspan="2">Demand: Systems have been developed to define demand for some components of the revegetation supply chain. The systems have tended to reflect sector-based demand (for example reforestation) and focused on conifer tree species. While demand for traditional conifer species is declining, demand is growing for revegetation that uses a broader range of native species. There is also expectation for a greater reliance on passive restoration, so there is uncertainty as to demand forecasts for revegetation human resources, equipment, and materials. In terms of demand across the revegetation supply chain from forestry activities, recent FOR data suggests that 87% of the demand has been for planting with 8% for brushing (and 5% for site preparation).</td></tr>
<tr><th>Strengths</th><th>Vulnerabilities</th></tr>
<tr><td>A high level of concern about the capacity of the revegetation supply chain has resulted in many initiatives to address the issues at the international, national, provincial, and more local scales
An example is the federal 2 Billion Tree Program, which is focusing attention and serving to mobilize action to ensure that the national revegetation supply chain can support implementation of the program</td><td>Individual efforts are sometimes operating in isolation to solve a particular problem, which is impacted by broader factors than are being considered
The additional demands from the 2 Billion Tree program add to concerns about the ability of the supply chain to support current and forecasted demand
A survey suggested that B.C. has between 16-24% of the national revegetation supply chain’s capacity. Although B.C. exports some human resources and materials, its dependency on external businesses is greater; hence, the supply chain in Northeast Region will be impacted by vulnerabilities in the larger supply chain</td></tr>
<tr><td></td><td>A national survey (Spearing et al., 2023) identified the following factors that affect capacity to produce more native plants and shrubs (listed starting with top ranked factor):
Infrastructure
General labour
Seed availability
Market demand
Financing
Skilled labour
Land
Technology
Water
Profitability
Seed cost
Lack of desire to expand
Transportation logistics</td></tr>
</table>

	• Seedling/liner availability • Regulations
The national survey identified creative strategies for responding to increasing demand for seed, including: In the short-term • Greater reliance on passive restoration • Contract assurances will result in growers increasing capacity • New technologies • New tools to increase seeding efficiency and improve seedling establishment • Optimize existing staff and production capacity Longer-term • Training and knowledge exchange • Contract assurances will lead to investments to increase production • Hire more summer students, part-time workers • Source seed from outside B.C.	The national survey also identified limitations for increasing seed in the short-term, including: • Lack expert seed processing, testing and storage capacity • Lack of skilled growers to make use of underutilized production capacity • Lack of skilled seed collectors • Lack seed supply from genetically appropriate sources For both the short- and longer-terms, survey participants noted the importance of contract assurances to match demand and supply
A greater awareness of the need for seed collection is leading to training of across numerous organizations and discussions on other challenges within the supply chain for seed collection.	• Low employment income from seed collection has been identified as a barrier to expanding capacity. Survey respondents stated 57% make <$10,000/year; 21% make >$50,000/hear. Hence, the market has, apparently, not yet responded to concerns about lack of seed supply. • Seed orchards take 15 years to become established, so long-term planning is required, including if there is a change in demand towards a more diverse range of species • Beyond current reforestation commitments, access to mature seed orchards and excess seed is rare. >50% of producers accessed wild or restored natural areas to manage their production
	• Training to expand seed collection capacity is not being matched with increased capacity to clean, process, certify, and store seed. <50% involved in seed lack seed coolers, processing equipment, or freezers to improve storage and

	distribution capacity. Industrial scale equipment is often too expensive for most operations that are smaller scale • There is little capacity in BC to respond to demand for a broader range of native species seed. To date, demand has tended to be for a wide variety of species with quantities that are too small to cost-effectively produce

There is strong interest in expanding capacity to propagate a greater diversity of seed and seedlings:
• BCER's Ecologically Suitable Species Guidelines is helping to clarify demand for native species seeds and seedlings
• Some First Nations are working towards building native plant nurseries
• There is currently excess capacity in some established nurseries.
  ○ Partnerships with First Nations could explore opportunities to use the existing capacity to speed up production of native species seeds and seedlings
  ○ Some suppliers anticipate that Forest Landscape Planning will clarify and increase demand, including for traditional tree species and anticipate that the demand will utilize existing excess capacity
• An existing business is creating a network of native plant nurseries at a scale larger than BC. As most native plant nurseries are 12-15 employee in size with significant challenges for creating larger operations, a flexible business network can increase overall capacity and resilience
• There is innovation in response to risks from climate events, such as wildfires, that could delay planting or seeding. For example, some nurseries are including in their contracts the cost of growing seedlings in larger containers in case there is a delay in planting
	• The propagation and planting or seeding of a diverse range of native deciduous trees, shrubs, and grasses is currently at a project/site scale. It is unlikely that existing capacity can support scaling up in the near term as it takes time to establish new nurseries
	• There are challenges in converting traditional greenhouses to native plant nurseries
	• Practitioners report some native plant nurseries struggle to provide the required quality and dependability
	• Establishing nurseries in relatively remote locations can increase
	  ○ production costs but may reduce distribution costs for projects in close proximity
	  ○ risks to business operations and seedling survival from wildfires, including although large urban centres also experience evacuations
	• While there is some innovation in response to risks from climate events, there are also increased costs and in cases a lack of storage space to hold seedlings for an extra year or two. There is concern that some seedlings could be dumped if they can't be stored. Not all contracts are allowing for the extra costs. Smaller scale nurseries are particularly challenges to absorb any of the costs and risks
	• While there has been some innovation to reduce the costs of transporting seed and seedlings, distribution costs remain higher in the north than other parts of the province partly due to the reliance on helicopters.

	There are challenges even for ground transport. One project that has scaled up seeding requires multiple shipments from the distributor to Prince George because there is a lack of warehouse space in the city to store the seed while trucks that can travel on forestry roads take multiple smaller loads to the remote worksite.

• Forestry sector contractors that support revegetation as well as forest health and stand structure are organized and seek to proactively identify and address challenges and opportunities. While there are significant concerns about the capacity to support the demand for human resources, a workforce strategy has been developed.
• Cross training to support workers to participate in numerous components of the vegetation supply chains is being used to extend the field season and provide more stable employment opportunities to help attract and retain workers. This is happening for both smaller, local crews as well as companies that work around the province
• Companies that service the oil and gas sector have a high degree of awareness of the demand within that sector and have established relationships with participants in the required supply chains
	• Contractors tend to be siloed with forestry-oriented companies having little direct knowledge of opportunities in the oil and gas sector in Northeast BC.
	  ○ Forestry contractors are concerned about an overall decrease in demand for reforestation but don't know how to connect with opportunities in other sectors.
	  ○ The reforestation sector has "matured" to do a limited number of activities well, but needs to adapt and pursue opportunities that will support resilience
	  ○ Some are not interested in expanding given the logistics and challenges of scaling up
	• A company reported successfully cross training a local crew and securing a diversity of contracts, but workers were needed to support wildfire suppression and then unavailable for other contracted work

• In 2021, BCWS expanded its wildfire programs to become year-round with increased capacity to support prescribed burns	• Prescribed fires are of interest to many First Nations so their capacity is a key factor in responding to demand

Source: Table developed by the authors

Fish and Wildlife	
Demand: The demand for habitat restoration is driven by recovery of species at risk, such as boreal caribou (red-listed or threatened/ endangered) and boreal fisher (blue-listed or vulnerable), as well as species of social concern, such as moose. There is growing concern with a single-species approach to restoration, yet focal species are effective in focusing attention and mobilizing resources. Hence, the demand for recovery of single species is being used to explore broader restoration objectives, which impacts demand on the supply chains. Habitat restoration can make demands on the supply chains for all restorative activities, for example access management, site preparation, and planting to accelerate habitat restoration, which may be necessary to create the conditions for investing in habitat structures and population management activities. As a result, understanding demand for specific fish and wildlife restorative activities requires considering demand on the restorative activities supply chain ecosystem. Conversely, some restorative initiatives are focusing on functional restoration, for example creating structures that reduce predator and human pressures on moose or caribou without undertaking other restorative activities. This may be a short-term response to immediate needs until there is opportunity to pursue more comprehensive restoration.	
Strengths	**Vulnerabilities**
Numerous Acts and regulations guide many fish and wildlife restorative activities, thus creating some certainty and clear expectations for the supply chains. There are numerous ongoing processes to address expectations for incremental restoration beyond legal obligations, which are increasingly being designed to consider potentially conflicting objectives between • species (e.g., moose and caribou) • fish/wildlife and broader restoration objectives. Recent functional restoration projects by Treaty 8 First Nations involved training and capacity building, which can support future activities The B.C. Fisher Habitat Working Group has created a website with information to support habitat restoration, including the design of habitat structures	Large-scale wildfires and floods can negatively impact investments in wildfire habitat structures Existing legislation and social expectations can make it challenging to shift from a single species focus to broader landscape-scale restoration objectives

Source: Table developed by the authors

16 Actions to Strengthen the Supply Chain Ecosystem

Interviewees identified numerous opportunities to strengthen the supply chain ecosystem, including through efforts that are underway as well as ideas for new initiatives. Two types of opportunities have been identified – responsive and strategic - which are discussed below followed by a compilation of opportunities that have been discussed throughout this report.

Responsive

Responsive opportunities are when participants in the supply chains can respond to information about changing demand within the existing context, including the current legal and policy framework. The responsive opportunities are currently being pursued at two levels:

- Individual efforts, including:

  - Innovations by individual businesses
  - Creative problem solving for specific challenges by planners and practitioners
  - Growth and contraction by individual businesses
  - Changes within sectors, such as consolidation or businesses outside of the restoration supply chain ecosystem purchasing a company within one of the supply chains. There is speculation that this may have started to happen or could happen in the near future as large external companies may use participation in the restoration supply chain ecosystem as one strategy to support their sustainability goals
  - Taking the initiative to build networks to support efficiencies for segments of a supply chain.

  One option is to accept the outcomes of leaving it to the market to address vulnerabilities and capitalize on opportunities to address gaps. The restoration market does not, however, function like a normal market because:

- Demand for restoration services and products is created by enabling activities, not consumer choices, and as a response to social issues, (e.g., impacts on Treaty Rights). As a result, the signals about demand to the supply chains can be complex, require interpretation, and often require more than individual responses to effectively respond to.

- Lack of recognition that restoration has become an economic sector, rather than a component of natural resource development, with a market that is responding to many complex drivers. This results in:
  - Some supplier companies not seeing restoration as a product, rather it is one component of their operations and often not the main priority. Hence, they do not invest in specialized machinery, special products, or innovations
  - Lack of incentives for specialized company formation, training, and other supports that are often provided to recognized markets
  - Allocation of resources that may lack rewards for realizing efficiencies, innovation, and effectiveness to meet complex restoration objectives. This can result in a lack

of competition with a small number of companies profiting and missed opportunities to grow local and regional capacity.

- Lack of understanding of the size and composition of the restoration market that can lead to viewing restoration as a short-term opportunity, which is a deterrent to investment and innovation.

Hence, while participants in the restoration supply chain ecosystem will continue to pursue individual actions to respond to their priority concerns and opportunities, optimizing the restoration market and maximizing the benefits at local, regional, and provincial scales would benefit from enhanced coordination.

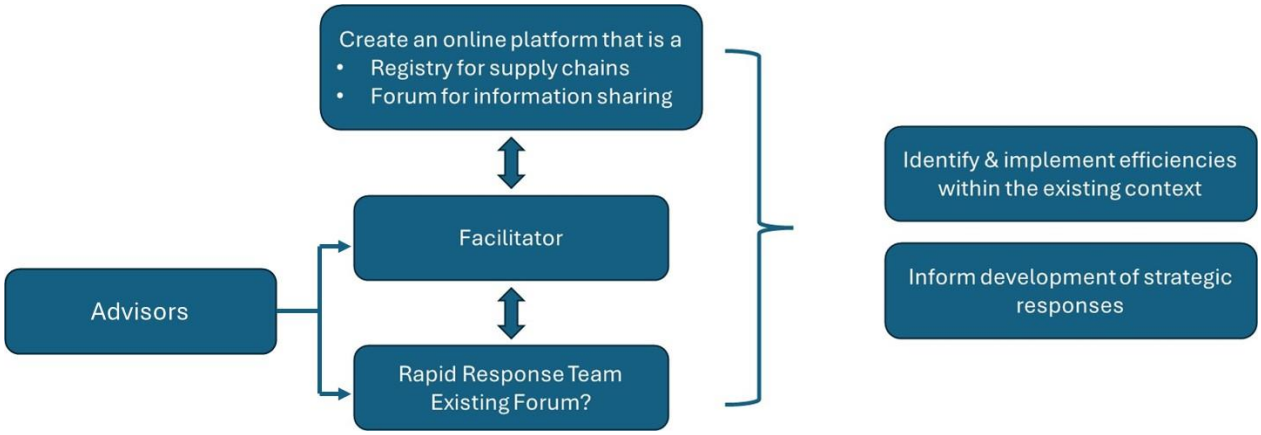
- Active facilitation and coordination

Coordinated responses to challenges are being pursued within segments of supply chains (e.g., the national seed supply), using a sector-based approach across a supply chain (e.g., reforestation), and to support specific impacts (e.g., orphaned oil and gas well remediation, wildfire recovery). Optimization of the restoration market would benefit from scaling up coordination across the supply chain ecosystem with the current efforts providing a foundation for doing so.

Expanding coordination across the supply chain ecosystem would support optimization of the restoration market in the short-term and inform the development of strategic, longer-term strategies. The scale and complexity of the restoration market in the Northeast Region make the region a good candidate for enhanced coordination with outcomes that could be designed to support broader application. As there are many existing initiatives and forums underway within the Northeast Region, it is suggested that active facilitation be used to improve communication and coordination across the initiatives, identify efficiencies, and add value to existing efforts. A flexible approach could be used, perhaps for a 3-year period. After that time, the short-term opportunities will, to the extent possible, be incorporated into regular business operations and longer-term issues will have been identified, including the processes that will be used to address priorities.

As outlined in Figure 18, an online platform could be used to create a registry of participants in the restoration supply chains to support information sharing and procurement processes. Some people have cautioned that online registries quickly become outdated and numerous online information sharing platforms already exist. There has, however, been a strong call for creating information about demand and supply at a regional scale. Hence, there could be value in creating an online platform with a focus on the Northeast Region's restoration market for an initial 3-year period to support institutionalizing changes into the business operations of government agencies, First Nations, industry, and businesses in the restoration supply chain ecosystem. The online platform could support linkages to existing platforms that support participants identify the networks and associated platforms that are most relevant for them.

Figure 18 Supporting Active Facilitation and Coordination across the Supply Chain Ecosystem



Source: Figure developed by the authors

To be effective, the facilitation services would benefit from being connected to a Rapid Response Team that would help determine if the vulnerability or opportunity can be addressed within the existing context, including the current legal and policy frameworks, or if a more strategic response would be needed. The Team would help determine priorities and identify champions and processes for taking actions. The membership of the Team would benefit from being small with a focus on systems-knowledge and change management experience. To incorporate diverse knowledge and experience into the prioritization process, the Team and facilitator would benefit from advice that may come through existing forums, networks, and planning processes as well as individuals.

Strategic

Strategic actions build momentum for improving system level efficiencies. The vulnerabilities are typically complex and require senior level support to explore new approaches within the existing legal and policy frameworks or changes to the frameworks. As strategic actions can require significant time and resources to pursue, a clear understanding of the likely costs and benefits is needed. As outlined in sections 8.4 and 12, an assessment of demand drivers (probability and significance) as well as impacts on the supply chain ecosystem (significance of the vulnerability and extent of impact (individual, a supply chain, or the supply chain ecosystem) could inform decisions on what strategic actions to pursue and how.

16.1 Mandates and Champions

As discussed in section 14.1, optimizing the restoration market would benefit from clear mandates for comprehensive, integrated restoration across natural resource and economic development agencies as the mandate could support:

- Identification of a team of champions with clear accountabilities and mechanisms for consistent reporting to senior leaders

- Linkages between:

    - Multiple objectives for restoration that define its contribution to landscape and community resilience
    - Broad restoration objectives and the range of priorities that are defined through legal and policy direction
    - Restoration planning and economic development planning
    - Budgets across agencies and programs

- A better understanding of the restoration market, which could inform policies that are intended to support restoration and the associated socio-economic benefits

- More effective collaborations between government agencies, First Nations, industry, and other participants in the supply chain ecosystem.

16.2 Improving Demand Forecasts

Improving demand forecasts was identified as a priority by many across the supply chain ecosystem. Demand forecasting would benefit from designing a cumulative effects assessment to improve the quantification and spatialization of needs and analyses of priorities relative to opportunities (section 8). Short-term actions to support improving demand forecasts include:

- Identifying one or more champions as well as broader roles and responsibilities within provincial government agencies and others in the supply chain ecosystem to develop comprehensive, integrated restoration demand forecasts.

Also, review and assess:

- Existing systems and processes for defining demand, which are typically focused on specific sectors, types of impacts, or types of ecosystems. The outcome would be to identify opportunities to integrate the available information into a comprehensive, integrated demand forecast at multiple scales, including the regional scale

- Existing and emerging technologies, including A.I. Demand forecasting would benefit from a strategy for the use of technologies to develop comprehensive, integrated forecasts. Technologies could support more complex analyses to generate real-time information to participants in the supply chain. Individuals within the supply chains are exploring the use of technologies to generate better information for their programs or projects, so their insights offer a starting point for development of an overall strategy

- The use of climate and wildfire refugia mapping to help prioritize needs for the restoration of resilience within at-risk landscapes (section **Error! Reference source not found.**)

- As wetlands are a key factor for identifying refugia areas in the Northeast Region, a review of methodologies used in other jurisdictions to assess the likely impacts on the future viability of wetlands could inform improvements of the refugia mapping and its use in prioritizing restoration investments

- Existing regulations and policies, including gaps, that provide guidance for the use of passive restoration. Understanding the use of passive restoration, including if and to what extent its use may increase, is important to integrate into strategic and tactical-level planning, which can then be reflected in demand forecasts. Hence, demand forecasting would benefit from a strategy to address policy gaps, provide guidance for applying the policies, and create a methodology for incorporating passive restoration into the assessment of needs and priorities relative to available opportunities

- While desk top analyses and protocols for defining demand will need to be field verified, there is likely opportunity to use technologies to strategically design field verification that can use a sampling approach. If methodologies and protocols were developed in parallel with the field verification within selected areas, both efforts could benefit and lessons learned would be generated faster.

16.3 Wildfire Resiliency and Recovery

As discussed in section 9.2, implementing broad scale Landscape Fire Management (LFM) would require transformative changes at the strategic and tactical scales and so it is unlikely in the short-term. A focused approach may be possible in the short-term with lessons learned used to consider how to expand LFM if the required policies and funding models are developed. Opportunities in the short-term might include a pilot project to explore:

- Synergies with implementation of other restoration, conservation, or resource development activities to leverage equipment and human resources to reduce costs, create longer seasons for seasonal employees, and more consistent demand on the supply chains

- Use of LFM to help protect investments in other restoration initiatives that could be undermined if subjected to a wildfire with LFM being incorporated into restoration program and project budgets. This would increase costs and could reduce overall demand for restoration, but it could improve effectiveness

- Prioritizing LFM treatment areas, for example a focus on climate and wildfire refugia areas. This would increase the effectiveness of treatments to support broader and longer-term restoration needs

- The type, intensity, and location of LFM activities that align demand with the capacity of the supply chains to avoid inflating short-term prices and help guiding investments in capacity building.

For wildfire recovery, a pilot project could involve a collaboration between wildfire recovery planners and participants across the supply chain ecosystem to define prototypes for consistent products, such wildfire recovery plans, that are intentionally designed to communicate demand for restoration services and products. Although wildfire will remain unpredictable, consistency in terms of content and structure as well as the timing of their release relative to defined stages of wildfire suppression would better enable the supply chains to respond to demand.

Strategic level policies, objectives, and criteria for wildfire recovery would also help clarify priorities for restoration services and products, including:

- To guide the extent to which passive restoration will be a primary strategy, including where and over what timeframe(s) as discussed in section 16.2

- How wildfire recovery fits relative to broader restoration objectives.

16.4 Comprehensive, Integrated Restoration Planning

As discussed in section 9.3, there was widespread agreement amongst interviewees that development of landscape-level restoration plans is key to optimizing the restoration market. In addition to improving demand forecasting (section 16.2), the following short-term actions could be used to build and test a framework for improving the incorporation of restoration into existing planning processes or, where necessary, developing a restoration plan.

- Identify one or more champions as well as broader roles and responsibilities within provincial government agencies and others in the supply chain ecosystem to develop a framework to support comprehensive, integrated restoration

- Compilation and review of existing regulations and policies across different Acts, government agencies, and sectors to:
    - Identify gaps
    - Prioritize gaps
    - Identify processes or mechanisms for addressing the priority gaps

- A strategic review of this report and other sources to:
    - Develop agreements on common terminology and concepts
    - Determine if and how the proposed common restorative activities (section 3.6) and associated supply chains (section 10.2) could be used to support consistency across restoration plans and programs. This would include guidelines that define consistent principles and strategies to help select the suite of restorative activities and the levels of intensity or investment for each (e.g., high, moderate, low). This would help identify and reconcile the interdependencies of selected activities across the landscape
    - Design a prototype for the structure and content of a comprehensive, integrated restoration plan. The intention would be to promote consistency, which is necessary to facilitate communication and coordination across planning processes and during implementation. Improved communication and coordination will help to optimize the restoration market, including at the operational level (timing, sequencing, and leveraging of activities)

- While developing a consistent framework, an interim measure could be to select one or more existing planning processes as pilots for including comprehensive, integrated restoration into landscape-scale plans. The pilot(s) could engage landscape ecologists,

restoration practitioners, program (rather than project) managers, suppliers, and trainers/educators. If these discussions occurred in parallel with the development of a consistent framework, both efforts could benefit, and lessons learned would be generated faster

- Decision-support:
    - Review existing monitoring programs to assess how they are currently supporting restoration and could be integrated and leveraged to create a comprehensive, integrated program
    - Determine if existing systems can be used and/or a new intentionally designed system is needed for evaluating lessons learned from the broad array of restoration initiatives, which are then used to inform decision-making to:
        - Improve integrated restoration planning, permitting, and practices
        - Inform the evolution of best management practices for resource use and development, which might reduce demand for future restoration and/or improve restoration outcomes.

16.5 Economic Development Planning

Optimizing the restoration market would benefit from a strategic-level economic development plan, which could be refined through implementation at the regional and local scales. Short-term opportunities to support development of a strategic-level economic development plan include:

- Identifying one or more champions as well as broader roles and responsibilities within provincial government agencies and others in the supply chain ecosystem to support development of a plan

- Develop agreements on the appropriate roles to address key gaps, including what would benefit from direct government and/or First Nations leadership, public-private partnerships, and competitive market-based responses

- Review work-to-date to incorporate a broad range of ecosystem services into analyses and decision-making to determine if changes may be required to support complimentary restoration and economic development planning and decision-making

- Review policies and prioritize opportunities to improve incentives for restoration, including as they relate to taxation, the creation of restoration tenures, transforming restoration into a market commodity to be traded or sold, etc.

- Review efforts to date to modernize and streamline permitting in B.C. Use lessons learned to develop a comprehensive strategy to support restoration across different sectors, Acts and regulations, and decision-making processes

- Review work-to-date in B.C. on reporting to support global targets and frameworks to inform the development of restoration and economic develop plans so they are structured to support consistent reporting

- Collaborate with relevant participants in the supply chains to develop strategies to support alignment of demand forecasts and supply chains, for example:
    - Co-management & reconciliation strategy within the context of a restoration market and associated First Nations goals
    - A.I. & technology strategy to support both demand forecasting and supply chain management
    - Education & training strategy
    - Funding & partnerships strategy
    - Procurement strategy, including development of a registry of supply chain participants and facilitation of collaborative purchases to create sufficient demand for specialty services and products (e.g., native plants).

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