

# PROVINCIAL SEED BANK FOR NATIVE PLANT SPECIES FEASIBILITY SURVEY

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## ABSTRACT

In British Columbia, the use of native plants in revegetating disturbed land is becoming standard practice. As local communities become more aware and involved in resource development, the demand for utilizing native plants for reclamation and restoration activities continues to grow. Various resource sectors in BC have responded by increasing their utilization of native plant species. However, uncertainty in relation to native seed availability, including factors such as timing, volume and species, still pose significant challenges to industries working to incorporate native species in their revegetation plans.

To explore these challenges, Keefe Ecological Services Ltd., DWB Consulting Services Ltd. and the BC Conservation Foundation are conducting a feasibility study to investigate the viability of developing a provincial seed bank for non-commercial native seed. The initial phase of this study was completed during the spring/summer of 2016 and included a stakeholder survey and review of seed bank models from around the world. The goal of the survey was to enlist a variety of stakeholders to share their opinions on a potential native seed bank facility in BC. Our survey focused on three main topics: Opportunities & Challenges, Functions & Practicality, and Governance & Structure. The paper reports on the findings of the initial phase of the study.

## KEY WORDS

Native Plants, Propagation, Revegetation, Seed Bank, Seed Collection

## INTRODUCTION

Native plants are deployed either as a direct application of seeds, live stakes, or in the form of seedlings, which are grown from seeds or vegetative plant material (cuttings) in greenhouses or outdoor nursery settings. Opportunities for the development of native plant nurseries have been growing over the last decade and major nurseries have become established in both northern and southern BC. However, these nurseries are often limited in their ability to address industry needs due to a limited supply of seeds for native tree, shrub and herbaceous species. Seed collectors throughout BC have been working to meet the

growing demand by developing viable businesses that provide native seed to nurseries or to industry directly. Yet, high variability in the timing, volume and species demands from industry has created uncertainty for seed collectors and has inhibited their ability to provide an adequate supply of native seed. Most seed collectors in BC would agree that the upon-request approach to supplying various sectors of the resource industry with native seed and seedlings is ineffective and requires a new paradigm.

To address this variable nature in the supply and demand between seed collectors and nurseries and industry, a central depository for native seed (seed bank) may be the solution. A seed bank would provide seed collectors with facility that would allow them to safely store collected seed between the time of collection and the time of sale. It would also provide industry and native plant nurseries with a one stop shop for their seed needs. A facility based on a similar concept currently exists in BC, the BC Tree Seed Centre, but does not currently provide seeds for non-commercial trees, shrubs and herbaceous species.

To investigate the viability of developing a seed bank for native seed, Keefer Ecological Services Ltd., DWB Consulting Services Ltd., and the BC Conservation Foundation have initiated a feasibility study. The native species of interest are those that are not of current importance to the forestry industry, such as non-commercial tree species, shrubs, grasses and wildflowers, which are all crucial ecosystem components. The goal of this study is to gather information from stakeholders across the province, Canada and internationally on the limitations and benefits of, and demand for, a provincial seed bank and provide its findings through a study report, publications and presentations. It is our hope that this study will help to advocate for the future development of a viable facility that would foster commerce, education and research opportunities.

Over the next 10 years, the development of natural resources in BC is set to significantly increase as numerous proposed major mining, oil and gas and hydro projects reach construction stage. As these developments are executed, the demand for native seed may be expected to significantly increase. Currently, the capacity of native seed and seedling providers in the province may be unlikely to meet the anticipated demands from the proposed developments (Keefer et al. 2013). Creating a central repository for native seed may aid in meeting current and future demands of the resource sector by providing the means to increase the collection, storage and inventory of native seed. This would provide industry with the resources necessary to execute and foster best practices in the revegetation of disturbed lands in BC.

This feasibility study is being undertaken in a phased approach due to lack of available funding. The initial stage included a stakeholder survey and review of seed bank models around the world. From April to June 2016, a native seed bank feasibility survey was developed and delivered. The goal of the survey component was to enlist a variety of stakeholders to share their opinions on a potential native seed bank facility in BC. Our survey focused on three main topics: Opportunities & Challenges, Functions & Practicality, and Governance & Structure.

With the Opportunities & Challenges section, the goal was to gain an understanding of why people are using native seeds and how they currently go about procuring seed. With an understanding of how native seeds are currently being procured and applied, the opportunity and potential challenges for a native seed bank can be assessed. The Functions & Practicality topic aims to determine what stakeholders would like to see in a seed bank. Seed banks around the world have many different purposes such as genetic

conservation, species extinction safeguarding, seed research, and seed retail. Our goal was to determine what objectives are of value to BC residents. The Governance & Structure section inquires about stakeholder's opinions on who should be responsible for operating a seed bank, who should be allowed to store and/or sell seed within the facility, and who should be allowed to access the seed. Together, the three sections of the survey give a snapshot of the survey participant's vision for a native seed bank facility in BC.

## **METHODS**

Twenty-three survey questions were developed to investigate how native seeds are currently being used and how stakeholders foresee the operation of a provincial seed bank. Survey questions were created with two main goals: determine how stakeholders are currently using native seeds, including current limitations, and then to determine how stakeholders envision a seed bank operating in the future. The survey was limited to 23 questions in order to get a sufficient amount of feedback from respondents but also being brief and approachable for stakeholders with limited time. The survey was created in Google Forms, an online survey application, and was delivered to stakeholders via an emailed link. Due to the functionality of the Google Forms application, all survey results were anonymous.

A broad range of stakeholders were identified in order to gain a variety of opinions. Stakeholders included individuals from government, First Nations, mining, hydro, environmental consultants, researchers, and native plant propagators. A full list of organizations contacted is included in Appendix A. Individuals were contacted and informed about the project by telephone and email.

## **RESULTS AND DISCUSSION**

### Seed Bank Survey

Between April 1st and June 9th, 2016, a total of 114 individuals received an invitation to participate in the seed bank survey. Of the total invited to participate, 71 completed the survey, resulting in a response rate of 62%. What follows is a summary of the results and a brief discussion for each of the survey questions. A copy of the survey is available in Appendix B.

#### *Opportunities and Challenges*

*1. Why do you use native seeds? If you are using seed for land restoration/reclamation, what are your goals (e.g., slope stability, erosion control, biodiversity)? If you have other goals, please specify.*

Survey respondents came from a wide variety of backgrounds, from major industry to university researchers. As a result, survey respondents had a many different goals when using native seeds. Land restoration and biodiversity enhancement were the most common seed uses. Slope and erosion control and invasive weed control were also predominant uses. Many respondents had overlapping goals, for example, slope stability while also trying to prevent invasion by noxious weeds. The responses suggest that the primary focus of a seed bank should be to provide seed for the revegetation of disturbed environments. The seed bank should provide high volumes of seed for the most desired species and where practical (e.g., alder [*Alnus* spp.]) to facilitate demand related to revegetation works. Less emphasis should be placed on secondary focuses such as landscaping, species conservation, and research but it may

be valuable to incorporate them if feasible.

2. *As a native seed purchaser, what types of species would you be most interested in purchasing? Select all that apply (• forbs and herbs • grasses and sedges • woody shrubs and deciduous trees • conifers).*

Survey respondents were interested in purchasing all types of native seeds. Grass and sedges and forbs and herbs had the greatest interest. Respondents were least interested in purchasing commercially important conifer seeds, such as lodgepole pine (*Pinus contorta* var. *latifolia*), hybrid white spruce *Picea glauca x englemannii*, and Douglas fir (*Pseudotsuga menziesii*). This is possibly due to the consistent availability of these seed and seedlings through by BC's forest industry and the BC Tree Seed Centre. These conifer species, which are the at the core of the forestry industry, are often referred to as 'commercial' tree species. A seed bank facility should therefore not be restricted to one category of native plants, but rather supply a mix of graminoids, forbs, shrubs, and deciduous trees. Commercial conifer species should likely not be included due to the overlap with the BC Tree Seed Centre, however it may be valuable to consider banking non-commercial conifer species such as whitebark pine, limber pine, and subalpine larch.

3. *How often do you or would you purchase seed (• as needed basis with no consistent schedule • annually once per year • seasonally 2-4 times per year • 5 or more times per year)?*

The majority of survey respondents indicated they have no consistent schedule when purchasing seed and make purchases on an as needed basis. This response demonstrates the challenge for a seed bank to meet a fluctuating demand. To solve this issue, industry and/or government could fund the collection and storage of an annual baseline supply of seed for a limited number of priority species that are in the most demand. With this approach, priority species will need to be identified and targeted.

4. *When procuring seeds, whether for native or agronomic species, how much lead time do you most often require between procuring a seed source and seed application? Select 2 of the 3 options that most apply (• 6 months to 1 year • 3 to 6 months • only when the immediate need arises)*

Sufficient lead time prior to seed procurement is critical when native seeds need to be harvested from the wild. Little or no lead time often results in species substitutions or use of agronomics as an alternative. Survey respondents indicated a varying amount of lead time, primarily from no lead time up to 6 months of lead time. Six months to a year of lead time was the least reported, with only 23% of respondents. It will be valuable to change the behavior of purchasers to request seed more proactively. For example, most practitioners are aware that they have to order native shrub and tree seedlings at least a year in advance. A similar awareness should be established for native seed procurement. Increasing lead time or increasing supply volumes and diversity will be crucial to increase seed availability.

5. *When procuring seed, how do you most often decide what species to purchase (• seed mix determined by legislation • by revegetation professionals • by project goals • by availability of seed and price • I have not purchased seed before)?*

The demand for native seeds is heavily influenced by whoever is making site prescriptions. Seed bank operators should be aware of common species selection methods and meet demand accordingly. The majority of respondents indicated they select species based on prescriptions from revegetation

professionals or use single species as identified in their project goals. Establishing a set of commonly used species and focusing on their collection and storage will help to make seed available whenever it is needed, whether seed users have 12 months notice or require seed immediately.

*6. If you are a native seed purchaser or a potential purchaser, what are your current limitations on obtaining native seed? Select all that apply (• Cost prohibitive • lack of availability for a desired species • for a specific seed zone • for volume of seed required • other).*

There are a number of obstacles that respondents identified as currently limiting native seed procurement in BC. Respondents said the lack of availability for their desired species and lack of availability from a desired provenance were their biggest limitations. Affordability and lack of volume availability were also major limitations. Some respondents do not currently purchase native seeds and were unable to comment. One respondent mentioned that there was limitation based on a knowledge gap on how native species perform when used in restoration.

Wild collection of native seeds is a time consuming and expensive process. Seed collectors often have to travel great distances collect desired species from specific locations and may need to make multiple trips to conduct reconnaissance, monitor seed development, and finally to collect species. The seed collection process could be made more efficient if local residents could be utilized to comment on species locations or seed ripeness. Knowledge of plant identification and seed ripeness can be a limiting factor in the total number of seed collectors. Providing seed collection training may be an excellent way to increase the number of seed collectors in BC. A variety of training methods could be deployed, including hands-on training through employers, 2 to 3 day workshops, or even incorporation of seed collection techniques into biology related technical diplomas.

The labor involved with seed collection is typically the highest cost associated with seed. Biologists and consultants, who have expertise in plant identification, often increase the price of seed due to their wages. Adapting seed collection strategies to increase the employment of lower cost manual labour could help to lower seed costs. For example, collecting berries such as Saskatoon or huckleberry is a common summer pastime for some BC residents. Local residents may be enticed to collect berries and receive remuneration on a per weight pricing schedule. While there would be challenges in ensuring correct species identification and quality, if these issues could be overcome it may allow for an increased pool of seed collectors from around the province.

Ecological variety, often referred to as an ecovars, are field cultivated native species seeds that are suitable to specific environments (May et al. 1997). The development of ecovars for native species through field growing may be a solution to substantially increasing volume of seed available and thus decreasing price. Field cultivations of ecovars will likely not be suitable for woody species but could work for various graminoids and forb species. The development of ecovars is a long-term solution to solve the availability of seed volumes.

*7. Some limitations for seed purchasers include high cost, low volume and lack of guarantee of seed viability (i.e., no certification). Could you comment on these limitations? Are there any other limitations? Do you have any suggestions on how to overcome some of these limitations?*

The main limitations listed by respondents were insufficient volumes, limited or no availability for

specific provenances, and price. A number of respondents indicated that uncertainty in the germination and performance of native species is a limitation and they would like to see efforts made to increase the knowledge base surrounding performance. Suggestions for increasing the knowledge base included research into seed zones, site preparation, timing of seeding, seed stratification, and ideal seeding conditions. If feasible, a research branch of a seed bank or a collaboration with research institutions could be established to address the knowledge gap concerns.

One individual indicated that the viability and germination success of native seeds can be a limitation while another respondent suggested we could overcome quality issues through seed testing by an accredited seed lab and by developing ecovars or ‘improved’ seeds with increased viability. The BC Tree Seed Centre has done substantial work to increase the genetic worth of conifer seeds but one respondent indicated that it will likely be hard to justify the high costs to develop ecovars with increased viability for non-commercial species. In contrast, some respondents indicated they are willing to pay a higher price for native seeds if there was increased viability.

A number of respondents reported that they think a native seed bank will help alleviate some of the challenges in procuring native seeds while one respondent indicated that seed increase plots or ecovar cultivation would be more valuable in providing seed availability than a seed bank. Ecovar cultivation is a long term fix to increasing seed supply. Many species used in restoration will likely not perform with field cultivation. A combined approach of seed increase plots and seed banking may work best to increase seed volume availability and reduce costs of native seeds.

A number of respondents avoid limitations by collecting their own seeds and giving themselves ample lead time to plan and collect or procure. Ample lead time will likely always be a challenge for some seed users due to the nature of their respective industries. A seed bank will hopefully reduce the need for extensive lead time by storing a variety of species on hand at any given time. One respondent mentioned there needs to be incentives or subsidies for seed collectors to stockpile large amounts of seed in a seed bank and that industry and reclamation specialists should discuss species priorities annually.

Lastly, rather than tackling limitations individually, one respondent suggested the implementation of policy and regulations will increase the demand for native seeds which will likely initiate market pressure to increase supply and decrease costs. For example, regulations that require restoration on public land to be done using native seeds will increase the demand for native seeds and force supply to increase. The implementation of regulations requiring native seed deployment on public lands will likely make a seed bank more viable due to an increase in demand and added regularity in seed ordering.

*8. Do you feel the demand for native seed will grow in the future (● yes ● no ● unsure)?*

The majority of respondents felt that native seed demand will increase in the future. While this does not indicate where the demand will come from, it demonstrates the interest of stakeholders in using native plants. Barriers to using native plants must be overcome in order to make increased demand a reality.

*9. Are you aware of any native seed suppliers in BC? If so, who are they and what products and quantities do they sell?*

Survey respondents listed over 15 companies who they thought were suppliers of native seeds in BC. 15% of respondents were not aware of any seed suppliers in BC. Of the companies listed, 3 companies were specific seed collectors/seed service providers, one company was a small scale retail operation catering to home gardeners, 7 operations were primarily plant propagators and nurseries, 3 were agronomic seed producers, and 7 companies specifically dealt with conifers, and two companies were environmental consulting firms. The results of this survey question indicate there is a very limited number of seed vendors who sell seed as their primary business, and perhaps this is due to the challenging sales climate for native seeds.

Survey responses highlighted that it may be difficult or unfeasible to operate a business with native seed collection as its main business activity. Only three of the fifteen companies identified in the survey collect and sell native seeds as their primary business. Assessing the challenges in operating a seed collection business may identify obstacles that need to be overcome in order to increase seed availability.

Based on this feedback, a future native seed bank may need to incorporate a variety of services that are in demand in order to create a viable business model. The services considered should aim to compliment the seed bank in terms of equipment, facility requirements and clientele. A research component could also help attract funding to help support the facility.

#### *Functions & Practicality*

*10. As a seed purchaser, would a seed certification from the seller indicating species and seed origin be valuable to you? Would a professional seed analysis report from an accredited laboratory be valuable to you? What other forms of information would be useful? Select all that apply (● seed certification showing species and origin from seed collector ● seed analysis report from an accredited third-party laboratory ● I don't know).*

Survey respondents were interested in both seed analysis reports from an accredited third-party seed lab and seed certifications showing the species and origin of a seedlot. Both services could be easily incorporated into a seed bank facility. Seed analysis and certification may be more difficult to implement and monitor under a private business model where native seeds are sold by private seed vendors unaffiliated with a centralized organization. Regardless of the model used to sell native seeds, the development of standards for native seed sales and deployment will increase interest in using native seeds.

Information on the status of stored seed stocks, provided by seed certification and seed analysis reports (e.g., viability, purity, non-target propagules such as invasive species), will likely be required in order to maintain marketability of the seed. A future seed bank may benefit from having in-house seed analysis and certification services. This would also provide an opportunity for conducting further research on objectives suggested by respondents, such as seed stratification for challenging species.

*11. What type of services would you like to see from a native seed bank? Select all that apply (● seed cleaning ● stratification ● seedlot record keeping and metadata storage ● facilitation of seed sales ● germination and viability testing ● seed-related research or other).*

Survey respondents indicated they are interested in a variety of services from a potential seed bank. The list of services provided in the survey is similar to the services offered by the BC Tree Seed Centre. Those

who selected the ‘Other’ category indicated they would be interested in having genetic testing, custom seed harvesting for specific projects, site prescriptions and technical advice, seed certification, seed improvement and multiplying, and genetic conservation through long-term storage. A seed bank facility should establish a number of key services and add additional services, such as genetic testing, if they are financially feasible.

*12. Seed viability reduces over time of storage. However, seed viability for some species does not deteriorate as quickly as others. For native seed bank, would it be more practical to consider only storing seeds for species with high longevity (● yes, consider only storing species with high longevity ● no, consider species with any range of longevity ● other)?*

Some species, such as some of those in the Salicaceae family, have fairly short longevity, while other species, such as in the Pinaceae family, can remain viable for decades or longer. Additionally, for many native species, seed viability is uncertain or unknown due to a lack of research. Storing short longevity species in seed bank could result in seed wastage if seed is not sold quickly, and could result in excess costs to the seed bank and seed owners. Alternatively, eliminating these seeds from a seed bank all together could result in a gap in the range of species available for restoration. The majority of survey respondents believed seed of any longevity range should be incorporated into the seed bank despite the challenges in practicality. Suggestions for storage included: accepting advance orders for short term viability species, only accepting limited volumes of short term viability species, conducting research on species viability, conducting regular viability tests on stored seed, and selling short term longevity species in the form of seedlings rather than seed.

Focusing on native species with high longevity seeds may be an important consideration during the initial establishment of the native seed bank in order to increase the chances of success. Providing a reliable source of viable native seed will help to build confidence in the seed bank. With time, the diversity of species offered can then be expanded to include more challenging species.

*13. There is variation in seed demand from year to year. What challenges does this pose for a seed bank? How can it be addressed?*

The primary challenges outlined by survey respondents were: variability in seed viability, diverse needs from seed users, high cost of maintaining seedlots, and the annual variability in wild seed production. A number of recommendations for regulating demand were provided:

Five responses indicated the importance of establishing priority species that a seed bank could focus on. This is in line with the approach that the Canada’s Oil Sands Innovation Alliance’s Oil Sands Vegetation Cooperative (OSVC) has taken. The OSVC has identified twenty-five species that they are putting effort into collecting and banking. Starting a seed bank with a list of priority species could simplify seed bank operation and reduce costs. Research into seed longevity and storage could help allow a list of priority species to grow.

Pre-orders and ample planning were identified as key solutions in tackling varying seed demand. Pre-ordering seed will always be a challenge for some industries due to the nature of their businesses. One respondent suggested that a seed bank should be a large facility so ample supply of long longevity species can be supplied. One respondent suggested that government should pressure industry to regulate

reclamation schedules in order to reduce variation. Pressure to regulate reclamation schedules may be challenging because of fluctuating nature of resource industries due to commodity pricing, however it will be an important factor in fostering the growth of a native plant supply. Establishment of seed contracts with end users, and multi-year commitments could be a stepping stone to further regulation.

Regular input from seed purchasers was outlined as an important factor. Feedback to determine priority species and anticipated volumes could help to regulate demand. Conducting a gap analysis study that interviews native plant users and nurseries would be an effective method of determining priority species.

The scale of a seed bank was identified as an important factor in regulating demand. Some respondents suggested that rather than a seed bank, seed users should solely rely upon on-demand seed collections. This option may be a challenge for some industries but, as one respondent suggested, increasing education surrounding native seed use could increase demand and make an on-demand collection system more practical. Some suggested increased diversity in both the collectors and purchaser. Multiple seed collectors would help meet demand when high, and a diverse client base could even out demand from year to year.

A variety of approaches to funding were suggested to regulate variable demand. One suggested industry should fund seed collections upfront, others mentioned a seed bank should be subsidized, and one mentioned seed prices should be adjusted in order to deal with potentially wasted seed. It was also recommended that seed be brokered out when buyers are unable to use it or old seed should be grown out into seedlings.

#### *Governance & Structure*

*14. Multiple organizations and agencies would likely play a role in funding and governing a provincial seed bank; however, there would likely be one body that would play the lead role. The lead body may be from industry, government or an educational institution. Please select which agencies you feel should lead a native seed bank (● Ministry of Forest, Lands and Natural Resource Operations ● Ministry of Transportation and Infrastructure ● Ministry of Agriculture ● mining and/or oil and gas industry ● hydro-electricity industry ● education institution ● other).*

Over half of respondents indicated that the BC Ministry of Forests, Lands, and Natural Resource Operations (MFLNRO) would be the best organization to play a lead role in managing a native seed bank. A third of respondents selected “Other” and described a combination of organizations, for example, shared responsibility between MFLNRO and BC Ministry of Agriculture (MA) or MFLNRO and an educational institute. Other suggestions included an accredited botanical garden, a cooperative of all seed users, or a non-for-profit in conjunction with an educational facility. One respondent indicated the lead role should be selected based on which organization is able to prioritize seed sourcing, storage, and ensure accessibility.

It is of the authors belief that the best approach to managing a native seed bank would come from a partnership between government, industry and an educational institution. Combined, there would likely be numerous opportunities and avenues for funding, research and public oversight. In addition, further organizations could play an important role in day to day operations, including First Nations and non-profit organizations. One educational institution has already expressed interest in a partnership and additional

parties would likely come forward if a potential framework was established.

*15. One rationale for developing a provincial seed bank may be in preparation for large unintended environmental disturbances or emergency response (e.g., Mount Polley). Do you feel this is rationale is justified (● yes ● no ● other)?*

Storage of a variety of seeds in a seed bank will mean that remediation of disturbances or disasters can happen rapidly and may increase the likelihood that seeds with the correct provenance will be deployed. 71% of respondents felt that a seed bank would be valuable for emergency disturbance situations. Other respondents said it should not be a main priority and only a few species should be used in these situations, another said the need and effectiveness should be determined before prioritizing seed for emergency use.

Seed storage for emergency use can likely be easily incorporated into a native seed bank model. Perhaps this initiative should be conducted and funded by industry with support of the government. Major industries such as mines or hydro could collect and store seed within a seed bank that is suitable for their disturbance areas and could be quickly deployed in case of emergency.

*16. Another rationale for developing a provincial seed bank could be to provide a safeguard for some Species--at--Risk. Is this rationale justified (●yes ● no ● other)?*

Most respondents feel that banking seed of Species-at-Risk (SAR) would be a justifiable use of a native seed bank. 17% did not believe this would be a good choice but did not indicate why. One person felt that storage of SAR may justify extirpation at natural sites. One respondent suggested that the Forest Genetics Council is already banking seed for SAR and two respondents suggested that recovery plans need to be in place prior to seed banking and funding needs to be established for this work. Seed banking of SAR should be a coordinated effort to minimize duplication and to ensure efforts are in line with species recovery plans.

*17. Some suggest that the best approach to a provincial seed bank for non-commercial plant species would be to expand/collaborate with the BC Tree Seed Centre. Do you agree? What would be some of the roadblocks to making this a reality?*

Many respondents felt that incorporating a native seed bank into the BC Tree Seed Centre was a plausible idea with added funding, more manpower, training, and equipment. Those who were against incorporating native seeds into the BC TSC felt that native seeds did not fit within the business model and expressed concern about government priorities, funding, a potential clash in organization culture. One respondent suggested to use the BC TSC model to design a native seed bank but to keep organizations separate. Although some felt that native plant species did not fit within the business model of the BC TSC, one respondent felt that we should develop an ecological economics strategy in order for government to recognize the value of native plant ecology and thus prioritize investment in a seed bank.

Given the responses, incorporation of a native seed bank into the BC TSC should be considered as an option and, if it proves to be unfeasible, the BC TSC model should be analyzed for relevancy to a native seed bank.

18. *As an alternative to establishing a physical seed bank, one option may be to create an online database for seed collectors and distributors. Individuals or organizations could register for the database and post their seed for sale along with pertinent information (collection location, storage conditions, seed analysis report, etc.). This approach would be significantly less costly and would provide all native seed collectors, distributors and purchasers with a single tool for selling or locating native seed. Do you feel that this approach would be effective in meeting demand for native seeds (● yes ● no ● other)? Please provide any additional comments you have on this approach.*

An online database or network could be a useful tool in connecting native plant collectors with purchasers without the large start-up and operational costs that would be associated with a physical seed bank. This model is utilized in the United States by the Native Seed Network as well as in Canada through the lesser known Canadian Native Plant Materials Exchange, which connects vendors and purchasers from across the nation. The Native Seed Network allows users to search the site using a number of categories including species, ecoregion, ecosystem, etc. The major concerns with an online network model listed by respondents were: seed quality and certification due to lack of regulation and an overall lack of seed suppliers in BC specifically. Some respondents suggested an online database would be a good transition tool to move towards a physical seed bank and could also be used as part of a hybrid approach. Those against an online platform suggested there would be challenges in timing and availability of seed, wouldn't meet SAR goals, and overall it would not be sufficient to meet the demand for native seeds. An online database platform may not sufficiently reduce the obstacles in using native seeds but it may help to better connect vendors and purchasers. It could also act as a hub for native species research. As mentioned by some respondents, an online model could be considered as a transition tool prior to establishing a physical seed bank. If an online platform is established, it is important that it is marketed and promoted far and wide in order for it to gain traction among seed users.

19. *Some individuals who have been contacted regarding this study suggest that a provincial native seed bank will likely not be feasible without changes in regulations relating to requirements around the use of native seed, such as is the case in Alberta. Do you feel this is a valid concern (● yes ● no ● other)?*

Respondents had mixed opinions on whether regulation changes are a necessary prerequisite for a native seed bank to be feasible. While the majority of respondents felt that regulation requiring deployment of native seeds would be necessary, a large number of respondents felt it was not a concern or felt unsure. There will be no definitive answer to whether a seed bank will be viable without regulations on the use of native seeds, however, further market analysis should be conducted to determine viability of a seed bank. Some of the major questions will include: Will major seed purchasers choose native seeds over agronomic species even if they are not required to do so by law? What is the anticipated demand for native seed in the future?

20. *Who should be allowed to access and purchase products or services from a native seed bank (●government ● industry ● non-government organizations ● educational institutions ● general public ● no restriction on who can buy seed ● other)?*

Seed banks around the world have a variety of access limitations based on the goals of the bank. For example, the Millennium Seed Bank in Sussex, UK is primarily used for species conservation and access is strictly limited. Seed can be withdrawn by public organizations only for non-commercial research and restoration purposes and there is a strict registration process. For a seed bank in BC, many respondents

felt that there should be no restriction on who can access a seed bank. A no restrictions approach may promote the use of native seeds to the general public, however, there is a risk that seed may not be available when needed for important restoration projects or that seed would be deployed inappropriately. Alternatively, if the general public is able to purchase seed, it may help inject money into the system and promote more seed collections. One respondent indicated that seed is too valuable to open up access to the general public, and that a model similar to the BC Tree Centre's Seed Planning & Registry Application (SPAR) should be used. Other suggestions included restricting volume allowances rather than seed bank users, creating a purchasing hierarchy, and prioritizing users based on seed uses. One respondent indicated the goals and objectives of a seed bank must be clearly defined before limiting access. The goals of a potential seed bank facility should be clearly defined by organizers and access should be implemented in a manner that best meets those goals.

*21. Should a native seed bank be a for--profit or not--for--profit enterprise (● for-profit ● not-for-profit ● other)?*

Opinions were mixed on the business model, for-profit vs. not-for-profit, for a native seed bank. Some felt that the business model should depend on who will run the operation, some suggested a cost recovery model, or a co-op model, and many suggested some kind of reliance on subsidies. One person recommended the BC Tree Seed Centre model (BC government run facility where seed vendors are able to sell seed for a profit) be used. One person justified a non-profit model because it would allow for a seed bank to work with wider variety of species and thus be a benefit to biodiversity. Both non-profit and profit business models should be analyzed further within the context of specific seed bank goals.

*22. Who should be allowed to store and sell seed through a native seed bank? Do seed sellers need to be a registered business, non--government organization, First Nation or government organization? Could non--affiliated individuals sell or store seed at the seed bank (● sellers must be a registered business, government agency, non-government organization or first nation organization ● sellers can be individuals but must have proof or relevant training or certification ● other)?*

When determining who can use a seed bank, some sort of legitimacy was preferred by respondents, whether it is a registered business or organization or a qualified individual with training and/or certification. The creation of a training program for individuals to gain experience in plant identification and seed collection is an option for increasing the number of seed collectors in BC. Involvement of educational institutions and government in the creation of training programs could help to provide training that is rooted in science and current best practices. A standard program that could be delivered throughout the province would be ideal to regulate training. In developing a program, it is important to consider access to training. Rural communities are important assets in accessing native seeds, and delivery of training or certification programs should extend to these areas.

*23. Do you have any additional thoughts or comments that you would like to add?*

Collaboration was one of the dominant themes in the closing comments of survey respondents. There is a breadth of experience and expertise surrounding native plants in BC, which should be utilized in the inception of a seed bank. A multijurisdictional model with representation of a variety of user groups should be considered.

Seed quality, affordability and availability stood out as major challenges in using native species. Despite numerous obstacles in the creation of a native seed bank but it is important to keep regulatory hurdles to a minimum while adhering to solid quality control and developing a professional and well managed operation. This could possibly be achieved by utilizing the expertise and facilities of the BC Tree Seed Centre but supplementing with additional staff and resources.

Some respondents felt that a seed bank should start out small by focusing on a few keystone species while others felt native species should be necessary and affordable for both industry and personal use.

A number of respondents called for development of standards and regulation of native species, referencing the Alberta Forest Genetics Resource Management and Conservation Standards (Alberta Sustainable Resource Development, 2009). Genetic integrity, seed certification, and sustainable collection practices were identified as important.

#### Examples of National and International Seed Bank Facilities

##### *BC Tree Seed Centre*

The BC Tree Seed Centre (TSC) is operated by the Ministry of Forests, Lands, and Natural Resource Operations under the Tree Improvement Branch of the Forest Stewardship division. The mission of the TSC is “Excellence in Cone and Tree Services.” They offer registration and storage of seedlots, seed extraction, stratification, and seed testing services for conifer species. The TSC primarily services BC’s forestry industry but also supports researchers, educational institutions, and the mining industry. Private industry and government organizations are permitted to register and store seed in the TSC seed bank. Seedlot owners can retain their seed for private use or can allow seed to be available for purchase. Seed users can search for, purchase and withdrawal seed using the Seed Planning and Registry application (SPAR).

The BC Tree Seed Centre has established a high functioning seed bank that serves the forestry industry well. We believe this system could be modified and scaled to deal with native seeds such as shrubs, forbs, and grass species.

##### *Alberta Tree Improvement and Seed Centre*

The Alberta Tree Improvement and Seed Centre (ATISC) is located in Smoky Lake, Alberta and is operated by the Alberta government. Similar to the BC TSC, ATISC primarily focuses on conifer species, however they contribute resources and research to native deciduous trees, shrubs, and herbaceous species. The facility includes a large seed bank that is temperature regulated at sub-zero temperatures as well as an on-site research lab. ATISC is responsible for registration of seedlots deployed on public lands in Alberta as set out in the Alberta Forest Genetics Resource Management and Conservation Standards (Alberta Sustainable Resource Development 2009). Limited information about the facility and its mandate was available online, and the facility manager was nonresponsive to requests for information, however further investigation into the ATISC operating model should be conducted in subsequent phases of this study.

##### *Oil Sands Vegetation Cooperative*

The Oil Sands Vegetation Cooperative (OSVC) is a joint effort in Alberta initiated by oil sands companies to build up a seed inventory of native species used in reclamation. OSVC works in partnership with the Alberta Tree Improvement and Seed Centre to store seed at the ATISC seed bank in Smoky Lake, AB. Twenty-five priority species were selected as priorities and have been collected and registered in the seed bank. The COSIA OSVC model is unique in its approach as a joint project with both industry and provincial government. With support from the Alberta government, oil and gas companies are collectively invested in increasing seed availability. This model allows for seed users to work together to gather a resource, spreading out cost and effort.

#### *KEW Millennium Seed Bank*

The Millennium Seed Bank is a facility operated by the Kew Royal Botanic Gardens in Sussex, UK, which aims at storing 25% of the world's plant seeds by 2020. The main objective of the seed bank is seed storage for species conservation, particularly of species that are facing extinction or are of particular value for the future. The seed bank is operated as a partnership of countries from around the world and relies on private sponsorship. Seeds that are conserved at the facility are prepared and then banked in a cold storage facility at -20 degrees Celsius, and 15% relative humidity. In addition to conservation goals, the Millennium seed bank allows the withdrawal of seeds for research or non-commercial restoration through public organizations.

Kew's Millennium Seed Bank model is an invaluable resource for the conservation and research of the world's plants. The reliance on private donation and overall coarse scale approach of the Millennium Seed Bank model does not fit with objectives for a seed bank in BC, however, there are many lessons to be learned in terms of facility operation and procedures. Additional information about the Millennium Seed Bank can be found online at: <http://www.kew.org/science-conservation/collections/millennium-seed-bank>.

#### *Native Seed Network*

The Native Seed Network is a non-profit organization that acts as a central online locale for seed vendors and purchasers to connect. The website, [www.nativeseednetwork.org](http://www.nativeseednetwork.org), has a directory of seed vendors throughout the United States and allows vendors to list seed for sale. Seed purchasers can search by vendor, species, ecoregion, and other variables. The Native Seed Network is an example of how a collective of private businesses can meet the demand of native seeds for revegetation. In addition to connecting vendors and purchasers, the organization's website provides resources on native seed restoration practices.

This private industry based model is beneficial because the costs associated with seed collection and storage are essentially funded by the seed users and are covered in prices set by seed retailers. However, with the lack of a defined system or centralized seed repository, there is no assurance of seed availability or consistency. Seed users may have to develop specific relationships with seed vendors in order to gain consistent seed availability.

## **RECOMMENDATIONS**

This survey is a first step in illuminating the challenges and opportunities surrounding native seed supply in BC. This survey was issued to key stakeholders from government, industry, First Nations, and consultants. The high response and the quality of responses indicates the interest in a provincial native seed bank in BC. The next step to continue the work of this study is to secure funding to conduct a full feasibility study, with a financial and market analysis. Gaining an in depth understanding of potential revenue and expenses is critical in moving forward with this research.

Identifying priority species for a seed bank to start with was suggested by participants throughout the survey. This process can be conducted through a gap analysis study which interviews seed users. Questioning native plant nurseries about most commonly ordered species and speaking with industry stakeholders about priorities will be an efficient way to conduct a gap analysis.

Identify a key group of stakeholders who are interested in contributing or championing this project and establish a working group. Engaging with relevant government departments will be necessary to determine if there is an interest in pursuing a native seed bank as a government initiative, or if it could be feasibly incorporated into the BC Tree Seed Centre. A working group may be difficult to manage and maintain, but collaboration and stakeholder involvement are critical in the establishment of a native seed bank. Once a working group is established, one of the first actions should be to determine clear objectives and goals for a facility. Our survey identified that native seeds for revegetation of disturbed areas was the primary interest for a native seed bank. A working group must determine if other goals, such as species conservation or native seed research, should also be incorporated into operating objectives.

Many survey respondents mentioned knowledge gaps surrounding native seed use for restoration. A centralized online network to house research on native seed use would be valuable to all seed users. There are networks currently in place, such as the Technical and Research Committee on Reclamation, but these networks are generally exclusive to a specific user group (e.g., mine reclamation). Creation and promotion of an online network could bring more awareness to research on native plants, identify areas requiring more research, and could connect various seed user groups. A native plant organization with broad mandates such as the Native Plant Society or the Society for Ecological Restoration should be considered to spearhead this initiative. In the establishment of such a network, it would be advantageous to conduct a literature review summarizing the current body of knowledge on native plant use.

Additionally, a public/private cooperative approach should be used to fund graduate level research on native seeds and applications in restoration works.

The establishment of regulation surrounding native seed deployment in BC is an important puzzle piece in increasing native seed use. A major priority for regulation should be the creation of native seed use zones, such as the Seed Planning Zones in place for conifer species. The incorrect deployment of poorly adapted seed is disadvantageous to restoration goals (Bowers et al. 2014). The BC Biogeoclimatic Zone (BEC) system provides an excellent framework for seed zone development and should be utilized. Models used in Alberta or in the US should be reviewed in this process.

As identified by this study, there are a number of obstacles that stand in the way of the creation of a native seed bank facility in BC. Continuing this work with a feasibility study is the priority action in moving forward with this project. This survey has gained great interest from stakeholders and immediate action

should be taken to maintain momentum.

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Mention of companies and organizations in this report does not constitute endorsement.

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