Guidelines for Translocation of Plant Species at Risk in British Columbia

by
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Photo: Brenda Costanzo

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EXECUTIVE SUMMARY

Translocation is the deliberate moving of propagules and/or plants from one location to another location in the wild in order to mitigate threats and assist in the recovery of the species. There are increasing recommendations for translocations to be part of recovery planning for plant species at risk in British Columbia, and translocations of some species at risk have already occurred in the province.

However, there are significant risks associated with translocations, in particular those that are poorly planned. Translocations have the potential to cause inadvertent harm to natural ecosystems and species at risk. Translocations often have low success rates, may be expensive, and may use significant amounts of the limited resources available for species at risk recovery. These guidelines were developed to assist with the decision of whether translocations are necessary, and if necessary, to provide general advice for the development of specific translocation plans, and to outline basic questions to guide the development of translocation methodology and technique.

The main objectives of these guidelines are to:

- Provide guidance to determine if and when translocations are appropriate, given limited resources and the potential risks and expense associated with translocation projects.
- Provide guidance for when to use conservation techniques as an alternative to translocation to decrease the potential for inappropriate translocations and to ensure the conservation and management of existing populations of species at risk.
- Provide general guidelines to increase the likelihood of success of translocation attempts and to ensure that the information gained adds to the knowledge of species at risk through proper experimental design and monitoring.
- Ensure that translocation projects are thoroughly documented and that the information is made available for other conservation efforts.
- Minimize harm to native plant communities and existing populations of plants at risk and other species.
- Ensure that the selection process for a translocation site and the choice of a donor population are transparent and based on the needs of the species.
- Ensure that translocation projects focus on the mitigation of potential threats to species at risk and are based on careful evaluation of the biology and ecology of the species.
- Ensure that translocation projects follow appropriate federal, provincial, and municipal legislation and involve the appropriate recovery team and/or botanical and ecological experts.
- Ensure that those planning translocation projects consult with the appropriate stakeholders and that there is long-term commitment by all

stakeholders before a translocation project is initiated to foster long-term commitment to the project.

- Provide general guidance for developing and implementing specific translocation plans to ensure that the necessary background planning accompanies translocation projects.
- Ensure that translocation projects have appropriate post-translocation documentation, monitoring, management, and evaluation with clearly established goals and objectives to allow quantitative evaluation of the project.

These guidelines have been drafted in consultation with the Garry Oak Ecosystems Recovery Team's Plants at Risk Recovery Implementation Group. The guidelines are not meant to encourage casual reintroductions or to encourage the translocation of plant species at risk in British Columbia. They are not intended to undermine the essential need for preservation and management of in situ populations of species at risk. These guidelines do not endorse mitigation plantings or moving existing populations to facilitate development of any kind. The opinions and recommendations in this document are those of the author and are not endorsed by the Ministry of Environment.

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1. INTRODUCTION

As of May 2009, 66 vascular plant species in British Columbia have been assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as extirpated, endangered, threatened, or of special concern. Of these, 49 are currently listed under Schedule 1 (the legal list) of the federal *Species at Risk Act*. The B.C. Conservation Data Centre (CDC) also tracks provincial species at risk.

Recovery plans are required under the federal *Species at Risk Act* (SARA) for those species listed as extirpated, endangered or threatened on Schedule 1. Once brought into force by regulation, the *Wildlife Amendment Act* (2004) will provide protection for provincially listed species at risk on non-federal lands in British Columbia. Recovery planning is a process to ensure the survival and recovery of species and ecosystems at risk that is usually undertaken by a recovery team. These plans consist of two parts: a recovery strategy and an action plan. The recovery strategy provides the best available information about what is known about the species or ecosystem at risk and the requirements for recovery. The action plan includes detailed information to achieve the objectives of the strategy.

> For more information on recovery planning for species at risk refer to the B.C. Ministry of Environment:
>
> http://www.env.gov.bc.ca/wld/recoveryplans/rcvry1.htm
>
> or the SARA registry website:
>
> http://www.sararegistry.gc.ca/default_e.cfm

Internationally, translocations are becoming an integral part of recovery planning for species at risk. Recovery plans for approximately a quarter of all federally listed plants in the United States and more than 70% of endangered species in Australia call for reintroduction or translocation as a component of their recovery (Falk et al. 1996; Monks and Coates 2002). Of the current recovery plans for all species at risk in Canada, approximately 70% recommend translocations or reintroductions (Sinclair et al. 2004).

In British Columbia, there are increasing recommendations for translocations as part of the recovery for plant species at risk and translocations are currently occurring in the province. However, to date, there are no specific guidelines or direction to inform translocation projects in British Columbia. Poorly conducted translocations may cause damage to both donor populations and recipient sites. Many translocation projects are expensive and have low success rates. For these reasons, translocations should not, under any circumstances, undermine the importance of protection and management of currently existing *in situ* populations of species at risk.

However, if translocation projects are planned and conducted carefully, they can be an important tool for answering key questions about the biology and ecology of species at risk as well as restoring and managing populations. At this time, all translocations should be considered experimental and subject to careful monitoring and documentation. The experiments should be designed to further the science of translocation and/or to inform future management of the species at risk. Translocation projects should also abide by all levels of legislation and involve the appropriate experts.

These guidelines have been drafted to help ensure that translocation projects achieve their intended conservation goals and to minimize the potential harm to natural systems and existing populations of species at risk. These guidelines incorporate aspects of the World Conservation Union (IUCN) and the Canadian Botanical Association guidelines, but focus on particular concerns and elements of recovery necessary for plants at risk in British Columbia.

1.1 Definitions of Translocation, Augmentation, Introduction, and Reintroduction

In this report, translocation is defined as the deliberate moving of propagules and/or plants from one location, either a natural population in the wild or off-site collections, to another location in the wild in order to assist in the recovery of the species. Translocations may include augmentation, introduction, and reintroduction, as defined below (definitions adapted from Vallee et al. 2004). Transplanting is the moving of whole plants or seedlings. Further details of when augmentation versus reintroduction or introduction is appropriate are included in **Section 2.4**.

Augmentation: is adding new individuals to an existing population in order to increase the number of individuals and/or the genetic diversity of the population. This may be done by propagating genetic stock from the receptor site *ex situ* or by adding genetic material from other locations if the existing population is suffering from demographic collapse due to inbreeding.

Introduction: is establishing a population in a location with appropriate habitat that lies within the historic range for the species but where there are no historic records indicating the species previously occurred there. This may be difficult to determine if the locations of historic records are imprecise.

Reintroduction: establishing a population in a location that is known to have previously supported the species but from which it has since been extirpated.

Translocation techniques include:

- collection of seed from extant populations and direct sowing of seeds at the new location;
- pollinating flowers with pollen from a different population or even from the same population if pollination is a limiting factor in reproduction
- collection of seed, cuttings, or tissue culture from extant populations, off-site propagation of material, and planting of propagated material to new locations (Vallee et al. 2004); and/or
- collection of seedlings or plants from extant populations and transplantation to new locations.

Direct transplantations of existing seedlings or plants from an *in situ* population is not encouraged by these guidelines and should be done only after careful evaluation on a species-by-species basis because of potential harm to extant populations of species at risk (**Section 3.4)**. The only exception should be where the source population is certain to be eliminated by approved construction.

1.2 Objectives of Translocation Programs

The key goal for most translocation projects should be to ensure the long-term survival of species at risk by establishing viable, self-sustaining, populations in the wild, while retaining the genetic integrity and diversity of the species (IUCN 1995; Hawaii Rare Plant Restoration Group 1999). Translocated populations should be able to: withstand demographic collapse and environmental stress, reproduce with natural recruitment, and have sufficient genetic diversity to adapt to habitat changes (Vallee et al. 2004).

At this time, all translocations in British Columbia should be considered experimental and subject to thorough documentation and ongoing monitoring. Experiments should be designed to inform future management of species at risk and/or to further the science of translocation. The only way to accurately assess the success of translocations is by setting measurable goals and objectives that can be evaluated by ongoing monitoring.

Translocations should not undermine the importance of *in situ* conservation of existing populations of plants at risk. The first priority for conservation should be the protection and management of currently occupied habitats by species at risk. Existing populations of plants at risk should not, under any circumstances, be moved to more convenient locations for development as compensatory mitigation planting (Canadian Botanical Association 2004). Compensatory mitigation plantings generally have very poor success rates and therefore should be used only as a last resort. There are so few extant populations of most species at risk that translocations should be used only as a tool for conservation of the species, including augmenting existing populations and increasing the number of existing populations. Rare species are important within the context of their habitat and ecological processes, which should be preserved wherever they remain (Canadian Botanical Association 2004; Vallee et al. 2004).

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2. GUIDING PRINCIPLES: EXAMINING THE SUITABILITY OF TRANSLOCATIONS

2.1 Benefits and Risks of Translocation

Many of the plant species at risk in British Columbia are limited to only a few extant populations and often have a smaller range than they did historically (as indicated by historical collections). In addition, many of these species face a range of threats and often occur in fragmented habitats that experience a greater influence of edge habitat than in more intact ecosystems. Habitat fragmentation, which creates dispersal barriers, may have prevented natural recolonization of suitable habitat of some species and may limit the "rescue effect" from immigration (Binggeli 1994; Willi and Fischer 2005). Small, isolated populations may be particularly vulnerable to extirpation from large-scale destructive events such as climatic change, fire, spread of diseases or pests, and natural disturbance regimes (Holsinger 1990; Guerrant 1992; Binggeli 1994; Speilman et al. 2004; Vallee et al. 2004).

Although the protection of extant populations should be the primary conservation focus, protection alone may not be sufficient to ensure the survival of species at risk and to maintain their genetic diversity (White 1996). Translocations are especially important when the preservation of extant populations does not ensure the long-term survival of a species and when other management options have failed. Translocations can also be important tools for re-establishing species' historical distribution; maintaining and /or restoring biodiversity; promoting conservation awareness; and increasing understanding of the biology/ecology and genetic adaptation of species at risk (Table 1) (Austin 2004; Vallee et al. 2004; McKay et al. 2005).

The scientific foundation required for supporting successful translocation of species at risk is extremely limited and there are many risks associated with the process (Table 1). Translocations can be expensive. Long-term monitoring data that will determine whether short-term success leads to long-term stability of new populations are not available (Fiedler 1991; Falk et al. 1996). Plant communities are complex and field management of rare species may be different from academic *ex situ* studies (Austin 2004). Many previous plant translocation projects have had limited success because they were mitigation-related and were planned with insufficient knowledge of species at risk biology, ecology, and genetic adaptation (Coumbe and Dopson 2001; Vallee et al. 2004; McKay et al. 2005). Failures have also occurred due to a lack of effective means of controlling threats to the species before, during, and after translocation (Fiedler 1991; Coumbe and Dopson 2001; Vallee et al. 2004). "The majority of translocations associated with development consent are ill-considered, poorly planned and even more poorly implemented.... These translocations ultimately fail and do not contribute towards the conservation of the species." (Vallee et al. 2004). A British Nature Conservancy Council

Table 1. Risks and benefits associated with translocation.

Risks	Benefits
• Many transplantations of species at risk have low success rates (Fahselt 1988; CBA 2004). • Translocations can be expensive. They may require money to research required background information, perform the translocation, manage invasive species, conduct monitoring, etc. (Fahselt 1988). • Translocations are labour intensive (Fahselt 1988). • Translocations require regular, long-term maintenance and long-term commitment for success (Fahselt 1988). • Translocated populations often do not maintain a full range of genetic variability (Fahselt 1988). • Donor populations of species at risk may be harmed by soil disturbance and by removing propagules (Fahselt 1988; CBA 2004). • Recipient plant communities may be harmed by soil disturbance, introduction of diseases, trampling, alteration of ecological processes, and/or displacement of other species (Fahselt 1988; Vallee et al. 2004). • Translocations may shift the social focus away from protecting existing populations (Fahselt 1988). • Mixing individuals from different populations can lead to outbreeding depression and loss of fitness (Vallee et al. 2004). • Introducing or reintroducing populations with maladapted genotypes may negatively affect adjacent populations of species at risk through gene flow (McKay et al. 2005).	• Introductions and reintroductions may restore the natural historical range and/or historical abundance of species that have been extirpated from some locations (Joint Nature Conservation Committee 2001). • Introducing or reintroducing new populations may decrease fragmentation and allow genetic exchange between populations. • Small and/or isolated plant populations, particularly of plants at risk, may suffer from limited genetic diversity and inbreeding depression (Richards 2000; Speilman et al. 2004; Willi and Fischer 2005). Augmentation may alleviate the risks associated with limited genetic diversity. • Augmentation may increase dwindling populations (Coumbe and Dopson 2001). • Translocations may provide robustness in the face of large-scale catastrophic events (Binggeli 1994; Vallee et al. 2004). • Reintroductions help restore plant communities to their former composition (Coumbe and Dopson 2001). • Translocations may increase scientific knowledge of the biology, ecology, and genetics of plants at risk through experimental trials and may help inform translocations of other plant species. • Experimental translocations may help determine management options for mitigating the threats faced by extant populations of plants at risk without directly subjecting extant populations to unproven management techniques (Coumbe and Dopson 2001).

study determined that of 144 translocation attempts conducted from 1824 to 1991, 28% were failures, another 27% of populations had not been found in the previous 10 years, and 15% were less than 5 years old and could not be evaluated. Only 22% were still extant and had persisted over a minimum of 5 years. (Birkinshaw 1991).

Translocations have the potential to cause severe damage to remnant natural ecosystems and existing populations of species at risk through the introduction of pathogens, soil disturbance, trampling, alteration of ecological processes, and/or displacement of other species (Fahselt 1988; Vallee et al. 2004). Introducing or reintroducing populations with maladapted genotypes may negatively affect adjacent populations of species at risk through gene flow, and augmenting populations with non-local genotypes may harm existing populations (McKay et al. 2005). For these reasons, all plant translocations should take a precautionary approach and research should involve experimental translocation trials.

Because there is great need and limited resources for recovery, developing a transparent translocation priority list for all species at risk in British Columbia is increasingly important (Austin 2004). Ranking will help ensure that a translocation effort is an effective use of resources, that alternative conservation approaches have been evaluated and that the potential for adverse impacts to the species at risk is minimal.

A higher ranking should be given to species (or taxa) with the following traits:

- Species endemic or with a high percentage of the global range in either British Columbia or Canada (Cannings et al. 2005);
- Species with high rarity, such as high risk COSEWIC status and/or high global risk ranking (Cannings et al. 2005; Environment Canada 2005). Where COSEWIC listings are not in place, use a high B.C. Conservation Data Centre listing (e.g., provincial lists for Red and Blue species). See B.C. Species and Ecosystems Explorer at: www.env.gov.bc.ca/atrisk/toolintro.html);
- Species with a high contribution to biodiversity either as designated by COSEWIC (Environment Canada 2005) or populations with unique genetic traits (e.g., populations that are widely disjunct from populations in the main portion of a species' range); or through the B.C. Conservation Framework Tool at: www.env.gov.bc.ca/conservationframework/;
- Species with a high number of historical sites lost and a high degree of habitat fragmentation (Guerrant 1992);
- Species with a high anticipated degree of translocation success;
- Species that have potential synergy with recovery actions for other species at risk (Environment Canada 2005);
- Species with a low estimated cost of translocation.

The appropriateness of translocations should be decided by weighing the risks and benefits on a case-by-case basis. Other, potentially less intensive conservation options should be ruled out before translocation (Austin 2004). However, in some cases, translocations may be the only viable option. For example, translocation can be a useful tool to mitigate threats to plants in development areas where no other option is feasible.

Species-specific research should indicate that it is feasible to successfully establish translocated propagules and those translocations are likely to assist in the recovery of the species. Translocations should be used to help meet the population and distribution objectives required for the species' recovery (Austin 2004). Research should ensure that relocating propagules poses minimal risk to extant populations of species at risk and other species. Secure sites should be available and threats, particularly those that have caused decline or extirpation, should be managed and controlled (Austin 2004; Vallee et al. 2004). Secured funding for future monitoring and maintenance of the population should be in place.

In the short-term, all newly established populations should be treated as experimental and clearly documented to develop translocation techniques and test management options. Translocation attempts should be designed so that even "failures" will increase our knowledge of the species (White 1996; Vallee et al. 2004).

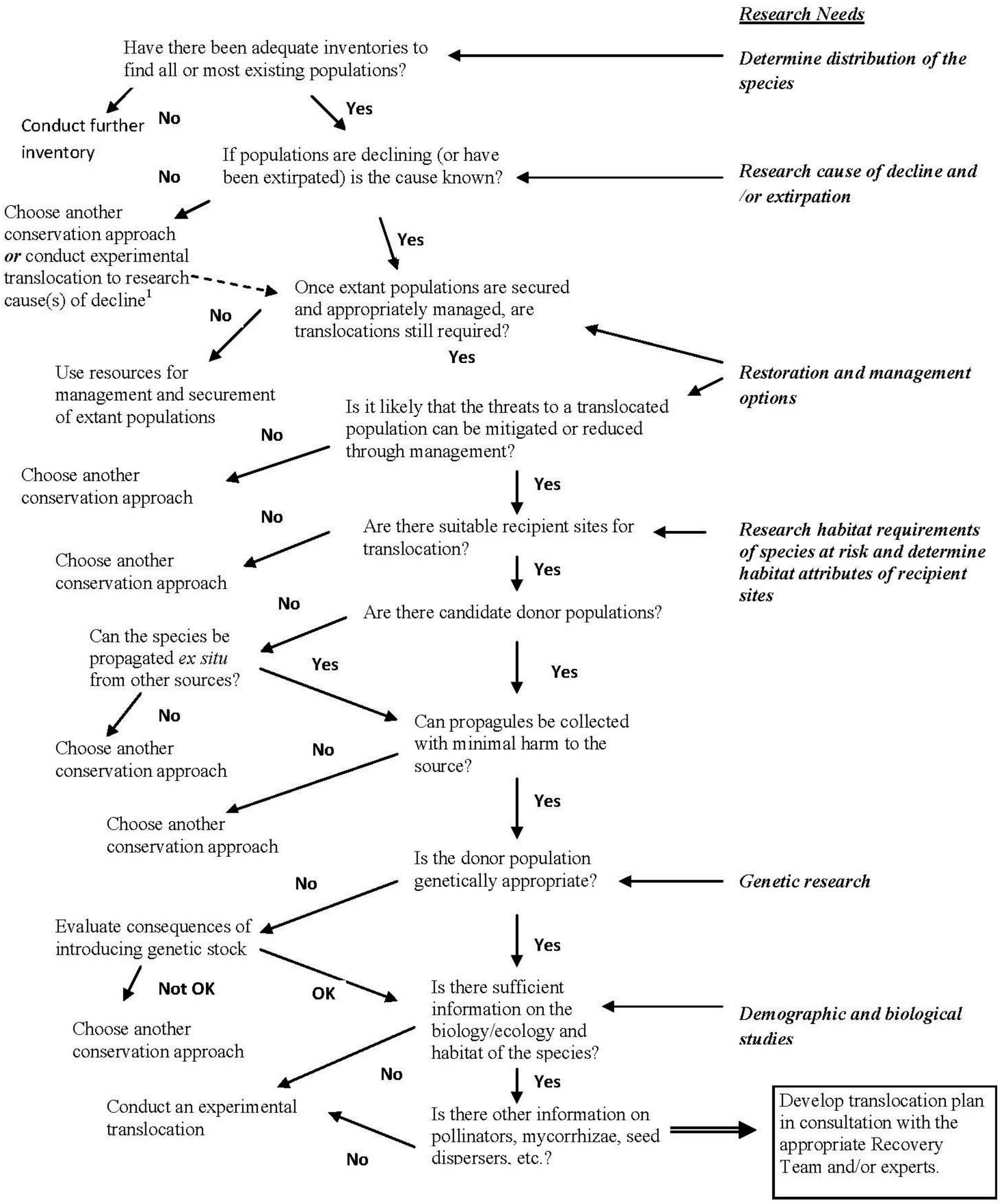
If translocation is the only way to protect a species, landowners and land managers may have to proceed with translocation even with incomplete biological or ecological knowledge of the species. Biological information about species at risk is always limited and there may not be sufficient time to do comprehensive studies for species that are under imminent threat. Experimental translocations may help understand and answer key questions concerning the biology and ecology of the target species, and a proper monitoring program will assist in collecting this data. However, all translocations should still take a precautionary approach.

2.2 Determining the Feasibility of Translocation

(Refer to Figure 1)

- ☐ Have all alternative management options been reviewed and deemed unsuitable or likely to be unsuccessful? **Section 2.3.**
- ☐ Does the translocation follow appropriate legal requirements and are recovery teams and/or suitable experts involved in the plan? **Section 5.2 and 5.3.**
- ☐ Are the underlying causes of decline or extirpation understood and can they be controlled? **Section 3.1.**
- ☐ Is there sufficient information about the biology/ecology and habitat of the species to determine whether translocations will be successful (including evaluation of translocations of the same or related species, determination of appropriate translocation techniques to overcome demographic constraints, etc.)? **Section 3.2.**
- ☐ Are there suitable recipient sites (including understanding the distribution of the species to prevent genetic contamination, minimizing the risk of damaging extant populations of plants at risk, prioritizing historical sites before "new" sites, etc.)? **Section 3.3.**

- ☐ Are there appropriate donor populations for translocation material (including evaluation of risk to donor populations and an understanding of the taxonomic status and genetics of the populations)? **Section 3.4.**
- ☐ Are there measurable goals and objectives in place to allow evaluation and monitoring of the project? **Section 3.6.**
- ☐ Is there long-term commitment by all involved parties (landowners, land managers, volunteers, funding sources, etc.) to ensure appropriate evaluation, monitoring, and maintenance? **Section 5.2 and Section 8.**



[1]Including genetic research to determine if inbreeding depression is a factor in the decline of a population.

Figure 1. Assessment of translocation. Modified from Lind (2003).

2.3 Alternatives to Translocation

Given the risks, expense, and uncertainty involved with translocation attempts, it is essential to determine whether any other appropriate management options can be implemented before initiating a translocation project. Management options that are least interventionist, and therefore involve lower levels of risk, should be evaluated first (Vallee et al. 2004). Compared to translocations, management of existing populations will often be more cost-effective, more likely to stabilize populations at their natural levels, and not introduce the risk of new pests or genetic contamination (Vallee et al. 2004). However, management of existing populations does not address the risks associated with inbreeding depression. Translocations should be considered as a last resort when all other management options have been considered and rejected and when the protection and management alone of extant populations cannot ensure the long-term survival of the species. However, in many circumstances, translocations may remain the only viable option.

The following management options are listed in increasing order of degree of intervention (adapted from Vallee et al. 2004):

Further inventory: A review of existing records[1] and targeted surveys may reveal additional populations of some species, in particular species that only occur periodically due to weather conditions or are small and difficult to identify. Identifying additional undocumented populations may reduce or eliminate the need for translocations (Vallee et al. 2004).

Habitat securement: Habitat securement is essential to ensure the long-term survival of populations of species at risk. Habitat securement may be achieved through acquisition of property or protection under stewardship agreements, such as conservation covenants or other voluntary measures.

Habitat restoration/active management and removal of threats: For many species, habitat protection alone is not sufficient to ensure the long-term survival of a population. Invasive alien species, herbivory, fire suppression, introduced pests, and human disturbances may require active threat mitigation[2]. More intensive restoration measures, such as restoring ecological processes through prescribed burns, may alter the habitat for other species. Effective management may stabilize and/or increase population size, thereby reducing or eliminating the need for translocations.

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[1] Contact the B.C. Conservation Data Centre and/or search the B.C. Species and Ecosystem Explorer at: www.env.gov.bc.ca/atrisk/toolintro.html.

[2] Refer to Ministry of Environment website postings of Draft Provincial Recovery Strategies for actions on plant species at risk at: www.env.gov.bc.ca/wld/recoveryplans/recovery_doc_table.html.

2.4 Population Augmentation Versus Introduction or Reintroduction

Determining which translocation approach (augmentation, introduction, or reintroduction) is most appropriate will require careful evaluation on a species-by-species basis. The decision of whether to introduce a population to a place with no historical records for the species or to reintroduce a population to a former historical site will depend on selection process of the recipient site and whether appropriate historical sites are available. Consultation with the relevant recovery team and the cooperation of the landowner are integral to choosing a recipient site (**Section 3.3**).

Augmenting an existing population of plants at risk by adding new individuals is one approach to increasing small populations and/or increasing the genetic diversity of a population (Falk et al. 1996). The decision of whether to augment an existing population is complicated and requires a thorough understanding of the genetic issues associated with translocations (**Section 3.5**).

Small and/or isolated plant populations, in particular, species whose populations have become highly fragmented, may suffer from inbreeding depression (Richards 2000; Speilman et al. 2004; Rogers and Montalvo 2004; McKay et al. 2005; Willi and Fischer 2005). The degree of inbreeding is related to a number of factors including the size of the founder population, the type of mating system of the plant, the type of pollination and dispersal systems, and environmental conditions (Guerrant 1992; Rogers and Montalvo 2004; McKay et al. 2005). Many species at risk have a lower level of genetic diversity than those of more common species (McKay et al. 2005).

Augmentation should be conducted only under a discreet set of circumstances and should be carefully evaluated first (refer to Table 2). The stock used for augmentation should be disease-free and should be collected locally if at all possible from donor sites with similar habitat conditions (IUCN 1987; McKay et al. 2005). Refer to **Section 4.2** for more information on collection of source material. When the population is not suffering from inbreeding depression, the most conservative approach is to use material from the recipient population itself (Falk et al. 1996).

Table 2. When to consider augmenting an existing population.

Augment an Existing Population	Do not Augment
• Augmentation with propagules from a source different from the recipient population is appropriate only for small populations where inbreeding depression has been clearly identified as a major threat. In this case, adding even a few non-local genotypes may have rescue effect (Austin 2004; Willi and Fischer 2005). However, extensive genetic analysis of the species is necessary to determine whether inbreeding depression is occurring and to weigh the importance of local adaptation against the genetic variation within a population (McKay et al. 2005). • Augmentation is appropriate only when the reason for population decline has been identified and mitigated and appropriate management/restoration will not naturally increase population size (IUCN 1987). • Augmentation is appropriate when demographic study indicates that without augmentation, the population may collapse (Austin 2004).	• Augmentation is not appropriate if the extant population is robust enough to withstand demographic collapse and environmental stress without augmentation (Vallee et al. 2004). • Augmentation is not appropriate if the extant population is stable or increasing after taking natural fluctuations into account (Vallee et al. 2004). • Augmentation is not appropriate if appropriate management and/or restoration will increase robustness and population size without the addition of new individuals (IUCN 1987). • Augmentation is not appropriate if there are uncontrolled risks of contaminating the existing population with noxious weeds, pests, or diseases (Hawaii Rare Plant Restoration Group 1999; Vallee et al. 2004). • Augmentation is not appropriate if adding new genetic material will lead to outbreeding depression or disrupt co-adapted gene complexes of the extant population (Austin 2004; Vallee et al. 2004; McKay et al. 2005).

Photo: Brenda Costanzo

3. PRE-TRANSLOCATION ASSESSMENT AND PLANNING

It is not possible to identify parameters for translocation assessment for all plant species at risk in British Columbia. However, this section is designed to guide decision-making and identify key considerations. Decisions will need to be made on a species-by-species basis, with site-specific considerations in mind.

3.1 Evaluating Threats and Mitigation Strategies

One of the most important factors in any translocation project is minimizing or controlling potential threats (Joint Nature Conservation Committee 2001; IUCN 1995; Vallee et al. 2004). This includes identifying the causes of extirpation or decline and determining approaches to mitigate these threats. Threats that have only a small impact on natural populations may devastate a newly established population (Monks and Coates 2002). Threats to translocated populations may be different than threats to wild populations (Hawaii Rare Plant Restoration Group 1999; Monks and Coates 2002).

If threats can be successfully controlled in extant populations, the need for translocations may be decreased or eliminated (Vallee et al. 2004). Carefully designed experimental translocations may also be a useful tool for determining threat mitigation options without negatively impacting extant populations of species at risk.

3.1.1 Evaluation of threats and threat mitigation

The decision of whether or not to conduct a translocation will depend on evaluation of the following factors:

- ☐ Have the reasons for species decline/extirpation been determined and is mitigation possible (Joint Nature Conservation Committee 2001; IUCN 1995)?
- ☐ Could habitat restoration and management increase extant populations without translocation (Joint Nature Conservation Committee 2001)?
- ☐ Does the potential recipient site (and any necessary buffer areas) for translocation have long-term protection through secure land tenure (IUCN 1995; Vallee et al. 2004)?
- ☐ Is the recipient site degraded and in need of restoration prior to translocation? Are appropriate restoration techniques known for the species (IUCN 1995)?
- ☐ Is there a management plan in place to address short-term (e.g., site preparation, watering, weeding of non-native plants, fencing) and long-term site management (invasive species management, restoring ecological processes) (Fiedler 1991; Hawaii Rare Plant Restoration Group 1999)?

- ☐ Is the site accessible for management and monitoring (Fiedler and Laven 1996)?
- ☐ Has there been a systematic review of all existing literature and former studies to fully determine potential threats and mitigation options (Austin 2004)?

3.2 Species-Specific Biological and Ecological Assessment

Background biological and ecological information on each species at risk is required to identify whether translocations are likely to be successful; to determine the most appropriate life stage and season for translocation; to evaluate the most appropriate translocation techniques; to identify the most appropriate propagule (i.e., seed, seedlings, cuttings) and propagation techniques; and to determine biological bottlenecks, etc. White (1966) states that "...we should have a healthy skepticism about our ability to restore nature given our inadequate understanding of natural processes, species interaction and ecosystem function". Therefore, if there are serious gaps in the biological and ecological understanding of the species, it is prudent to undertake further studies prior to translocation to decrease the risk of unsuccessful translocation.

However, because of the small numbers of populations and small population sizes of plant at risk in British Columbia, it may not be possible to determine all of the relevant biological and ecological parameters prior to translocation (Vallee et al. 2004). Information on the biological and ecological parameters may be determined from literature reviews (including status reports and recovery strategies), herbarium specimens, consultation with the recovery team and experts, field observations and cultivation observations and experiments (Birkinshaw 1991). A well-designed experimental translocation project may be a useful tool for determining biological and ecological information without negatively impacting extant populations of species at risk (**Section 4.1).**

3.2.1 Evaluation of biological and ecological factors

- ☐ Are critical **abiotic** habitat attributes well known for the species (e.g., soil texture, soil depth, pH, slope, aspect, hydrology, ecological processes, etc.) (Fiedler and Laven 1996)?
- ☐ Are critical **biotic** habitat attributes well known for the species (e.g., species composition of community, successional stage, host plants for parasites/hemiparasites, pollinators, dispersal vectors, *Rhizobium* bacteria for N_2 fixing, tolerance to herbivores and insect pests) (IUCN 1995; Fiedler and Laven 1996; Hawaii Rare Plant Restoration Group 1999; Vallee et al. 2004)?

☐ Are habitat attributes well known for all life stages of the species at risk to allow successful regeneration (Birkinshaw 1991)?

☐ Have any previous translocation attempts of the same or related species been examined to determine their successes/failures (IUCN 1995; Joint Nature Conservation Committee 2001)?

☐ Are existing populations stable with sufficient recruitment to replace dying adult plants (Vallee et al. 2004)? If the population is not stable, are the demographic constraints or causes of decline known?

☐ Are there extreme year-to-year natural fluctuations in population size of extant populations? If so, are the reasons for fluctuation known?

☐ Has another species filled the gap left by an extirpated population that would prevent successful reestablishment of the translocated species (IUCN 1995)?

☐ How does the species respond to ecological processes such as fire, disturbances, and different management regimes (e.g., mowing, pest control) (IUCN 1995; Vallee et al. 2004)?

☐ What is known about the reproductive biology of the species, including:
  - Method and distance of pollen dispersal (Hawaii Rare Plant Restoration Group 1999; Vallee et al. 2004)?
  - Dispersal distance and mechanisms (IUCN 1995)?
  - Demographic composition and bottlenecks of extant populations (Vallee et al. 2004)?
  - Lifespan of plants and average time to reproduce?
  - Does the species reproduce sexually, asexually or both (Vallee et al. 2004)?
  - Is the species self-compatible or self-incompatible (Hawaii Rare Plant Restoration Group 1999; Vallee et al. 2004)?
  - Is the species dioecious or monoecious (Hawaii Rare Plant Restoration Group 1999)?
  - What are the levels of successful flowering and fruit production (Vallee et al. 2004)?
  - Does the species form a seed bank and if so what is the distribution and longevity of banked seeds (Vallee et al. 2004)?
  - What are the viability, germination rate, and dormancy mechanisms of seed (Vallee et al. 2004)?
  - Are there management techniques available to aid recruitment (Vallee et al. 2004)?

3.3 Selecting the Recipient Site

Reintroducing a species to a historical site or introducing a new population to a location where it did not formerly occur requires a systematic approach to site selection. Site selection will present many challenges given the highly fragmented nature of most ecosystems where species at risk occur and the limited subset of these with habitat suitable for the species in question (review in Fiedler and Laven 1996). There will be ethical dilemmas associated with translocating a species at risk whose habitat is considered threatened or endangered because of the potential threats translocation poses to the recipient site (Vallee et al. 2004). These decisions should be made by careful deliberation by the relevant recovery team and/or experts. The relevant recovery team and/or provincial botanical experts should be consulted during the site selection process.

Historical sites where a species formerly occurred but from where it has since been extirpated are most likely to have the most appropriate habitat for reintroducing species at risk. Although priority should be given to locations that formerly supported populations, this may not always be possible. Early botanical inventories were poor and historical sites are known with widely varying degrees of precision. Historical sites that can be relocated may be unsuitable for re-establishment; sites may have been destroyed or degraded since the population was extirpated or changes to the site may have caused the extirpation (IUCN 1995). Historical sites that occur on private land may not have adequate protection for reintroducing populations.

Mapping the historical and present ranges of a species at risk and identifying all known populations and translocation sites is recommended to assess the feasibility of translocation projects (Hawaii Rare Plant Restoration Group 1999; Vallee et al. 2004). Determining the distribution of the species and identifying metapopulation dynamics is important to guide selection of donor source(s) and to identify recipient sites (Fiedler and Laven 1996). Targeted surveys may also identify additional populations, thereby decreasing or eliminating the need for translocation.

3.3.1 Evaluation of the recipient site

- ☐ Is the biotic and abiotic habitat appropriate at the translocation site, given what is known about the species' critical habitat attributes and necessary ecological processes (**Section 3.2**) (Fiedler and Laven 1996; Vallee et al. 2004)? Recipient sites should be compared to historical and existing locations for the species. Imprecise historical records or ecological changes to historical sites may complicate evaluation of historical habitat attributes. The future effects of climate change on recipient sites may also require evaluation. Background research will be necessary to determine the critical ecological requirements for each species at risk.
- ☐ Choosing a recipient site requires careful evaluation of the potential risks to the existing plant community including any plants at risk. Translocations may damage the recipient site by disturbing the soil, increasing trampling from monitoring, allowing hybridization with other related species, and introducing pests and diseases (Vallee et al. 2004).

- ☐ If recipient sites have suitable habitat, why is the plant not there already? What are the limiting factors affecting dispersal and population expansion (Klinkenberg 2005)?
- ☐ Have the potential threats been identified and is threat mitigation possible at the recipient site without impacting existing species (Vallee et al. 2004)? **Section 3.1.**
- ☐ Does the site have long-term protection and is long-term management possible at the site and in buffer areas, if required? **Section 3.1.**
- ☐ Is the site easily accessible for the translocation and for ongoing monitoring (Vallee et al. 2004)? Sites that are too accessible may be subject to vandalism or theft (Vallee et al. 2004).
- ☐ Is the site within the historical range for the species? Although it is unlikely, some British Columbian species at risk may become weedy or invasive when planted outside of their range. The success of translocations may decline if species are translocated outside of their natural range (Fiedler and Laven 1996; McKay et al. 2005). This may require further inventories to determine the extent of the species' range.
- ☐ Are there remnant populations of the target species at the site that may be negatively impacted by translocations? Introducing new plants may spread diseases and may introduce alien genes by either seed or pollen transfer (Joint Nature Conservation Committee 2001; IUCN 1995; McKay et al. 2005). The site should be thoroughly checked and the presence of remnant seed in the seed bank should be investigated (Birkinshaw 1991).
- ☐ Are there other species or communities at risk at the recipient site that may be adversely affected by the translocation (Vallee et al. 2004)? Assessment should include evaluation of all factors associated with the translocation (e.g., introducing plants may allow hybridization with other related species, potential for disease introduction, increased trampling from monitoring). Translocation to recipient sites with species of the same or similar "at risk" rank present are not encouraged, in particular if soil disturbance, trampling, and introduction of foreign materials and organisms are likely to occur during the translocation, subsequent maintenance, and monitoring.
- ☐ Are there other species or communities at risk at the recipient site that may be adversely affected by management of a translocated population (e.g., by reintroducing the ecological processes the translocated species need)?
- ☐ Is the site large enough and is there sufficient appropriate habitat to support a self-sustaining population of the species at risk (Vallee et al. 2004)?

3.4 Selecting the Donor Sources for Propagation

Populations used as source material for translocations should be carefully monitored to ensure that collection of propagules causes minimal damage and that source populations retain their genetic diversity. Many plants at risk have small numbers of populations and small population sizes. Any propagules are therefore extremely precious and should be used only in ecologically suitable sites (Klinkenberg 2005).

For more information on collecting guidelines, refer to the Garry Oak Ecosystems Recovery Team, Native Plant Propagation Steering Committee's Guidelines for the Collection and Use of Native Plants: http://www.goert.ca/at_home_guidelines_native.php

These guidelines caution against transplantation of whole plants, root cuttings or divisions of *in situ* plants since these propagation techniques are likely to harm extant populations and may introduce diseases. However, for some species (e.g., those that reproduce primarily by asexual means), transplantation, root cuttings, or divisions may be the best or only options. Refer to **Section 4.3** for an assessment and ranking of propagation techniques.

For most species, collection of seed is the best option. Plants grown from seed are likely to adapt more easily to new site conditions than transplanted plants or seedlings. In addition, the risk of contaminating the recipient site with invasive weed seeds, pests, and/or pathogens is smaller when translocating a population by planting seed or by planting seedlings and/or plants grown *ex situ* from seed (Birkinshaw 1991).

For a more comprehensive discussion of how to minimize the impact of seed collection on perennials at risk refer to Menges et al. (2004). In general, harvesting 10% of the seeds in 10% of the years has been determined to be a safe harvest level for perennials (Menges et al. 2004). Annuals, in particular those that do not have persistent seed banks, should be carefully monitored to prevent over-collection (Fahselt 1988; CBA 2004; Menges et al. 2004). Refer to **Section 4.2** for further information on the collection of source material and determining founder size.

3.4.1 Evaluation of donor sources

- ☐ Does the species have clear, unambiguous taxonomy to help determine an appropriate donor source? Genetic studies may be required for taxonomic assessment (IUCN 1995; Austin 2004; Vallee et al. 2004).
- ☐ Is the donor population the most genetically appropriate source? Studies may be required to determine the degree of local adaptation, whether widely separated populations are genetically distinct, and whether there

are risks of hybridization (Vallee et al. 2004; McKay et al. 2005). **Section 3.5.**

- ☐ Are there any potential negative impacts to donor populations from obtaining propagules (IUCN 1995)? Material collected should include seed or shoot cuttings. The collection of whole plants or root cuttings should be evaluated on a species-by-species basis. Over-harvesting material from species at risk, in particular from annuals, may harm the population (Fahselt 1988; CBA 2004). Refer to **Section 4.2** for more information on collection protocols.
- ☐ Is the donor population viable and self-sustaining?
- ☐ Based on what is known about the biology and ecology of the species, should collections be made over several years (Birkinshaw 1991)? **Section 3.2.**
- ☐ Is the donor population large enough to support collection for translocation? The source population should retain its genetic and demographic diversity after collection (IUCN 1995).
- ☐ Can a genetically representative sample be obtained from the donor population? This may involve evaluation of the breeding system and ploidy level of the species at risk **Section 3.5.**
- ☐ Have all necessary approvals been granted for collection of the species at risk (Birkinshaw 1991)? **Section 5.3.**

Any potential donor source should be subjected to careful genetic evaluation. Preliminary genetic surveys should include examining the genetic variation within populations, between different populations, and in the species as a whole (Holsinger 1990; IUCN 1995; Joint Nature Conservation Committee 2001). It may be especially difficult to select an appropriate source population if the remaining populations are highly fragmented and genetically isolated. Peripheral species may be widely disjunct from potential donor populations in the centre of the species' ranges. Donor populations may also occur in habitats that differ from the recipient site, with associated genetic adaptation to that habitat.

In addition to ensuring that the genetic composition of the donor population is appropriate for the recipient sites, care should be taken to ensure that the material collected captures the full range of genetic diversity of the donor population. Plant material should be collected as locally as possible and from habitats similar to the recipient site (McKay et al. 2005). Plant material should be collected from a range of microhabitats and over the full phenological range of fruiting (McKay et al. 2005). To obtain genetically representative samples of the population, it is also important to avoid oversampling larger plants that produce more seed (Menges et al. 2004). Refer also to **Section 4.2.**

To increase numbers of plants at risk, *ex situ* propagation may be required (GOERT 2004) **Section 4.4.** *Ex situ* propagation can help prevent over-collection from donor populations and can increase plants of a local provenance, preventing the importation of foreign genetic stock (Joint Nature Conservation Committee 2001; GOERT 2004). However, there are risks associated with *ex situ* propagation that should be carefully evaluated, including the “unconscious” selection of genotypes that favour agronomic conditions (McKay et al. 2005).

Using maladapted genetic stock can increase the likelihood that a translocation will fail (McKay et al. 2005). Selection of inappropriate genetic material for translocations can lead to negative impacts on the translocated population such as inbreeding depression, genetic swamping, hybridization, and/or outbreeding depression (IUCN 1995; Levin et al. 1996; Hufford and Mazer 2003). Using non-local genetic material may harm existing populations of species through genetic drift (McKay et al. 2005).

3.4.2 Herbarium specimens as a potential source for seeds or genetic material

Seed or tissue culture should be collected from herbarium specimens only under special circumstances since it involves at least partial destruction of the specimen, which in many cases cannot be replaced. However, for populations that have been extirpated, herbarium samples may be the only remaining material that is genetically representative of that population. The viability of seeds found in herbarium specimens will vary depending on the pest control techniques used: use of a microwave can dramatically decrease seed viability, while use of a deep-freezer may allow seeds of some species to remain viable (Bowles et al. 1993). Plants grown from herbarium samples may also help restore the genetic diversity of species that are suffering from inbreeding depression or are self-incompatible (Bowles et al. 1993).

Seed collected from herbarium samples will have widely varying germination rates depending on the species, the maturity of the seed when the specimen was collected, the drying and storage conditions of the sample, the pest control treatments used on herbarium samples, and the age of the sample (Bowles et al. 1993; Kerik, pers. comm. 2005; Pinder-Moss, pers. comm. 2005). Most herbarium specimens are collected when the plants are in flower and the seed is immature and the seeds may be killed by the drying process and/or pest control treatments (Kerik, pers. comm. 2005; Pinder-Moss, pers. comm. 2005). Germinating green seed in custom agar-type media may yield the best results (Pinder-Moss, pers. comm. 2005). Only seeds that are likely to have high success rates should be used to minimize unnecessary damage to herbarium specimens. Future development of tissue culture techniques may allow cloning of fragments of plant material from herbarium samples (Kerik, pers. comm. 2005).

3.5 Evaluating the Genetic Issues

Local adaptation results from the dynamic interactions between natural selection, gene flow, genetic drift, and mutation (Bridle and Vines 2006; Pertoldi et al. 2007). If the appropriate genetic variation to survive and reproduce (a measure of genetic fitness) under current and local conditions exists, populations are considered locally adapted (Pertoldi et al. 2007). If adaptation is possible, populations have reduced risk of extinction in the face of environmental stochasticity (Hellman and Pineda-Krch 2007). In a stable environment a population will remain well-adapted if genetic variation is sufficient. Genetic variation and fitness have been shown to increase directly with population size in many rare and widespread plant species (Gitzendanner and Soltis 2000; Leimu et al. 2006), suggesting that larger populations are more stable not only because of the greater number of individuals, but also because of the genetic variation maintained.

In small, isolated populations, founder effects and genetic drift can result in the random loss of genetic variation. Furthermore, these populations are also subject to loss of genetic variation (heterozygosity [H]) owing to increased opportunity for mating among closely related individuals (inbreeding). Fitness is negatively correlated with the degree of inbreeding, termed inbreeding depression, where increased inbreeding results in decreased overall fitness of populations. In turn, this results in a decreased potential to adapt to environmental change (Rogers and Montalvo 2004; Frankham 2005; Willi and Fischer 2005). Inbreeding is population-specific and related to a number of factors, including the size of the founding population, the type of plant mating system (i.e., outcrossing, mixed mating, and selfing), the type of pollination and dispersal systems, and environmental conditions (Guerrant 1992; Hamrick and Godt 1996).

In some species, inbreeding depression can reduce the fitness of individuals, reduce their breeding capability and decrease the potential for future adaptability to environmental change and random events (Guerrant 1996; Vallee et al. 2004; McKay et al. 2005). However, not all species with limited genetic diversity will require mitigation (McKay et al. 2005). For species suffering from inbreeding depression, interbreeding different populations can increase the genetic diversity of the populations, leading to increased fitness, particularly in highly variable but predictable environments (Birkinshaw 1991; Rogers and Montalvo 2004; Willi and Fischer 2005).

Along with population size, isolation may also influence the degree of genetic variation exhibited among populations. Many species at risk have restricted geographic ranges, occurring in small, isolated populations that exhibit lower levels of genetic diversity than that found in more widespread species (McKay et al. 2005). Low levels of genetic variation may present a significant extinction risk in these species (Frankham 2005). Furthermore, geographically peripheral populations at the edge of a species' range and/or disjunct populations, of otherwise widespread species, face similar threats. Small population size and spatial isolation make these populations more prone to the stochastic loss of genetic variation (genetic drift), resulting in reduced evolutionary potential (Hamilton and Eckert 2007).

The genetic goals for translocations will be to ensure the capability for self-maintenance following transplantation, while retaining pre-transplant genetic diversity, composition, and function in translocated populations (Fahselt 2007). Documented successes and failures of translocations focus both on the ability of populations to maintain genetic variation following translocation and whether introduced genetic variation impedes a species' ability to adapt to local conditions due to outbreeding depression (Binks et al. 2007; Guerrant and Kaye 2007). Both short-term goals, such as successful reproduction, and the more long-term goal of maintaining genetic variation must be considered in translocations (Krauss et al. 2002). An example in which short-term success did not translate into long-term success is the case of Grevillea scapigera (Corrigin grevillea) one of Australia's most "at risk" plant species (Krauss et al. 2002). Although there has been successful establishment and reproduction of the species after translocation, including the generation of thousands of seeds through a variety of propagation techniques, substantial declines in genetic variation between founding plants and offspring were observed (Krauss et al. 2002). The decrease in genetic variation was attributed to differential reproductive success between founders, where only a few individuals contributed to ensuing generations, resulting in an overall reduced effective population size that is highly susceptible to the detrimental effects of inbreeding (Krauss et al. 2002). Where translocation is advocated, Krauss et al. (2002) emphasize the importance of restoring or simulating historical processes to achieve and maintain genetic variance within and among native populations.

During the process of recovery planning for species at risk, two distinct genetic issues require evaluation at different points in time; however, it may not be practical for all projects to assess these issues due to limited budgets.

1. How do we assess whether a population is in demographic decline as a result of the negative effects of reduced genetic variation and increased risk of inbreeding or as a result of non-genetic factors such as increased susceptibility to predation, desiccation, competition with weedy species, or other ecological/environmental factors?

Genetic variation in natural populations may be assessed in several ways: heterozygosity; allelic richness; or proportion of polymorphic loci (Rogers and Montalvo 2004). The most common means of measuring genetic variation is by evaluating the proportion of individuals within a population that are heterozygous (heterozygosity, H) at a genetic locus. Two measures of heterozygosity are estimated: the observed heterozygosity (Ho), which reflects the proportion of heterozygotes in the population, and the expected heterozygosity (He), which reflects the proportion of heterozygotes expected if mating is random (Allendorf and Luikart 2007). Significant departures from expected heterozygosity suggest possible inbreeding and loss of heterozygosity – genetic factors that result in demographic decline.

In addition, rare alleles may be lost in small populations as a result of genetic drift or in populations that have passed through a genetic bottleneck. A range-wide survey of genetic and allelic diversity can indicate which populations may have lost rare alleles, those that are genetically depauperate, and those that are genetically differentiated relative to other populations within the species' range. Although these methods do not indicate the particular cause(s) of reduced genetic variation, they do provide a species-specific measure of the genetic health of populations of concern (Reed and Frankham 2003) and can indicate whether translocation and the various strategies therein should be considered.

2. Once we determine that plant material should be translocated, how do we decide which populations are the most genetically suitable donor sources for the recipient site or population?

Three major strategies are considered in restoration: (i) introduction is the deliberate release of a species with the goal of establishing a new population; (ii) in reintroduction the goal is to re-establish extirpated species; and (iii) in augmentation the goal is to add to existing natural populations (Menges 2008). Moritz (1999) summarizes the genetic issues involved in each restoration strategy that will be important to evaluate in translocation situations. Although research is accumulating rapidly in the field of restoration genetics, currently there is no simple method or set protocol for determining the most genetically suitable donor source for translocation. We simply do not know how adaptive genetic variation is partitioned and distributed within species and across environments. However, the goal of translocations should be to minimize movement of individuals between different climatic, edaphic, or biotic regimes (McKay et al. 2005). Furthermore, in the case of augmentation in which non-native individuals breed with native individuals, dilution of the locally adapted gene pool may result in overall decreased fitness of subsequent generations (outbreeding depression).

Augmenting an extant population may pose risks to the recipient population. Augmentation with propagules from a source different from the recipient population may lead to genetic swamping, which may cause outbreeding depression (Vallee et al. 2004; McKay et al. 2005). Augmentation may disrupt the co-adapted gene complexes of the extant population leading to loss of fitness over time. This is especially true if the plants added have been propagated for more than one generation *ex situ* or have been collected from a single source (Austin 2004; Vallee et al. 2004; McKay et al. 2005).

Augmentation may also contaminate the recipient site by introducing diseases, altering soil structure, and damaging existing roots (Hawaii Rare Plant Restoration Group 1999).

Augmentation should be conducted only under a discreet set of circumstances and should be carefully evaluated first (refer to Table 2). The stock used for augmentation should be disease-free and should be collected locally if at all possible from donor sites with similar habitat conditions (IUCN 1987; McKay et al. 2005). Refer to **Section 4.2** for more information on collecting source material. When the population is not suffering from inbreeding depression, the most conservative approach is to use material from the recipient population itself (Falk et al. 1996).

Candidates for translocation might be considered genetically unsuitable if:

- They are maladapted to the environmental conditions at the recipient site, and are unable to survive or reproduce in the new environment. If possible, local collections should be made to preserve the genetic integrity of the restored population. The goal is to match environmental and climatic conditions at both restoration and collection sites (McKay et al. 2005).
- Outbreeding depression may occur where **hybrids** between recipient and donor populations have lower fitness than either parental species.
- Introduced individuals may be too genetically differentiated from local populations to allow for successful sexual reproduction and gene flow. **Genetic swamping** of non-native individuals within the native population may result in domination of non-native material, and greater possibility of losing rare or population-specific locally adapted alleles or genotypes.
- Differential reproductive success could result in genetic erosion where the local species dies off without gaining breeding opportunities or loses breeding opportunities to the introduced individuals.
- Relationships among founding individuals (degree of inbreeding) may result in an overall low effective population size even if census size is great.
- Plant mating system (outcrossing, mixed, or selfing) may identify candidates that are unsuitable for translocation. Small populations of **obligate outcrossers** are at increased risk for inbreeding depression (Menges 2008). In some cases not all populations will exhibit the same mating type, which will influence the choice of source population.

A number of factors render translocations complex and thus they require extensive review before they are attempted. Monitoring in the short-term for reproductive success of translocated populations, as well as studying the more long-term genetic issues that may limit or prevent success is key to these conservation efforts. Consideration of all genetic issues, including inbreeding depression, outbreeding depression, genetic mixing, and founder effects through monitoring of genetic variation may estimate the species' evolutionary potential and consequently its ability to persist in a changing environment.

3.5.1 Methods for assessing genetic divergence, genetic diversity, and the risk of inbreeding and outbreeding depression

- **Common garden studies** are a useful tool for determining whether the observed phenotypic variation between populations is due to environmental differences between sites or to heritable genetic differences. Plant materials collected from different populations are cultivated under identical conditions in field plantings, greenhouse trials, or growth chambers to determine whether there are observable differences in morphology, phenology, reproductive output, or other measurable characters. Although the presence of observable differences in a common garden does not indicate whether these are the result of random genetic drift or adaptation to the environment (Hufford and Mazer 2003; McKay et al. 2005), it does suggest genetic divergence between populations that may be important.
- **Controlled crossing experiments** can be conducted to compare the relative success of progeny from selfed and outcrossed matings between individuals from different populations. Differences in seed-set among matings may indicate that there are barriers to sexual reproduction in some pair-wise crosses. Variation in success among the progeny from these matings may suggest either a risk of inbreeding or outbreeding depression or even heterosis, a benefit of increased vigour in hybrid progeny (Hufford and Mazer 2003; Rogers and Montalvo 2004). An example of an excellent experimental design can be found in Willi and Fischer (2005).
- **Molecular marker studies** can be used to assess whether the cause of demographic decline may have a genetic component, expressed as a reduction in observed heterozygosity or the loss of rare alleles. Molecular markers can also be used to detect population genetic differentiation, evolutionary relationships among populations and can be used to identify closest genetic relatives. Although the genetic variation detected by neutral markers does not necessarily reflect adaptation to ecological conditions (Guerrant 1992; Bekessy et al. 2003; Hufford and Mazer 2003), they are a good proxy when used in conjunction with other types of studies.
- **Chromosome studies** of root tip or pollen cells can be used to confirm whether donor and recipient populations have the same ploidy level and/or the same number of chromosomes, a condition that is generally necessary for successful sexual reproduction.
- Other experimental techniques, such as **reciprocal transplants**, are not recommended for species at risk. The goal of the reciprocal transplant is to identify individuals locally adapted to particular environments within the species' range.

3.5.2 Patterns of genetic diversity in plant populations in B.C.

Many rare species within British Columbia often represent otherwise common species, that are, in B.C., at their northern geographic range limit, are geographically peripheral, or are geographically disjunct from populations within other political jurisdictions (Bunnell et al. 2004). This is particularly true of species associated with the Garry oak ecosystems in south-western B.C. (e.g., *Lotus formosissimus, Sanicula bipinnatifida*) and with the south Okanagan grassland ecosystems in south-central B.C. (e.g., *Hedeoma hispida*, *Gaura coccinea*). Based on the abundant centre hypothesis, populations at the periphery of a geographic range will be smaller and more susceptible to stochastic loss of genetic variation. In many widespread plant and animal species in western North America, there is evidence that genetic diversity is lower in populations in the north than in the south (Soltis et al. 1997; Brunsfeld et al. 2001). There is mounting evidence that this pattern also holds true in populations of both common and rare species in B.C. (Allen et al. 1996; Ritland et al. 2005; Wheeler 2007). Rare species within British Columbia because of their isolation often at the northern geographic range may be negatively influenced by lower genetic diversity due to lack of gene flow from conspecific populations elsewhere in the range. Consequently the negative influences of both small population size and low genetic diversity (inbreeding and genetic drift) will have a significant impact in these populations. Based on allozyme variation, northern populations of *Erythronium montanum* in BC were less genetically diverse than southern populations in WA and OR (Allen et al. 1996). Not all small populations exhibit low levels of genetic variation. For example, in *Castilleja levisecta,* an insular endemic of the islands of BC and WA, small populations were not genetically depauperate in relation to more widespread congeners based on allozymes (Godt et al. 2005).

However, the reduced gene flow and differential selective pressures experienced by these populations may result in rapid evolutionary divergence reflected by extensive genetic differentiation. Although populations at the geographic range margin in British Columbia may exhibit lower levels of genetic diversity, these populations may be genetically divergent from southern conspecific populations due to reproductive isolation (lack of gene flow) and differential selective pressures experienced in peripheral habitats (Willi et al. 2006). Consequently it is these populations at the limit of species' ranges that may facilitate geographic range shifts during periods of rapid climate change (Hamilton and Eckert 2007). Populations at the limit of species' geographic ranges, including much of British Columbia's species at risk, offer an excellent opportunity for testing for adaptive divergence in key phenological, ecophysiological, and other adaptive traits.

The conservation genetics community recognizes the need for large-scale studies to investigate the correlation between neutral genetic markers and adaptive quantitative variation (Kohn et al. 2006). A keystone species of the endangered Garry Oak ecosystem, Garry Oak (*Quercus garryana*) has been assessed for neutral genetic variation across its range in British Columbia and beyond using molecular markers (Ritland et al. 2005). Although low levels of genetic variation were observed, populations were grouped into distinct groups based on neutral genetic variation – separating Washington/Oregon populations from Vancouver Island/Gulf Islands populations. These differences would be an important consideration if translocation were proposed for this species ("local is best"). An additional study is currently underway to assess quantitative genetic variation in adaptive traits in a common garden experiment from individuals across the entire range of Garry oak (Huebert and Aitken, unpublished data). The two studies combined will address questions regarding the consequences of neutral genetic variation in peripheral populations in British Columbia, along with quantification of adaptive divergence of populations across the range. The combination of these approaches may inform the design of translocations addressing two of the major drawbacks: inbreeding and outbreeding depression (Grauver et al. 2005). Using molecular markers it is possible to assess the level of genetic variation, providing insight into the degree of inbreeding and genetic differentiation among populations. Quantifying the mechanism of genetic differentiation among populations in a common garden experiment may provide evidence for local adaptation among individuals and whether candidate donor populations will be locally adapted to the same conditions as the recipient population or cause outbreeding depression if translocated to the site.

Genetic analysis provides an essential tool in conservation biology and its increasing use provides greater insight into the evolutionary potential of species. Our ability to predict the influence of genetic variation in natural populations and its consequences will allow us to make more informed decisions on strategies for conserving species at risk.

For a more thorough discussion of genetics and restoration refer to *Genetically Appropriate Choices for Plant Materials to Maintain Biological Diversity* (Rogers and Montalvo 2004).

3.6 Setting Goals and Objectives

Without meaningful goals and objectives, it is impossible to accurately determine the success of translocation projects and develop appropriate monitoring techniques. Pavlik (1996) stated that "our current inability to construct a robust definition of success is due largely to our past unwillingness to document failure." In a review of translocation projects in the United States, Fiedler (1991) found only 15 of 46 projects had explicit evaluation criteria, and the success of projects without criteria could not be measured.

Setting clear biological goals is especially difficult for translocation projects because of the complex ecological variables involved and the reliance on ongoing management to maintain populations (Pavlik 1996). To learn from translocation "failures," it is essential to have clear, relevant goals and objectives that can lead to consistent design of translocation projects and that can be used to develop measurable evaluation criteria. Following a plan with clear objectives is vital to success and objectives should be stated from the start of the project (Kaye 2008).

It is useful to distinguish between biological success (i.e., successful establishment of a population and of the individuals within that population) and the success of a project. Even if a translocated population does not establish successfully, the project may be considered a success if it contributes to knowledge of the species, develops new management techniques, informs conservation policy, or increases public awareness (Pavlik 1996).

3.6.1 Biological goals

Biological goals should be linked to the goals outlined in the recovery strategy and action plan, if these documents have been written for the species. The short-term biological goals of any translocation project should be linked to the establishment of a new population that can reproduce, disperse, and has a low risk of extirpation. The long-term biological goals should be to create a population that has sufficient genetic diversity to adapt to changing environmental conditions through evolution or migration (Pavlik 1996). The goals should take into account the abundance, extent, resilience, and persistence of the population (Pavlik 1996).

The biological objectives of a translocation project should be considered "stepping stones" in the development of the goals. The objectives should take into account the demographic, genetic, and ecological characteristics of the species. The objectives should also incorporate a rigorous experimental design used to test translocation techniques and/or management options for the species at risk (Pavlik 1996).

Monitoring and evaluation should be designed to directly evaluate whether the objectives and therefore the goals are being met. This should include predefined measures of success (Austin 2004). Refer to **Section 8** for further monitoring and evaluation information.

3.6.2 Project goals

Determining the success of a translocation project will be more broadly defined than simply evaluating the biological goals (Monks and Coates 2002). Objectives for measuring the success of a project may include increasing knowledge about a species at risk, developing effective management techniques for the species, developing informed debate on policy, and increasing public education about species at risk (Pavlik 1996).

Project success may also be determined by how well the translocation was conducted and whether the project contributed to development of the science of translocation. "With an experimental design and careful monitoring, a reintroduction project can be successful, even if its new populations fail, by contributing to our knowledge of rare and endangered plants or by developing new ecosystem-management techniques" (Pavlik 1996).

Evaluation may include an assessment of the documentation and dissemination of both positive and negative results of the translocation, whether all relevant stakeholders were involved in the process, and whether decisions were made based on sound scientific background (Austin and Prior 2004). In addition, assessment should include whether the monitoring and experimental design were effective in answering the questions posed by the project.

Photo: Brenda Costanzo

4. DETERMINING THE TRANSLOCATION METHODOLOGY AND TECHNIQUE

Determining the most appropriate translocation techniques will be species-specific and will depend on the parameters of the site selected. After the pre-translocation assessment, the following factors should be determined before any translocation project:

Determine experimental design **Section 4.1.**

- ☐ Determine the sampling protocol and the number of plants required **Section 4.2.**
- ☐ Determine the most appropriate propagation method and techniques **Section 4.3.**
- ☐ Determine logistics of translocation, including timing of translocation **Section 6.**
- ☐ Develop a communications plan and roles and determine the responsibilities of all stakeholders **Section 5.2.**
- ☐ Determine methodology for post-translocation management, monitoring, and evaluation (Vallee et al. 2004) **Section 8.**
- ☐ Ensure appropriate finances are in place to cover all phases of the project, including post-translocation management, monitoring, and evaluation.
- ☐ Prepare a translocation proposal to be approved by the appropriate recovery team and/or experts **Section 5.1.**

4.1 Experimental Design for Translocation Projects

At this time, it is recommended that all translocation projects in British Columbia should be considered experimental. Using a solid experimental design will allow even translocation “failures” to increase our understanding of the species and inform any future attempts. To develop an experimental design, different treatments are applied to plants: some plants are given a treatment and others are treated as controls. A biometrician or statistician can help with developing a sound experimental design (Vallee et al. 2004). Experimental translocations can help determine the factors causing population decline and test threat mitigation techniques to overcome those factors without harming extant populations (Hawaii Rare Plant Restoration Group 1999).

In many cases, a small-scale pilot introduction may be appropriate to resolve procedural, logistic, or other concerns. Small-scale translocations are less expensive than full-scale projects and make valuable use of limited propagation material (Vallee et al. 2004).

Experimentally controlled trials should be designed, with sufficient replicates, so that the answers to specific questions can be determined through ongoing monitoring of the project (Vallee et al. 2004). In short, the translocation design should include what we think we know about the species and focus on determining what we need to find out. Experimentation should focus on key research questions to minimize project costs and limit collection of plant material from donor populations. The experimental monitoring should be designed to provide evidence-based answers to the specific questions asked and evaluate the approach taken (Austin 2004).

Key research questions for translocation experiments may include:

- ☐ Should donor material be collected from single or mixed sources (Guerrant 1996)?
- ☐ What are the most appropriate planting techniques?
  - different propagules (e.g., planting adults vs. seedlings) (Hawaii Rare Plant Restoration Group 1999; Alley and Affolter 2004)?
  - different plant material (bare-root vs. in potted soil) (Hawaii Rare Plant Restoration Group 1999; Alley and Affolter 2004)?
  - different plant spacing (clustered vs. individual seedlings) (Hawaii Rare Plant Restoration Group 1999; Alley and Affolter 2004)?
- ☐ Should plantings be done over several years based on the biology/ecology of the species and on climatic variation (Vallee et al. 2004)?
- ☐ What are the most effective post-translocation management techniques for increasing plant survival (e.g., mulching, watering, and weeding) (Hawaii Rare Plant Restoration Group 1999)?
- ☐ How does the genetic composition of the species reflect its ecological adaptation (McKay et al. 2005)?

Guidelines for Ethical Field Research on Rare Plant Species (2005).
New England Wildflower Society:
http://www.newfs.org/protect/rare-plants-and-conservation/policies-issues

4.2 Collecting Source Material and Determining Founder Size

Collecting plant material from a donor population requires developing a sampling protocol and determining what the optimal population size of the translocated population should be. Both of these decisions should be based on a solid understanding of species-specific demography and population genetics (Guerrant 1992). "Although there are intuitive guides as to how much seed collection some plant species can withstand relative to others, we do not yet have a good quantitative handle on the actual proportions that any species can tolerate" (Guerrant 1992). A thorough discussion of the many factors that should be weighed in collecting source material and determining sample size is outside the scope of these guidelines. The Center for Plant Conservation (CPC; 1991) and Guerrant et al. (2004) contain more comprehensive guidelines.

4.2.1 Collecting source material

In general, a translocated population should have enough plants from a wide enough genetic background to prevent inbreeding and should capture sufficient genetic variability (Austin 2004; Vallee et al. 2004). In deciding the amount of plant material to collect, the benefits of intensive sampling that will capture a wide range of genetic variability should be weighed against the potential negative effects on existing populations and the expense involved in sampling and propagating the plant material (Guerrant 1992). As sample size increases, diminishing amounts of genetic variation will be captured, depending on the population size and the amount of genetic exchange of the species (Guerrant 1992). In addition, sampling must weigh the benefits of collecting a wide range of genetic diversity against the probability of local adaptation (McKay et al. 2005).

The sampling protocol may involve sampling from one or more donor populations, depending on the genetic variability and the risks of outbreeding depression (CPC 1991; Guerrant 1992, 1996). The number of individuals sampled per donor population and the number of propagules collected from each individual will also vary. In some instances, depending on the biology and ecology of the species at risk, sampling over several years may be recommended (Guerrant 1996; Guerrant et al. 2004). The sampling protocol will also be determined by the final number of propagules desired, the type of propagation and how easily the species is propagated, and the risks of *ex situ* propagation (Guerrant 1992; McKay et al. 2005).

The collection of seed from annual plants without a seed bank can easily damage a donor population (Guerrant 1992) and is therefore recommended only after careful species-specific evaluation. For some species, it may be possible to harvest a small percentage of annual seed without damage to the donor population and increase the numbers *ex situ.* If inbreeding/founder effect is a concern, a small percentage of seed could be collected from multiple populations.

To determine the sampling protocol, the following factors should be taken into account:

- ☐ Genetic variability and gene flow among and within populations (Guerrant 1996)
- ☐ Risks of outbreeding depression from mixing genes from different populations (Guerrant 1996)

- ☐ Habitat variability within a population and between donor and recipient sites (Guerrant 1992; Hufford and Mazer 2003; McKay et al. 2005)
- ☐ History of disturbance (Guerrant 1992)
- ☐ Type of mating system (McKay et al. 2005)
- ☐ Ploidy level of the species at risk (McKay et al. 2005)
- ☐ Annual or perennial and longevity of the plant (Guerrant 1992)
- ☐ Successional stage of the species (Guerrant 1992)
- ☐ Type of pollination and dispersal (Guerrant 1992)
- ☐ Woody or herbaceous plant (Guerrant 1992)

4.2.2 Determining population founder size

A comprehensive discussion of how to determine the sample size for a translocation project is outside the scope of these guidelines. The optimal founder population size will be related to the longevity of the plant, breeding system, growth form, fecundity, ability to reproduce vegetatively, survivorship, seed longevity, environmental variation, and successional status of the species at risk (Birkinshaw 1991; Pavlik 1996). Populations started from a limited number of individuals are more likely to suffer from founder effects (Hufford and Mazer 2003). The optimal population size should also take into account the amount of donor material available, the resources available for propagation (staff, funding, equipment), the carrying capacity of the recipient site, and number of recipient sites (Birkinshaw 1991; Vallee et al. 2004). If collected amounts are small, increasing the number of plants by *ex situ* propagation may be required. Section 4.4 discusses some of the advantages and disadvantages of *ex situ* propagation.

Each collection should be carefully labeled to identify the source population and, in circumstances where there will be clonal propagation (i.e., cuttings, root divisions, or tissue culture), the source plant. This information should be retained with the plant through the propagation and translocation phases so the provenance of each plant can be tracked at all stages of the project (Vallee et al. 2004).

4.3 Assessing Propagation Methodology and Techniques

Translocation projects can be designed with or without *ex situ* propagation. Plant material can be propagated *ex situ* from seed, cuttings, tissue culture, grafting, or clump separation (Guerrant 1996; Vallee et al. 2004). Vegetative propagation (i.e., cuttings, tissue culture, grafts, or clump separation), which produces genetically identical clones, should be evaluated for the genetic impact to the population. For a sample to represent a population genetically, it should include at least one copy of 95% of all alleles in the population that occur at frequencies greater than 5% (Guerrant et al. 2004).

Translocations without *ex situ* propagation include direct seeding, transfer of soil containing seed, and salvage of mature plants (Guerrant 1996; Vallee et al. 2004). Salvage of mature plants and transfer of soil from extant populations are not endorsed by these guidelines. Transplantation of whole plants, root cuttings or divisions of *in situ* plants is cautioned against and should only be considered for select species where propagation from seed is not a viable option.

> Although propagation options will need to be determined based on species-specific biology and ecology, the following propagation methods are ranked from more to less desirable, based on negative impact to the donor population:
>
> 1) seed collection (unless seed set is rare or poor and limits reproduction)
> 2) shoot cuttings
> 3) root or rhizome cuttings
> 4) on-site division of plants (discouraged)
> 5) transplantation (unacceptable)

All plant material should be collected with sanitized tools (e.g., clippers for cutting) to minimize the potential for spread of diseases both to the donor population and to the recipient site (Hawaii Rare Plant Restoration Group 1999).

The decision of whether to propagate plants *ex situ* will depend on the following factors:

- ☐ How much donor material is available and is it necessary to propagate the species *ex situ* to have sufficient propagules to establish a translocated population?
- ☐ Will there be sufficient pretranslocation site preparation to minimize population decline of newly translocated propagules?
- ☐ Will there be sufficient short-term management of the population to care for plants that have been propagated *ex situ* (e.g., watering, mulching, fertilizer application) (Vallee et al. 2004)?
- ☐ What are the demographic bottlenecks of the species? What life stage will be most effective at overcoming the bottlenecks (i.e., seed, juvenile, mature plant)?
- ☐ How large should the translocated population be in order to become self-sustaining?
- ☐ What are the potential threats to the translocated population and what life stage will be most effective at withstanding the threats?

- ☐ What is known about the germination and vegetative propagation requirements for the species? What are the propagation options (Vallee et al. 2004)?
- ☐ What is known about growth requirements and the inter-relationships with other taxa (mycorrhizae, rhizobium for N_2 fixation, hosts for parasites and hemiparasites)? How will this affect propagation options (Vallee et al. 2004)?
- ☐ What are the potential risks associated with *ex situ* collection and propagation?
- ☐ Is there sufficient funding allocated/available for each and any of these stages?

4.4 *Ex situ* Collections and Propagation

Growing or storing plants offsite or *ex situ* has a number of applications for translocations. Seed can be stored *ex situ*, plants can be propagated and/or increased *ex situ* for replanting or plants can be permanently stored *ex situ* in gardens or botanical collections. For more information on *ex situ* collections and propagation refer to "*Ex Situ* Plant Conservation: Supporting Species Survival in the Wild" (Guerrant et al. 2004).

Under no circumstances should *ex situ* collections be considered an alternative to *in situ* populations. Collections of plant material for *ex situ* growth and storage should not harm the donor population (Guerrant 1992; Austin 2004; Guerrant et al. 2004).

These guidelines recommend that *ex situ* propagation and storage of plant species at risk should be developed with the final goal of translocating the plants collected back to the wild and with the input of the relevant recovery team. *Ex situ* collections should be maintained indefinitely only as a last resort when plants have become extirpated from *in situ* sites or for species that are highly endemic and experience large fluctuations in population size (Austin 2004). For most species at risk, too little is known about long-term viability rates and required storage conditions to justify storing seeds for extended time periods without translocation as a final goal.

Growing plants *ex situ* is a useful tool for translocations. Seedlings or plants may have higher survival rates than planted seeds. For example, plants rather than seeds may be easier to plant at aquatic sites (Birkinshaw 1991) and may be more able to withstand competition from invasive plants. In addition, *ex situ* growing is an important tool for increasing the numbers of plants while minimizing the collection impact on donor populations.

Although there are benefits to growing plants *ex situ*, there are significant risks that should be evaluated.

Refer to the IUCN technical guidelines for management of *ex situ* populations: http://intranet.iucn.org/webfiles/doc/SSC/SSCwebsite/Policy_statements/IUCN_Technical_Guidelines_on_the_Management_of_Ex_situ_populations_for_Conservation.pdf

4.4.1 Risks of growing species at risk *ex situ*

- ☐ Plants grown under horticultural conditions may harbour weeds, diseases, and/or pathogens, which may be transferred to translocated populations (refer to Vallee et al. 2004 for phytosanitary guidelines for propagation).
- ☐ There may be inadvertent hybridization with related species grown *ex situ* (Levin et al. 1996; Klinkenberg 2005).
- ☐ Plants may suffer from outbreeding depression if grown with other stocks of the same or related species (Birkinshaw 1991).
- ☐ Greenhouse conditions, overwatering, and overfertilization can lead to the growth of lush plants that are more susceptible to herbivores, drought, and transplant shock (Birkinshaw 1991).
- ☐ Plants grown in greenhouse conditions may require hardening off and other measures to prepare them for planting in the wild (Vallee et al. 2004).
- ☐ Selection pressures of agronomic growing conditions associated with *ex situ* propagation may alter fitness and survivability of plants at risk in the wild, such as potential chemical alteration of plants leading to increased herbivory and potential loss of fitness (Klinkenberg 2005; McKay et al. 2005).

Garden clubs and botanical gardens may be useful resources in developing *ex situ* methodologies and for promoting issues of conservation genetics. The Canadian Botanical Association and the Kew Gardens Millennium Project are currently researching these issues. “The world’s botanic gardens have a role to play in helping to secure important plant habitats and ecosystems” (Raven 2004).

Ex situ collections should be genetically representative (**Section 3.5.**) and should be used to re-establish self-sustaining populations that are genetically comparable to donor populations (Guerrant 1992). Collections for *ex situ* growing should be made in the context of species recovery and there should be clear population goals for the final translocation population prior to collection (Austin 2004) (**Section 4.2**). To reduce the risk of “unconscious” selection, the planted populations should be harvested as often as possible and the *ex situ* growing conditions should be matched as closely as possible to the donor population (McKay et al. 2005). Any *ex situ* growing should include disease and pest monitoring to prevent the spread of noxious weeds and pathogens to wild populations (Austin 2004).

All *ex situ* propagation should be carefully documented. Documentation should include the origin of material collected, including the type of material collected (seed, cutting, tissue culture), the location of the collection, and the date collected. Documentation should also include all details of the *ex situ* growing conditions such as potting media, temperature of propagation area, watering and fertilizer regimes, treatment of seeds, and germination rates. This information should be maintained for each plant through translocation and monitoring stages (Vallee et al. 2004). The information should be published and shared with other conservation groups (Austin 2004).

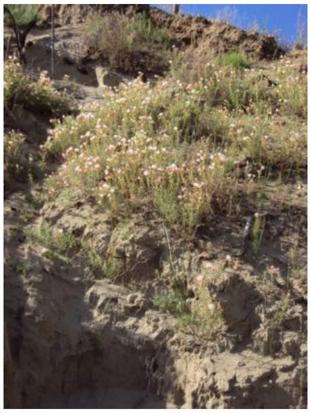

Photo: Brenda Costanzo

5. DEVELOPING A TRANSLOCATION PROPOSAL

Before any translocation, a detailed proposal should be drafted. This will involve researching the necessary background information to assess the translocation, consulting with relevant stakeholders and recovery teams (if existing), and ensuring that the proposal meets the necessary legal requirements. The relevant recovery team or experts should review the translocation proposal prior to any translocation work, and approve a detailed translocation proposal prior to any site preparation or collection of plants at risk.

5.1 Preparing a Translocation Proposal

Prior to any translocation project, a detailed translocation proposal should be developed that addresses horticulture, experimental design, ecology, genetics and management of the proposed population (Vallee et al. 2004). “As reintroductions become more important in endangered species conservation and management, the need for more systematic holistic reintroduction efforts grows. Such efforts should address the socio-economic, political, and organizational aspects of species reintroductions more comprehensively, rather than focusing strictly on biology as is currently the case” (Reading et al. 2002).

The relevant recovery team, or if a recovery team is not in place, the appropriate rare plant species experts, should review the proposal and assess whether the translocation is appropriate, feasible, and justified based on the species’ recovery needs. Organizations providing funding for translocation projects may also need to approve proposals.

A translocation proposal should include but not be limited to the following:

- ☐ Justification of translocation including:
    - Why habitat restoration or management of existing populations is insufficient for recovery of the species at risk (IUCN 1995). **Section 2.3.**
    - Demonstrate that the proposed translocation will benefit the species at risk and the science of translocations (Austin 2004).
    - Process for ensuring the species at risk is absent from recipient site for reintroductions and introductions (IUCN 1995). **Section 3.3.**
    - Documentation to ensure translocation is within the species current or historical range (IUCN 1995). **Section 3.3.**
- ☐ Short- and long-term project goals and objectives with a clear process and criteria for evaluating the success of the project (Falk et al. 1996). **Section 3.6.**

- ☐ Best available knowledge of the original causes of decline or disappearance of the species at risk and details of any former translocation attempts of the same or related species (IUCN 1995). **Section 3.1.**
- ☐ Documentation of management and restoration techniques to control threats (i.e., restoring ecological processes, invasive species management), including a management schedule and evaluation to determine whether management is effective. **Section 3.1.**
- ☐ Ecological (including genetic and demographic) knowledge gaps (Falk et al. 1996) and how these are considered in the translocation process. **Section 3.2.**
- ☐ Detailed translocation process including experimental design to test translocation and management techniques. At this time, all translocations should be designated as experimental. **Section 4.1.**
- ☐ Details of the recipient site selection process (Falk et al. 1996). **Section 3.3.**
- ☐ Details of the donor source site-selection process. **Section 3.4.**
- ☐ Location of source material, collection details (e.g., collection date, number of plants collected), processing of material, propagation methodology, nursery performance, demographic composition of founding population, and appropriate collection approval (Falk et al. 1996; GOERT 2004). Unless material from several sources is pooled, material should be separated by year and source (GOERT 2004). **Section 3.4 and Section 4.**
- ☐ Communications plan for engaging implicated landowners and stakeholders from the beginning of the project to ensure long-term commitment from all parties. **Section 5.2.**
- ☐ Details of phytosanitary measures taken to prevent the introduction of diseases or pathogens to the donor site (Vallee et al. 2004). **Section 4.**
- ☐ Documentation of when and how the new population was established and provisions for information sharing. All translocations should be reported to the B.C. Conservation Data Centre for their records. **Section 7.**
- ☐ Monitoring techniques and schedule, including assessment of survival, growth, flowering and seed production, recruitment, and seedling growth. Monitoring should compare the new population to a reference population and should be long-term, cost effective, useable by many people, and able to detect real changes (Sutter 1996). Monitoring should also include a pre-translocation baseline of the recipient site in order to accurately evaluate changes in species composition. It may also be appropriate to monitor the donor site to determine the impact of collection activities associated with the translocation. **Section 8.**
- ☐ Documentation of who is conducting the plant collection, *ex situ* propagation (if necessary), translocation, ongoing monitoring, and record keeping. This should include the roles and responsibilities of various

stakeholders to ensure proper co-ordination of each project (Joint Nature Conservation Committee 2001; Vallee et al. 2004).

- ☐ Identify funding sources for all phases, including comprehensive monitoring, ongoing management, and evaluation. **Section 8.**
- ☐ Guidelines for decision making for revising, rescheduling, or discontinuing the translocation project (IUCN 1995; Vallee et al. 2004). **Section 8.3.**

5.2 Communicating with Landowners, Land Managers, and other Stakeholders

Translocation projects require more than sound biological and ecological techniques; the projects require strong partnerships and social support that can only be ensured through solid communications between involved parties (Reading et al. 2002). The presence of species at risk, in particular, those listed on Schedule 1 of SARA, may present issues for landowners that intensifies the need for well developed communications planning. Local community groups can provide stability and continuity for a project, local knowledge, ideas of how to foster community involvement, and wider resources than those available through official funding sources. Community groups should work closely with the project coordinator and have a firm understanding of the background scientific knowledge used to develop the project (Vallee et al. 2004).

Communications planning can help make translocation projects more efficient and more effective, and can garner the long-term commitment and support required for a successful project.

Communication planning should include the following:

- ☐ Appoint a project coordinator or team leader to be responsible for the project and co-ordinate the translocation.
- ☐ Obtain necessary approval from recovery team and/or experts, funding organizations, and appropriate levels of government. **Section 5.3.**
- ☐ Obtain necessary approval from landowners and land managers at both the donor and recipient sites.
- ☐ Communicate details of the translocation plan with other conservation organizations (including volunteer organizations) that are likely to be interested or affected by the translocation (IUCN 1995; Vallee et al. 2004).
- ☐ Coordinate the translocation team required for plant collection, *ex situ* propagation (if necessary), translocation, ongoing monitoring, and record keeping. This should include details of the roles and responsibilities of all stakeholders.

- ☐ Develop conservation education to foster long-term support of the project. This may include training of long-term monitors, media, and community public relations, and involving local groups (IUCN 1995; Vallee et al. 2004).
- ☐ Ensure there is long-term financial support and commitment to the project or define the steps needed to secure the required support.
- ☐ Develop efficient management of decision making to ensure that decisions are made in an appropriate time scale, based on scientific rather than political foundations have appropriate follow through and peer review, and that communications involve all affected parties (Austin 2004).
- ☐ Address any potential public conflict and foster local interest and support in the project (Austin 2004). Involving implicated landowners and stakeholders from the beginning of the project may help minimize conflicts and foster long-term commitment to the project.
- ☐ Expect translocation planning and implementation to take 2 to 5 years, depending on amount of background information available, site preparation, potential conflicts between stakeholders, etc. (Birkinshaw 1991). Ongoing monitoring and evaluation will have a much longer time frame that depends on the lifespan of the species at risk and the goals and objectives of the project. **Section 8**.

5.3 Legal Requirements

5.3.1 Federal policies (SARA)

Under the federal Species at Risk Act (SARA), a permit is required to remove any plant material or to disturb the habitat of species listed as extirpated, endangered, or threatened on Schedule 1 that occurs on federal lands. Schedule 1 of SARA is the official list of extirpated, endangered, threatened, or special concern species in Canada (Government of Canada 2005).

Permits are also required for the introduction/reintroduction of species at risk onto federal lands. SARA also includes a safety net clause to provide protection to species at risk and their habitat on non-federal lands.
Permits are available through Parks Canada Agency for activities in national parks, national historical sites owned by Parks Canada, or National Marine Conservation Areas. Permits affecting Schedule 1 aquatic species are available through the Department of Fisheries and Oceans (as of November 2005, no aquatic plants were listed). For all other federal lands (e.g., Department of National Defence, Indian Reserves, National Wildlife Areas), SARA permits are processed through the Canadian Wildlife Service (Government of Canada 2005). Permit processing time will differ between jurisdictions. In addition to requiring SARA permits, many federal lands (Department of National Defence, Indian Reserves, National Wildlife Areas, etc.) also require access permits.

On federal lands:
Permits for activities on land administered by Parks Canada Agency:
http://www.pc.gc.ca/apps/RPS/page1_e.asp

Permits for Schedule 1 aquatic species (Department of Fisheries and Oceans):
http://www.dfo-mpo.gc.ca/species-especes/permits-permis/permits-eng.htm

Permits for all other federal lands in British Columbia:
SARA Permit Applications and Agreements:
http://www.sararegistry.gc.ca/sar/permit/default_e.cfm
Email to Canadian Wildlife Service:
SARAPermitting.PYR@ec.gc.ca

5.3.2 Provincial policies

There are currently no provincial policies in place for translocation of plant species in B.C. However, when brought into force by regulation, the *Wildlife Amendment Act* (2004) will provide protection to plants at risk on all non-federal lands. For all non-federal lands, it is expected that a permit will be required for collecting or introducing any at-risk plant material that is on the provincial legislated lists (T. Lea, pers. comm. 2005). The Permit and Authorization Bureau issues permits for species covered under the *Wildlife Act* and for activities in provincial parks and ecological reserves. It has not been determined whether experimental populations will be governed by the same regulations and policies as wild populations (D. Fraser, pers. comm. 2005).

Under the *Protected Areas of BC Act* and the *Ecological Reserves Act*, permits are required to collect plant material in provincial parks and ecological reserves in British Columbia. Permits are also required to introduce or reintroduce plant material to these areas.

On provincial lands:
Permits for species that are provincially listed:
Permit and Authorization Bureau:
http://www.env.gov.bc.ca/pasb/index.html
Permits for Parks and Protected areas:
http://www.env.gov.bc.ca/pasb/applications/process/park_use.html

5.3.3 Municipal or local by-laws/policies

Regulations and policies will differ between local governments. Local governments can enact bylaws to protect species at risk by regulation under the *Community Charter* (2003) (T. Lea, pers. comm. 2005). Before any translocation project, local governments should be contacted to determine their policies and permitting systems regarding collection of plant material and introducing or reintroducing plant material on lands under local government jurisdiction.

5.3.4 Recovery team/provincial experts

Under SARA, plants that have been listed on Schedule 1 require a recovery strategy to be written within a specific time frame after a species is listed: extirpated species (2 years), endangered species (1 year), or threatened species (2 years) (Fraser 2003). Species of special concern have management plans prepared (3 years). Recovery strategies provide background information on the species, assess the feasibility of recovery, and determine goals and objectives for recovery (Fraser 2003). If a recovery strategy has been drafted for a target species at risk, any translocation project should follow the population and distribution objectives outlined in the strategy.

Planning of all translocations should be done under the direction of the relevant recovery team or Recovery Implementation Group (RIG). The recovery team should systematically review proposals, assess the scientific background, and determine whether translocations are appropriate, feasible, and justified (Austin 2004). If no recovery team has been formed then advice should be requested from provincial or federal botanical experts.

Recovery Planning in British Columbia:
http://www.env.gov.bc.ca/wld/recoveryplans/rcvry1.htm#provincial
The relevant Recovery Team for each species at risk can be found at:
http://www.env.gov.bc.ca/wld/recoveryplans/recovery_doc_table.html

Photo: Brenda Costanzo

6. CONDUCTING A TRANSLOCATION PROJECT

Many factors should be addressed in order to successfully implement a translocation project. These include site preparation, preparing plants for translocation, and on-site planting. In addition, documentation of the translocation is essential for long-term success.

The following factors should be determined prior to translocation:

- ☐ Has the recipient site been prepared to reduce potential threats to the population (Vallee et al. 2004)? **Section 6.1**
- ☐ Have the plants been adequately prepared for translocation, including phytosanitary evaluation, appropriate labeling, preparation for field conditions, etc. (Vallee et al. 2004)? **Section 6.2**
- ☐ Are the details of the on-site planting finalized, including planting design, labeling, assessment of translocation timing, etc. (Vallee et al. 2004)? **Section 6.3**
- ☐ Has the translocation been documented appropriately? **Section 7.**

6.1 Preparing the Site

A wide range of potential threats need to be assessed in order to determine the most appropriate site preparation prior to translocation. A land management plan should be in place to address the threats and outline options for long-term management. Options for threat mitigation should be incorporated into the experimental design of the planting.

Threats include competition with invasive species, grazing, altered hydrology from adjacent land-use changes, and human disturbance (**Section 3.1**). Options for addressing these threats include mulching or weeding an area, habitat restoration, fencing, soil preparation techniques, and establishing buffers if necessary (Hawaii Rare Plant Restoration Group 1999; Austin 2004; Vallee et al. 2004). If composted materials are required, disease transfer may be minimized if they can be created from on-site native materials (Hawaii Rare Plant Restoration Group 1999).

Before the translocation stage, the recipient site should be confirmed as appropriate for the species at risk and have long-term protection (**Section 3.3**). The site should have had soil testing to determine whether the pH, fertility, moisture content, etc., is appropriate for the species at risk, or the translocation should be designed to test key knowledge gaps (Hawaii Rare Plant Restoration Group 1999; Vallee et al. 2004).

6.2 Preparing Plants for Movement / Replanting

Seeds and cuttings for translocation may be either directly moved from the donor site to the recipient site or may be grown *ex situ* before translocation. Except under exceptional circumstances, direct transplantation of species at risk is not recommended by these guidelines because of the potential harm to the donor population. There are precautions that should be taken to increase the survival rate of translocated plants and to minimize the potential harm to the recipient site.

The following considerations should be taken into account:

- ☐ Seed used for translocated populations should be sown as soon as possible after collection at a time when the seeds would be shed in natural populations. Any seed not used immediately should be stored appropriately to maintain viability or used for *ex situ* propagation if appropriate (Birkinshaw 1991).
- ☐ Plants that are grown *ex situ* prior to translocation should be prepared for field conditions. This may include hardening off, control of diseases and pests, and altered watering and fertilizing schedules prior to translocation (Birkinshaw 1991; Vallee et al. 2004). **Section 4.4.**
- ☐ Any existing flowers and fruit should be removed to encourage vegetative growth and eliminate the possibility of hybrids (Vallee et al. 2004).
- ☐ Labels of all plants should be carefully checked to ensure that the provenance of each plant can be traced (Vallee et al. 2004).
- ☐ Plant preparation for translocation should include a detailed phytosanitary plan to prevent the introduction of potential weeds, pests, and diseases to the donor site (Hawaii Rare Plant Restoration Group 1999; Vallee et al. 2004). **Phytosanitary** techniques should include:
    - Collecting all plant material with sanitized tools.
    - Sanitizing all boots, packs, and planting tools before planting, and
    - All plant material should be carefully screened for pathogens. Only healthy plants should be translocated (Hawaii Rare Plant Restoration Group 1999; Vallee et al. 2004).

6.3 Planting On-Site

On-site planting requires logistic preparations plus consideration of the biological and ecological needs of the species at risk.

The following parameters should be evaluated:

- ☐ Is the time of year the most appropriate for translocation? How does the timing of the translocation impact the species at risk, including the risk of transplant shock, presence/impact of herbivores, ongoing maintenance such as watering, site access, etc.? In years with extreme weather events, it may be preferable to postpone translocations for another year or stagger plantings over several years (Hawaii Rare Plant Restoration Group 1999; Vallee et al. 2004).

- ☐ Has the planting design for the site been established? The planting design will depend on the following:
  - The planting layout should be determined by the experimental design.
  - Plants should be spaced appropriately with existing vegetation to minimize competition but also to balance increased exposure to grazing. (Birkinshaw 1991; Vallee et al. 2004)
  - When planting clonal material (i.e., plants grown from cuttings), plants from the same parent should be as widely separated as possible to allow cross pollination (Vallee et al. 2004). The distance will depend on the type of pollination for each species and the number of donor sources.
- ☐ Have the areas planted or locations of individual plants been marked with permanent marking pins according to the experimental design to facilitate monitoring (Birkinshaw 1991; Hawaii Rare Plant Restoration Group 1999)? Plants should also be marked with identifier information that can be tracked back to the source, propagation techniques, etc., at all stages of translocation (Vallee et al. 2004).
- ☐ Will the plants be protected from the sun and/or wind as necessary during transport (Hawaii Rare Plant Restoration Group 1999)?
- ☐ Have all tools, equipment, and personnel required for the translocation been itemized, assembled, and sanitized (IUCN 1995)?
- ☐ If a translocated population is to be started from seed, does the seed require light to germinate or should it be buried so that it is less vulnerable to predation (Birkinshaw 1991)?
- ☐ Will plants be watered after planting? Watering improves the contact between pot soil and recipient site soil (Birkinshaw 1991; Vallee et al. 2004).
- ☐ Will compost, mulch, fertilizer, or pest control techniques be used at the site at the time of planting (Hawaii Rare Plant Restoration Group 1999)? If so, have they been created from on-site resources?

Photo: Brenda Costanzo

7. DOCUMENTATION

Documentation of translocations is essential in order to learn from the successes and failures of each project and to develop translocation skills. Documentation is also required to distinguish between a species' original distribution and where humans have planted it. Knowing which populations are anthropogenic in origin will help inform research about the natural ecology and habitat of species at risk (CBA 2004). Very little value comes from translocation projects with insufficient documentation because it is impossible to determine why a project succeeds or fails (Monks and Coates 2002). Documentation is also necessary to inform future translocations.

An essential part of documentation is providing the necessary information to the B.C. Conservation Data Centre (B.C. CDC), which tracks all known populations of species at risk. This will ensure that experts can know which populations have been altered and prevent confusion for future researchers. Reinartz (1995) states that there could be confusion between created and natural populations in the long-term, so managing the records is important, especially with respect to legal protection.

All translocations of species at risk should be reported to the B.C. Conservation Data Centre (B.C. CDC). See Appendix A for recommendations for CDC Documentation of Species at Risk Translocation. A rare plant observation form is available at: http://www.env.gov.bc.ca/cdc/contribute.html

- On the rare plant observation form, note whether the population has been reintroduced, introduced, or augmented and follow with a supplemental form for each type of population.
- Provide data to support an Element Occurrence (EO) rank for viability (A-D) that is assigned by CDC staff. All augmented, introduced, or reintroduced populations will also receive an Origin Sub-rank of "Reintroduced/ Restored."

Documentation should also include the following:

- ☐ In addition to the translocation proposal, the Recovery Team and/or experts should receive ongoing reports of the translocation and the monitoring details for review (Joint Nature Conservation Committee 2001).
- ☐ The site should be accurately mapped and all maps submitted to the B.C. Conservation Data Centre (Vallee et al. 2004). It may be appropriate to map not only the edges of the translocated population but also the location of each translocated plant to facilitate monitoring.

- ☐ Regular publications in peer-reviewed journals should be submitted to ensure that the information is widely distributed and the process is transparent. There should be adequate funding in place for data analysis and peer review (Austin 2004).
- ☐ In addition to the B.C. Conservation Data Centre, information concerning the translocation should be communicated to recovery team chairs, to other conservation organizations and, where appropriate, to the general public to foster long-term support for the project (IUCN 1995).

Photo: Brenda Costanzo

8. POST-TRANSLOCATION MONITORING, MANAGEMENT AND EVALUATION

Post-translocation stages are an essential component of any translocation project and should be an integral part of any translocation. Monitoring, ongoing threat management and evaluation of the translocation are essential for increasing the likelihood of project success, minimizing harm to natural populations and species at risk, evaluating the success or failure of projects, and informing future translocations. It is essential that adequate resources be in place during the initial stages of the translocation to ensure that all post-translocation phases can occur (Austin 2004; Austin and Prior 2004). The post-translocation stages are the key to advancing knowledge of translocations. This will move such translocations from the trial-and-error approach currently used to one based on a strong scientific foundation (Austin and Prior 2004).

8.1 Monitoring

Monitoring a translocated population is essential to identify problems, to allow an early response to any threats to the translocated population, and to evaluate the success of the translocation (Vallee et al. 2004). “The inclusion of monitoring in an experimental approach can result in a project that brings twofold success: success in biological terms by reintroducing a rare species to a site, and success in general project terms by obtaining information about species biology, community processes, management techniques, and conservation policy” (Sutter 1996). Monitoring should include both short- and long-term evaluation and should be designed to identify unanticipated threats (Monks and Coates 2002). The overall timeframe for monitoring should be long enough to detect real trends in the population and should be related to the lifespan of the species at risk (IUCN 1995; Sutter 1996 in Monks and Coates 2002; Austin 2004). Monitoring should also be linked to an evaluation of the goals and objectives of the project (IUCN 1995; Vallee et al. 2004).

The type of monitoring chosen should be inexpensive, quantifiable, and relevant to the experimental design (Vallee et al. 2004). The work should be simple enough to allow different people to collect the data with a sufficient level of precision (Sutter 1996 in Monks and Coates 2002; Austin 2004). To facilitate monitoring, the locations of translocated plants should be clearly identified and the provenance of each plant labeled. This may involve marking each plant.

Monitoring a translocated population should include both a short- and long-term assessment of the population (Birkinshaw 1991; IUCN 1995; Hawaii Rare Plant Restoration Group 1999; Valee et al. 2004). The short-term assessment should include an evaluation of whether the population establishes, reproduces, and disperses itself (Monk and Coates 2002). This may include daily monitoring for a week after the translocation to address any unforeseen threats (Hawaii Rare Plant Restoration Group 1999). The long-term assessment should determine if the population can integrate into the ecosystem and adapt through evolution and migration to environmental changes (Monk and Coates 2002).

Monitoring should include the following:

- ☐ A pre-translocation baseline assessment to determine the species composition of the recipient site and allow for evaluation of species changes over time (e.g., changes in the type and number of invasive species) (Hans Roemer, pers. comm. 2006).
- ☐ Short- and long-term assessment of the biology and ecology of the translocated population. Ongoing monitoring should examine both translocated plants and their offspring for the following:
  - Survival rates and reasons for mortality
  - Growth and vigour
  - Flowering and seed set
  - Reproduction and recruitment
  - Herbivory and presence of disease
  - Seed bank survival and seed viability
  - Presence of soil symbionts
  - Genetic monitoring to ensure genetic variation is maintained.
- ☐ Assessment of environmental factors, including impact to other native species at the donor site, effectiveness of threat management at donor site, presence of weeds or pests, etc. (Vallee et al. 2004). **Section 8.2.**
- ☐ Comparison to a reference *in situ* population (Sutter 1996 in Monks and Coates 2002; Vallee et al. 2004).
- ☐ Information for critical assessment of the translocation to determine whether to repeat, revise, or abandon translocation efforts and determine whether translocated populations require further augmentation (Austin 2004). **Section 8.3.**
- ☐ Assessment of the donor population for any negative impacts from collecting species-at-risk material (Austin 2004).

8.2 Managing Ongoing Threats

One of the most critical factors determining the success of any translocation project is effective, ongoing management of threats to the population. Ongoing management may include mulching, watering, weeding, pest control, maintenance of herbivore exclosures, managing disturbance regimes, etc. (Birkinshaw 1991; Hawaii Rare Plant Restoration Group 1999; Coumbe and Dopson 2001; Vallee et al. 2004). “It makes little sense to spend considerable time and resources to propagate transplants and then send these valuable transplants on a near-certain ‘death march’ back into the wild if the threats endangering the species have not been eliminated or controlled” (Mehrhoff 1996 in Monks and Coates 2002).

The type of management should be species-specific and be determined by ongoing monitoring. Incorporating alternative management options into the experimental design of the project is an important tool for determining which type of management is most critical for the translocated population and for assessing short- and long-term management strategies (Austin 2004). Determining the most effective management strategies can also help inform management of *in situ* populations of species at risk (Monks and Coates 2002; Vallee et al. 2004). Careful documentation of ongoing management activities is necessary to guide future translocations (Hawaii Rare Plant Restoration Group 1999).

8.3 Evaluating the Success or Failure of the Translocation

The overall success or failure of the project should be evaluated according to predetermined definitions of success with respect to the goals and objectives determined in the translocation proposal (Austin 2004; Vallee et al. 2004) (**Section 3.6**). The biological assessment should be evidence-based and quantitative, determined by the monitoring and data analysis of the experimental design of the project rather than *ad hoc* opinions about the project (Austin and Prior 2004; Vallee et al. 2004). The project assessment will have a broader definition of success based on the intended project goals and objectives, including the usefulness of the information gathered from the project and how well the information was disseminated (Monks and Coates 2002).

8.3.1 Evaluation of the project should include the following:

Biological assessment

- ☐ Short-term assessment of whether the population establishes, reproduces, and disperses (Fiedler 1991; Monk and Coates 2002; Vallee et al. 2004).
- ☐ Long-term assessment to determine if the population can integrate and adapt to environmental changes through evolution and migration (Fiedler 1991; Monk and Coates 2002; Vallee et al. 2004).
- ☐ Recommendations for the future of the project and other proposed translocations, including identifying the most appropriate translocation methodology and/or management approach based on experimental outcomes (Austin and Prior 2004; Vallee et al. 2004).
- ☐ Evaluation of whether information gained during the translocation can be used to reassess the feasibility of recovery of the species based on ability

to manage threats, manipulate ecological and evolutionary processes, and co-ordinate recovery between different landowners, land managers, and other stakeholders (Austin 2004).

☐ Evaluation of damage to other species and/or ecosystems during the translocation project (Austin 2004).

☐ Evaluation of the donor population to determine the impact of collecting plant material.

Project assessment

☐ Cost-effectiveness of the project compared to other potential recovery actions (IUCN 1995; Vallee et al. 2004).

☐ Evaluation of documentation and dissemination of both positive and negative results of the translocation and of the communications process in general (Austin and Prior 2004).

☐ Evaluation of the decision-making process and whether a thorough examination of the options relying on the diverse sets of skills on recovery teams or expert panels was included (Austin and Prior 2004).

☐ Evaluation of whether the project contributed to the scientific knowledge of the species at risk (Pavlik 1996).

☐ Evaluation of whether the translocation contributed to the development of effective management techniques for translocated populations or *in situ* populations of species at risk (Pavlik 1996).

☐ Evaluation of whether the translocation contributed to the development of informed debate on policy (Pavlik 1996).

9. USEFUL SOURCES

Legislation

British Columbia *Wildlife Act*: http://www.qp.gov.bc.ca/statreg/stat/w/96488_01.htm
British Columbia *Wildlife Amendment Act*:
http://www.leg.bc.ca/37th5th/1st_read/gov51-1.htm
British Columbia *Community Charter*: http://www.qp.gov.bc.ca/statreg/default.htm
British Columbia *Weed Control Act*:
http://www.agf.gov.bc.ca/cropprot/noxious.htm

For a full listing of **federal government** legislation, see: http://laws.justice.gc.ca/en/
Canada *Species at Risk Act*: http://www.sararegistry.gc.ca/ (general information) or
http://laws.justice.gc.ca/en/S-15.3/index.html (copy of the Act)
Canada *Wildlife Act*: http://laws.justice.gc.ca/en/W-9/index.html
Wild Animal and Plant Protection and Regulation of the *International and Interprovincial Trade Act*: http://laws.justice.gc.ca/en/W-8.5/index.html

Federal permits

Species at Risk Act, Permits and Agreements:
http://www.sararegistry.gc.ca/sar/permit/default_e.cfm
Species at Risk Act, Request for a Permit Form:
http://www.sararegistry.gc.ca/sar/permit/permits_e.cfm
Parks Canada, Research and Collection Permit System:
http://www.pc.gc.ca/apps/RPS/page1_e.asp
Permits for Schedule 1 aquatic species (Department of Fisheries and Oceans):
http://www.dfo-mpo.gc.ca/species-especes/permits-permis/permits-eng.htm

Provincial permits

B.C. Ministry of Environment, Permit and Authorization Bureau:
http://www.env.gov.bc.ca/pasb/

Inventory Information

B.C. Conservation Data Centre: http://www.env.gov.bc.ca/cdc/
B.C. Species and Ecosystem Explorer: http://www.env.gov.bc.ca/atrisk/toolintro.html
Sensitive Ecosystem Inventories http://www.env.gov.bc.ca/sei/
Community Mapping Network: http://cmnbc.ca/

Additional Guidelines

These Guidelines and Best Management Practices documents are (or will soon be) posted to the B.C. Ministry of Environment Environmental Stewardship Best Management Practices Web site (http://www.env.gov.bc.ca/wld/BMP/bmpintro.html)

The National Guide to Sustainable Municipal Infrastructure- Best Practices
Environmental Best Management Practices for Urban and Rural Land Development in British Columbia - http://www.env.gov.bc.ca/wld/documents/bmp/devwithcare2006/develop_with_care_intro.html

Instream Flow Guidelines for British Columbia - Working Drafts
Commercial Recreation Wildlife Guidelines
Best Management Practices for Amphibians and Reptiles in Urban and Rural Environments in British Columbia
Best Management Practices Guidebook for Raptors in British Columbia: Guidelines for Integrating Raptor Conservation with Urban and Rural Land Development
Best Management Practices for Recreational Activities on Grasslands in the Thompson and Okanagan Basins (Thompson and Okanagan Regions)
Standards and Best Management Practices for Instream Works (Lower Mainland Region)
Environmental Objectives, Best Management Practices and Requirements for Land Developments and Appendices (Vancouver Island Region)
Urban Bio-Inventory: Terms of Reference (Vancouver Island Region)
Sensitive Ecosystems Audit and Audit Summary (Vancouver Island Region)
Terms and Condition for Changes In and About a Stream Specified by MOE Habitat Officers, Cariboo Region
Timing Windows and Measures to Adequately Manage and Conserve Aquatic Resources in the Cariboo Region (Cariboo Region)
Skeena Region- Reduced Risk In-stream Work Windows and Measures (Skeena Region)

To contact regional B.C. Ministry of Environment offices see: http://www.env.gov.bc.ca/main/prgs/regions.htm

Species and Ecosystems at Risk and Recovery

B.C. Species Explorer: http://www.env.gov.bc.ca/atrisk/toolintro.html (British Columbia's species at risk)
NatureServe Explorer: http://www.natureserve.org/explorer/
Committee on the Status of Endangered Wildlife in Canada (COSEWIC): http://www.cosewic.gc.ca/eng/sct5/index_e.cfm (Canadian species at risk)
Endangered Species and Ecosystems: http://www.env.gov.bc.ca/atrisk/
Garry Oak Ecosystem Recovery Team: http://www.goert.ca/
Recovery Planning in British Columbia: http://www.env.gov.bc.ca/wld/recoveryplans/rcvry1.htm
South Okanagan-Similkameen Conservation Program: http://www.soscp.org/
Species and Ecosystems at Risk: http://www.env.gov.bc.ca/wld/serisk.htm

Sensitive Ecosystems

Sensitive Ecosystems Inventory: http://www.env.gov.bc.ca/sei/
Sensitive Ecosystems Inventory (East Vancouver Island and Gulf Islands) Conservation Manual: http://www.env.gov.bc.ca/sei/van_gulf/index.html
Sensitive Ecosystems Inventory (Central Okanagan) Technical Report: http://www.env.gov.bc.ca/sei/okanagan/index.html

Alien Species

Alien species: http://www.env.gov.bc.ca/wld/aliensp/index.html
Invasive Plant Council of B.C.: http://www.invasiveplantcouncilbc.ca/
B.C. Ministry of Agriculture and Land: http://www.gov.bc.ca/al/

Stewardship Publications

All publications in the Stewardship Series are available at
http://www.stewardshipcentre.bc.ca/cdirs/st_series/

Titles include:

Access Near Aquatic Areas: A Guide to Sensitive Planning, Design and Management.
B.C. Grasslands Stewardship Guide: A Guide for Ranchers and Recreation Users
Community Greenways: Linking Communities to Country, and People to Nature
Community Stewardship: A Guide to Establishing Your Own Group
The Streamkeepers Handbook: A Practical Guide to Stream and Wetland Care

Translocation Documents

The World Conservation Union Position (IUCN) Statement on Translocation of Living Organisms: Introductions, reintroductions and restocking:
http://www.iucnsscrsg.org/download/IUCNPositionStatement.pdf

The World Conservation Union Position (IUCN) Guidelines for Reintroductions:
http://www.iucnsscrsg.org/download/English.pdf

Canadian Botanical Association Conservation Policy Statement:
http://www.cba-abc.ca/pospaper.htm

Seed collection guidelines

Garry Oak Ecosystems Recovery Team, Native Plant Propagation Steering Committee. Guidelines for the collection and use of native plants:
http://www.goert.ca/at_home_guidelines_native.php

FloraBank. Guidelines 10: Seed collection ranges for revegetation:
http://www.florabank.org.au/default.asp?V_DOC_ID=882

Guidelines for Ethical Field Research on Rare Plant Species (2005). New England Wildflower Society:
http://www.newfs.org/protect/rare-plants-and-conservation/policies-issues

10. GLOSSARY/DEFINITIONS

Abundance: Number of individuals in a population. Population size is determined by the degree of reproductive success, establishment and completion of life cycle, and ability to withstand threats.

Abundant Centre Hypothesis: Species reach their highest abundance in the centre of their range and decrease in size towards the range periphery.

Allele: An alternative form of the same gene that occupies the same position on a chromosome. For example, there are two forms of the gene for pea seed shape: one allele for a round shape and a second allele for a wrinkled shape.

Allelic richness: A measure of number of alleles per locus.

Augmentation: Adding new individuals to an existing population in order to increase the number of individuals or the genetic diversity of the population. This is usually done using genetic stock from the receptor site, but other material may be added if the existing population is suffering from demographic collapse due to inbreeding.

Chromosome studies: Analysis of the number of complete sets of chromosomes in a biological cell. Ploidy is the number of complete sets of chromosomes found in each cell. A diploid cell contains two complete sets of chromosomes, but plants often range in ploidy. A greater number of chromosome sets referred to as polyploidy.

Conspecific: Belonging to the same biological species.

Demography: The study of population dynamics and their analysis to determine reproduction, deaths, age structure, etc., within a population.

Disjunct: A discontinuous population that is widely separated from the main portion of its range.

Donor population: Population of plants at risk in the wild where seeds, cuttings, or tissue culture are collected for translocation.

Donor site: Population of plants at risk in the wild where seeds, cuttings, or tissue culture are collected for translocation.

Effective population size: The number of breeding individuals contributing to subsequent generations in an idealized population.

Endangered: A wildlife species facing imminent extirpation or extinction (COSEWIC 2004).

Endemic: A taxon that is exclusively native to a particular place or region.

Establishment: The formation of a self-sustaining population that can withstand threats and self-replicate.

***Ex situ* conservation:** The conservation of a species or propagules of a species outside of their natural habitat. This may include seed banks, germplasm collections, botanical gardens, and temporary propagation in nurseries.

Extent: Number and distribution of populations.

Extinct: A wildlife species that no longer exists (COSEWIC 2004).

Extirpated: A wildlife species no longer existing in the wild in Canada, but occurring elsewhere (COSEWIC 2004).

Fitness: A measure of lifetime reproductive success.

Founder effect: "Change in genetic composition of a population due to its origin from a small number of individuals" (Vallee et al. 2004).

Gene flow: The movement of genes from one population to another – often expressed as a migration rate (m).

Genetic bottleneck: A dramatic decline in population size significantly influenced by genetic drift.

Genetic differentiation: The proportion of genetic variation that is due to differences among populations (divergence among subpopulations).

Genetic drift: The random change in allele or gene frequencies from generation to generation due to stochastic loss of genetic variation.

Genetic swamping: Domination of introduced genetic material in a natural population either through hybridization or by outnumbering the gene pool in the natural population. This may cause outbreeding depression (Vallee et al. 2004).

Genotype: The genetic constitution of a given organism (IUCN 1995).

Heterospecific: Belonging to different biological species.

Heterozygosity (H): An individual carrying both forms of an allele. Within a population, the proportion of individuals that are heterozygous.

Hybrid: Matings from individuals from more than one population distinguishable on the basis of one or more heritable characters.

Hybrid vigour (heterosis): Increased fitness exhibited in the progeny of genetically divergent parents.

Inbreeding: Breeding between close relatives, resulting in decreased heterozygosity.

Inbreeding depression: Reduced fitness, decreased ability to adapt to environmental stress, and/or decreased reproductive capability caused by reduced genetic diversity (Vallee et al. 2004); the population consequence of reduced fitness in inbred individuals; results from the expression of deleterious alleles in homozygous individuals.

***In situ* conservation:** The conservation of a species or propagules within the natural habitat or ecosystems where it occurs.

Introduction: Establishing a population in a location with appropriate habitat that lies within the historical range for the species but where there are no historical records indicating the species previously occurred there.

Locus: A fixed position on a chromosome that may be occupied by one or more genes.

Molecular markers: Specific fragments of DNA used to assess extant genetic variation.

Mutation: An inheritable change of a genetic structure, providing the variation in the gene pool.

Natural selection: The differential success of genotypes in contributing to subsequent generations.

Obligate outcrosser: Mating only between individuals that are either less closely related or from different populations.

Outbreeding depression: Decreased fitness in a population due to introducing plants that are less genetically adapted than their parents. Locally adapted genes or co-adapted gene complexes may be broken down (Vallee et al. 2004); reduced fitness in the progeny of individuals from different populations as opposed to individuals from the same population due to the break-up of locally co-adapted gene complexes and introduction of maladapted genes.

Persistence: Ability of a taxon to be self-sustaining and integrate into ecological processes and thereby withstand disturbances over the long-term.

Phenotype: Observable characteristics of an organism as a result of the interaction between genotype and environment.

Phytosanitary: Relating to the protection of plant health and the prevention of the spread of pests, diseases, and noxious weeds.

Polymorphic loci: Genetic loci with two or more alleles.

Population: A group of one species, within a particular geographic area, that is largely genetically isolated from other groups of the same species.

Propagule: Any part of a plant that has the capacity to give rise to a new plant, either through sexual or asexual reproduction.

Provincial lists: List of elements considered to be either endangered or threatened (Red List), of special concern (Blue List), or not at risk (Yellow List) in B.C. (B.C. CDC 2001).

Provincial rank: Conservation status rank for an element occurring or formerly occurring in B.C. (B.C. CDC 2001).

Recipient site: Plant community where a translocated plant is planted or seeded.

Reciprocal transplants: A test for genotype by environmental interactions through planting multiple common garden experiments (i.e., a range-wide collection of individuals) in multiple different environments across a species' range.

Recovery team: Team of experts tasked with the recovery of a species or ecosystem at risk.

Reintroduction: Establishing a population in a location that previously supported the species but from which it has since been extirpated.

Rescue effect: Increased persistence of a population caused by migration of new individuals to that population.

Resilience: Ability of a taxon to withstand disturbances, largely due to a sufficient degree of genetic variation.

Recipient site: A plant community that receives a translocated plant or seed.

Reciprocal transplants: A test for genotype by environmental interactions through planting multiple common garden experiments (i.e., a range-wide collection of individuals) in multiple different environments across a species' range.

Resilience: The ability of a taxon to withstand disturbances (largely due to sufficient genetic variation).

RIG (Recovery Implementation Group): A working group of the Garry Oak Ecosystems Recovery Team (GOERT).

Special Concern: A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats (COSEWIC 2004).

Species at Risk: An extirpated, endangered, or threatened species or a species of special concern (formerly called vulnerable) (B.C. CDC 2001).

Taxon (plural = taxa): A taxonomic category or group. In these guidelines, generally referred to a species, subspecies, or variety of plant at risk.

Threatened: A wildlife species likely to become endangered if limiting factors are not reversed (COSEWIC 2004).

Translocation: The deliberate moving of propagules and/or plants from one location to another location in the wild in order to assist in the recovery of the species.

Transplantation: Removing whole plants or seedlings from an existing *in situ* site and replanting them in another location.

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APPENDIX A. RECOMMENDED DOCUMENTATION OF TRANSLOCATIONS OF SPECIES AT RISK FOR THE B.C. CONSERVATION DATA CENTRE

All species at risk populations will be assigned an Element Occurrence (EO) rank for viability (A–D, or Excellent to Poor) by a CDC specialist, and furthermore, all translocated populations will be assigned an Origin Sub-rank of "Reintroduced / Restored" in the CDC database. To assign an EO rank, the CDC specialist needs the following fields populated on the CDC field forms: Element Occurrence Condition, Size of EO, and Landscape Context.

Existing CDC rare plant observation forms should be updated to include the field "Is this a reintroduced, introduced or augmented population?"

To effectively track the success of a translocation, the CDC form could also include reference to a supplemental translocation tracking form (yet to be developed) that should contain the following information:

- Justification of translocation, including:
  - why habitat restoration or management of existing populations is insufficient for recovery of the species at risk
  - demonstration that the proposed translocation will benefit the species at risk and/or the science of translocations.
- Who has approved the translocation (recovery team or experts)?
- Details of the process for ensuring the species at risk is absent from the recipient site for reintroductions and introductions and to ensure translocation is within the species current or historical range.
- Details of the autecology of species at risk, significant knowledge gaps, and how this information informed the translocation.
- Recipient site selection process, including permission obtained for translocation.
- Origin of material translocated, including:
  - how, when and where material was collected
  - details of any *ex situ* propagation
  - life stage of plants translocated
  - permission obtained for collection.
- Experimental design and methods of translocation, including details of site preparation, when the translocation occurred and short-term management plans.
- Management strategy for minimizing threats.
- Details of post-translocation monitoring, site management, and evaluation.

Much of the above information may be already documented in a translocation proposal. It may be easiest to just attach a copy of the proposal.