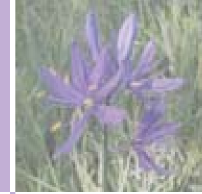

Restoring British Columbia's

Garry Oak Ecosystems

PRINCIPLES AND PRACTICES

Chapter 5
Restoration Planning

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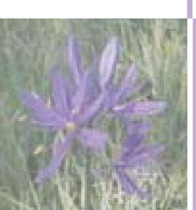

Chapter 5

Restoration Planning

by Conan Webb and Richard Hebda, in collaboration with Don Eastman, Shyanne Smith, Brenda Costanzo, Fred Hook, Dave Polster, and Thomas Munson

Restoration technicians at Fort Rodd Hill National Historic Site carrying out a hand-pulling treatment on Spurge-laurel (*Daphne laureola*). This was one of four manual treatments tried in this experimental removal of Spurge-laurel seedlings. While almost 100% effective, hand-pulling is labour intensive and there was a significant desire to find more efficient control methods. However, hand-pulling remains the standard removal method for Spurge-laurel seedlings at Fort Rodd Hill as other methods turned out to be unacceptable: weed-eating (exposure to Spurge-laurel toxin and excess litter disturbance), hoeing (soil disturbance, more labour intensive), mulching (disruption of native plant regeneration, and costly). Photo: Parks Canada/Conan Webb

5.1 Introduction

The complexity of restoration projects varies widely. You may want simply to remove invasive species in the backyard, or at the other end of the spectrum, you may wish to initiate and carry out a restoration of Garry Oak and associated ecosystems within a regional park that includes the re-establishment of rare species. In all cases, there needs to be some sort of route mapped out to the end point. The end point is the goal. Goals are a broad statement of what you want to achieve; a project may have a few goals or only one. This route towards achieving goals is mapped out by

Golden Paintbrush (*Castilleja levisecta*), an Endangered species in Canada. Restoration work can have unforeseen and detrimental consequences for rare species populations that are already stressed. A well-informed restoration plan, based on thorough research about the restoration site, is critical to prevent harm to rare species (see Case Study 1, Chapter 4). Photo: Nicole Kroeker

objectives. Objectives are very focused and specific: most projects will tend to have a few too many objectives for each goal. Each objective will likely require many tasks to be completed before it is achieved.

A restoration plan lays out the project goal(s), objectives, and tasks. Having a well thought-out plan is especially important where species at risk or multiple agencies are involved, when reporting to a grant provider is required, and for the sake of efficient use of human and financial resources (Nuzzo and Howell 1990).

A restoration plan lays out project goals, objectives, and tasks; includes a good schedule; incorporates monitoring; and is based upon sound knowledge of the site and species involved.

While any restoration project has its complexities, working with rare species has its own special considerations, some of which are discussed in Chapter 4: Species and Ecosystems at Risk. A well-informed restoration plan is important because all restoration work, no matter how well-meaning, can have unforeseen and potentially deadly consequences for rare species populations that are already stressed. In some cases, rare plants and animals could be trampled and killed during restoration work—sometimes knowing where not to step is just as important as knowing what to do. In other cases, rare species may have become dependent on alien invasive species for food or shelter, and removing the alien species could lead to the loss of a rare population (e.g., the case of Taylor's Checkerspot (*Euphydryas editha taylori*) and its host plants Case Study 1). For these reasons it is important to learn as much as you can about your restoration site before the project begins, so that your restoration plan is well-informed. A tenet many restoration practitioners try to follow is "do no harm"; after all, you are trying to fix a problem, not create another.

A good schedule is a central element of successful restoration projects. Obviously, you will become frustrated if you have organized a broom removal event, and no one shows up because the date happens to coincide with another major environmental initiative or public event.

Additionally, you may discover in your planning process that the restoration project will take much longer than you had anticipated due to the need for consultation meetings or permits, for example. Further, various restoration tasks are season-sensitive, such as planting and invasive species removal. A schedule is particularly important when working around streams where legal regulations afford only a narrow annual work window.

An oft-repeated Garry Oak ecosystem example involves the desire to plant camas bulbs in a meadow restoration. A project team or group gets excited about the project, and finally gets the approval and budget to buy the bulbs; however, the bulbs need to be purchased before the end of the fiscal year, and it is now late fall. The team calls up the supplier, who says that camas bulbs, like many other bulbs, are really only available in the late summer and fall. For the rest of the year the group either has to obtain potted plants (expensive and not usually available), or dig living plants and hope for the best. See Chapter 10: Species Propagation and Supply, Section 10.7, for further discussion regarding planning timelines. With a little planning, including the development of a schedule, such problems can be avoided or mitigated.

We approach the development of a restoration plan by considering a general series of stages that are common to restoration projects. These stages allow you to break the project down into smaller chunks to consider in sequence rather than trying to grasp the entire project at once. These stages are also useful for organizing tasks into a chronological sequence, or schedule. Once specific tasks have been identified and organized, you can assign required resources to each task and develop a budget for money and other resources (e.g., staff or volunteer time). Even if you are not necessarily spending dollars, you are, at the very least, using up your own time and that of others—the value of this time cannot be understated.

This chapter has two parts: a summary description of a restoration project and some associated tasks and planning issues, and a description of a planning tool—the planning table—to help you develop your own plans. When carefully considered, the process outlined below will help you develop a solid plan, which will increase your chances of success and reduce the risk of doing harm.

In Oregon, the remaining populations of Endangered Taylor’s Checkerspot *(Euphydryas editha taylori)* currently oviposit exclusively on a non-native larval host plant. This novel association requires restoration practitioners and land managers to re-think traditional approaches to managing alien species and is further complicated by the need to control other invasive plants in order to ensure adequate ground cover of the non-native host plant. Photo: Nicole Kroeker

Case Study 1. Reconsidering the Role of an Invasive Plant: Conserving Habitat Requirements for Taylor's Checkerspot (*Euphydryas editha taylori*), an Endangered Native Butterfly Species in Western Oregon

by Lisa Dumoulin

A restoration plan needs to carefully consider the suite of species and ecosystem processes that are interacting at a given site. Additionally, the goals of a restoration project must be clearly defined. Although common anthropogenic disturbances, particularly the presence of invasive species, are often targeted for mitigation in ecological restoration, the goals of the restoration should be the primary guides for decision making in the planning process. There is growing recognition that the mediation of disturbances such as invasive species must be reconsidered in light of each new restoration project (SERISPWG 2004).

Invasive species have become a prolific problem around the globe. Novel associations of invasive and native species are well documented (Graves and Shapiro 2003, King et al. 2006) and have been used to support the concept of ecological fitting (Agosta 2006). In brief, for plant-insect associations, the concept of ecological fitting proposes that the associations we observe presently (e.g., butterflies and their host plants) are not necessarily the result of tight co-evolution. Rather, an association may have formed through coincidences of time, space, and the innate suite of characteristics that the plant and insect carried at the time they came into contact. Novel associations, especially when involving species at risk, certainly complicate the process of restoration planning.

Such is the case in the Willamette Valley in western Oregon, where the two remaining populations of the Endangered Taylor's Checkerspot butterfly in the state currently oviposit exclusively on a non-native larval host plant, Ribwort Plantain (*Plantago lanceolata*). To the north, in Washington, some of the remaining small populations of Taylor's Checkerspot also feed on Ribwort Plantain but use a small variety of native host plants (paintbrushes, *Castilleja* spp.; Blue-eyed Mary, *Collinsia* spp.; and Sea Blush, *Plectritis congesta*) as well. Although many of the same native larval host plants consumed in Washington are also found throughout the Willamette Valley, only Sea Blush is found at a site where a remaining population of Taylor's Checkerspot persists, and despite its presence, the adult females in the Oregon population do not oviposit on it. Instead, the females favour Ribwort Plantain as the larval food source and oviposit only on this alien species (Severns and Warren 2008). Since no native species of *Plantago* are known to occur in Oregon, the dependency of Taylor's Checkerspot on Ribwort Plantain in that state is considered a novel association between an invasive and an Endangered species, presumably the result of a host shift, though the previous native host plants of Taylor's Checkerspot in Oregon remain unknown (Severns and Warren 2008).

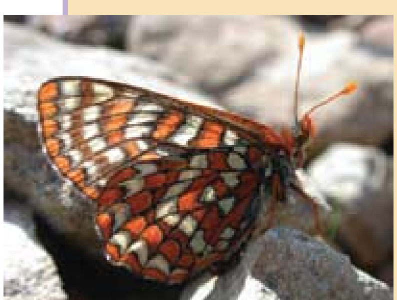

Photo: Nicole Kroeker

Although it may seem reasonable to think that the Oregon populations of Taylor's Checkerspot might benefit from the re-introduction of other potential native host plants (those observed as larval host plants in

Washington) to replace the use of the potentially invasive Ribwort Plantain, further investigation reveals that this is not a reasonable restoration or conservation effort. For example, in Oregon, the timing of the above-ground growth of *Castilleja* spp. and the emergence of Taylor's Checkerspot larvae from their winter dormancy do not coincide (Severn and Warren 2008, Severns 2008). Moreover, if the timing of these events did coincide, another host shift could lead to a reduction in the effective population size, causing a population bottleneck in the already small butterfly populations (Severns and Warren 2008). The exclusive use of Ribwort Plantain as a larval host plant by Taylor's Checkerspot in Oregon requires restoration practitioners and land managers to rethink traditional approaches to managing alien species and to protect the exotic plant in habitats currently occupied by, and of potential importance to, the remaining Taylor's Checkerspot populations (Severns and Warren 2008).

Restoration management decisions at the sites of the Oregon Taylor's Checkerspot populations also need to consider the presence of two invasive grass species. The increased cover of the tall invasive grasses Slender False Brome (*Brachypodium sylvaticum)* and Tall Fescue (*Festuca arundinacea)* is correlated with a decrease in ground cover of Ribwort Plantain. These grasses also out-compete native forbs, including Wild Strawberry (*Fragaria virginiana*), the primary native food plant on which adult Taylor's Checkerspots feed during their flight period (mid-April to early May). Oviposition patterns show that Taylor's Checkerspot in Oregon require habitat with sufficient larval food plants and adult nectar sources for successful reproduction (Severns and Warren 2008). Although Ribwort Plantain is an abundant weed, occurring widely throughout the Willamette Valley, the extant populations of Taylor's Checkerspot only inhabit remnant prairie areas where the cover of tall invasive grasses is low enough that native forbs persist as well. Therefore, to maintain high quality feeding and reproductive habitat in Oregon, restoration activities to remove the invasive grasses, or to control their spread, are necessary to protect native forbs as well as the exotic Ribwort Plantain.

This case study highlights contemporary problems that restoration practitioners face due to alien invasive species. Often, invasive species threaten native ecosystems and warrant removal. In Oregon, however, the exotic Ribwort Plantain is sustaining two extant populations of an endangered butterfly, and despite its weedy tendency and potential to become highly invasive, it requires protection within the suitable remaining habitat for Taylor's Checkerspot (Severns 2008). Traditional ecological restoration in North America may seek to return an ecosystem to a pre-colonial state. However, there is growing recognition that invasive species need to be considered for all of their potential roles in an ecosystem before management actions are taken (Rodriguez 2006, GOERT 2010). As native species are continuously out-competed by exotic ones, new species associations (herbivory, predation, and parasitism) will inevitably form (Agosta 2006). Some of these new associations may turn out to be critical in maintaining a native species, leaving restoration practitioners and land managers with complex management dilemmas. Consideration of the facilitative effects of invasive species in comparison to their detrimental effects should increasingly weigh into the decision-making framework for ecological and ecosystems restoration (Rodriguez 2006).

CASE STUDY

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5.2 The Structure of a Restoration Project: How do I Organize and Carry Out Restoration?

How to approach carrying out a major initiative may at first seem like an overwhelming question. Even a small project may be more complex than you think, especially if it involves a variety of groups or property other than your own. However, if you approach the matter systematically, step-by-step, rather than trying to grasp it all at once, you can develop a solid plan.

In general, a restoration project can be broken down into several steps or stages. While the specific number of stages varies somewhat according to the person describing them and the emphasis of the project, these stages provide an outline for planning. This restoration outline can be followed from beginning to end; it will help simplify the planning process and help ensure all the pieces for a solid restoration plan are put together. The following description considers seven stages, each with many tasks. This breakdown is taught in the University of Victoria's introductory course to Restoration of Natural Systems (Hebda 2007) and has at its core the concept that a restoration project is a very broad initiative involving more than just the actual on-the-ground work. Identifying the restoration goals and objectives is a key component of the project, as is widespread involvement of the public, if appropriate. Thus, the project stages cover much more than what people might typically consider when they think of restoration. While we will touch on the topic of public involvement in this chapter, readers should refer to Chapter 6: Outreach and Public Involvement for further information.

The outline of the restoration project is presented in a more or less chronological order (see box, Restoration Project Stages). In **Stage 1** the goals and objectives of the project are established.

The initial broom removal on Mill Hill was a major initiative requiring extensive planning for volunteers and equipment. Here Scotch Broom (*Cytisus scoparius*) is being prepared to be airlifted by a helicopter. A systematic, step-by-step approach to restoration planning helps identify and coordinate all of the necessary tasks. Photo: Capital Regional District

Stage 2 involves the collection of data. **Stage 3** follows with the analysis of field samples and data collected in Stage 2, and potentially requires consultation with experts. **Stage 4** builds on data collection and analysis, and with as much information in hand as possible, the restoration plan is developed and verified with interested parties. In **Stage 5**, the restoration process may begin at the site through pre-restoration experiments and field tests. Finally, the restoration work itself, **Stage 6**, occurs. **Stage 7** is the final stage; in this monitoring stage you are checking to see if your objectives are being met and what adjustments need to be made, if necessary, to achieve the objectives and ultimately the goals of the project. Depending on the project, the monitoring stage may be relatively short (months) or very long (decades).

In the sections that follow, the stage descriptions are in list form with annotations. Selected parts have been chosen for extended discussion to provide you with specific practical advice and a rationale for steps. In the case of the monitoring stage, because of its great importance and frequent omission, we have devoted an entire chapter in this publication to monitoring (Chapter 7: Inventory and Monitoring). Elements of many other stages are covered to some extent in other chapters too.

RESTORATION PROJECT STAGES (summarized from Hebda, 2010)

Stage 1 – Establish the context, goals, and objectives for the site. Setting clear, realistic goals for the restoration project is essential for success.

Stage 2 – Inspect the project site and surrounding area: conduct an inventory of the site and an inventory of a comparative site (referred to as a reference ecosystem), and identify biotic or abiotic constraints to recovery.

Stage 3 – Conduct laboratory and other analyses, if needed.

Stage 4 – Develop and verify the restoration plan (establish and verify what you want to do) in consultation with interested parties. This plan will document the goals, objectives, and tasks required to complete the restoration project.

Stage 5 – Conduct controlled experiments and field trials (if needed). Operational trials can be used where uncertainty exists. Here, a series of treatments are applied that are expected to result in recovery of the site. Careful documentation of the treatments and results provides information to refine the treatments as needed.

Stage 6 – Conduct the restoration on-site.

Stage 7 – Monitor the restoration site after project completion and make necessary adjustments.

The strategies and practical details of terrestrial ecosystem restoration, such as those use for Garry Oak ecosystems, have their roots in forestry, agricultural, botanical, and horticultural experience. To begin with, reclamation/restoration projects were viewed simply as a soil issue, wherein the soil was raw or unproductive and had to be improved. Routine soil analyses were carried out to determine which nutrients were in short supply. The soil was treated accordingly, and a standard seed mixture was chosen and sown. In other cases, selected plants, such as shrubs or forestry stock trees (Garry Oak, *Quercus garryana*, trees, for example), were planted. This relatively straightforward and narrowly focused approach met with some success (Bradshaw and Chadwick 1980) and was relatively simple to plan. However, as the scope of restoration broadened in recognition of the complexity of ecosystems, practitioners realized that there was a need for detailed and comprehensive site investigations that covered all aspects of the ecosystem, including interests expressed by various stakeholder groups or individuals.

With the development of the holistic concept of natural system restoration (as reflected in the Society for Ecological Restoration's definition of restoration (see sidebar), the concept of a restoration project expanded in scope to include a broader range of activities than in the past, particularly those involving people and social issues. Clewell and Aronson (2007), for example, have proposed the four quadrant model of ecological restoration to address this diversity of interests by explicitly including personal, cultural, ecological, and socio-economic values. The geographic scope of many restoration initiatives has also expanded from a specific site to the landscape scale. Garry Oak ecosystem restoration is very much this sort of initiative, consisting of many small- to medium-scale projects that are integrated on a regional landscape scale.

> "Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed."

This wider scope requires a broad approach to many projects. Consequently, the outline for developing a restoration plan is now more complex and includes an all-important initial step concerning site goals and objectives. As an example of this broader approach, you may want to undertake a simple, small restoration project in your neighbourhood. While you could proceed alone with your project, if you were aware of other nearby projects and the availability of resources, your project might be planned in the context of other projects, and in the long run would be likely to be more successful. You might have just the right spot for a rare plant species or to establish a key connection between two larger areas, but you become aware of this only when considering your project in the broader context (Raphael and Molina 2007). As a background to planning, you may want to look at Clewell et al. (2005) at the Society for Ecological Restoration website (www.ser.org/content/guidelines_ecological_restoration.asp); these authors consider the steps in a restoration project in detail.

5.2.1 Stage 1 – Establish the Context, Goals, and Objectives for the Site

Clear and shared goals are vital to a successful restoration project**.** These goals drive the objectives and tasks, which in turn shape the budget of the project. Unclear goals lead to confusion, and even to conflict among participants. In the case of a team, lack of a clear set of shared goals may result in inconsistent communication with supporting agencies and the public, including those who provided the budget. In other words, do not start doing anything until you know why you and others are doing it. The process of setting goals is a large subject: we will discuss some of the considerations below.

Setting goals consists of identifying the big-picture end points of your project. The goals for some major projects may be pre-specified by legislation and policy. For example, the restoration of roadsides falls into this category. At the other end of the scale, the goal of a small landholder may be to restore his/her backyard to a natural state. Though this goal may seem self-evident, we do need to consider how the landowner defines the "natural state" of the yard. Does the natural state include non-native and native species? Is it a natural state as exists today, or as existed 150 years ago? Are there municipal bylaws (such as tree removal or weed control requirements) that influence what that natural state may look like?

Clear and shared goals are vital to a successful restoration project.

Additional considerations, such as what the local community thinks or whether any adjacent lands or landowners/managers will be affected by the restoration, are also important. By speaking with these people prior to any on-the-ground work, they can help collaborate on the development of goals (if appropriate), and the discussion will help identify any potential issues up front. Many of these potential issues can be addressed in the restoration plan by adjusting goals relatively easily at the outset to avoid the major headaches of amending goals after work has already begun (see Chapter 6: Outreach and Public Involvement). This is particularly important where re-introduction of fire is being considered as a restoration tool. Below are a few steps to take during the development of project goals:

- Develop a list of parties who are interested in the project, such as:
  - landowners
  - adjacent landowners
  - environmental organizations
  - all levels of government, Provincial, Federal, and First Nations, and particularly local and regional
  - local residents
  - land users (recreational, etc.)
  - sources of support (e.g., volunteers, consultants, academic institutions)
- Meet with landowners, land users, and interested parties to develop restoration goals
- Facilitate a discussion of possible targets or end points for the restoration
- Involve those who have raised awareness of the issue through public means such as protests (this is particularly important)
- Establish ongoing communication links with interested parties to ensure feedback
- Establish which laws and policies apply (e.g., watershed restoration in a park will have very different legal requirements than wasteland reclamation). Also be aware of labour laws, union agreements, and other regulations that involve workers.
- Develop a list of resources for the project, as appropriate
- Gather basic background information and descriptions of restoration models and options
- Identify any biotic or abiotic constraints to recovery

These tasks are critical in planning the restoration project. In Section 5.3: Constructing a Plan, we will show how to construct a planning table, which is helpful in developing a schedule and budget for a restoration project.

Sun through the smoke and branches of a Garry Oak during a burn at the Cowichan Garry Oak Preserve in the Cowichan Valley. Fire re-introduction can be an important restoration tool, but often requires extensive consultation with adjacent landowners, permits, expertise, and planning that make it difficult to use in many restoration projects. Project goals may need to be adapted depending on the available tools. Photo: Thomas Munson

Assessing values and setting priorities is a useful and often critical exercise at this stage, since priorities provide a guide for making choices. For example, during the development of the master plan for Gowlland-Tod Provincial Park (just outside of Victoria, B.C.), preservation of the biodiversity of the park's coastal Douglas-fir ecosystem was identified as the first priority goal (BC Parks 1996). Available space for recreation was ranked as a lower priority goal. This important decision was made clear before any detailed planning began. As a result, intensive recreational activities such as mountain biking were restricted to areas of low biodiversity value. Where recreation activities occurred near biodiversity hot spots, such as rare species populations, actions were taken to eliminate the activity, minimize the risk, and encourage passive recovery (no active interference with the population, such as seeding, control of exotics, etc.). In this example, the work of restoration was the elimination of the activity, which allowed the site to restore itself.

It is important to make it clear that specific project details, such as what combination of plants to use, may need to change as new data are collected. However, the goal and priorities should be agreed upon at the outset because it will shape what field work and other activities take place in the next stage.

While the goals state broadly what is to be done, and they provide general direction, objectives state very specifically what needs to be achieved to reach each goal. Good objectives will be "SMART":

SMART: Specific, Measurable, Achievable, Realistic, and Timed (see examples in box below).

Specific – It is better to have many smaller objectives than one large one. It will be easier to communicate and monitor several small precise objectives.

Measurable – Where possible, objectives should be quantifiable. These objectives will determine what ecosystem attributes you select to monitor in later stages of planning. It is also easier to measure when a quantifiable objective has been achieved.

Achievable – There is no sense in having an objective that is not achievable under current circumstances.

Realistic – Do you have the resources to achieve the objective? Similar to the previous bullet, there is no sense in developing unrealistic objectives.

Timed – An objective should state a timeline. People need to know when an objective is expected to be achieved (weeks, months, years). It may be difficult to come up with a timed objective, but even if it is an educated guess, a timed objective will add context, help with consultation, and inform your monitoring plan and schedule. Without time-bounded objectives it will be difficult to know when to monitor.

Setting the objectives well in advance provides an opportunity to discuss the possibility of pre-disturbance tasks in the restoration. For example, if one objective is to have certain tree species colonize a disturbed site, it may be important to plan to leave selected old trees of the desirable species to act as post-disturbance seed sources.

EXAMPLES OF SMART OBJECTIVES

A SMART objective: Within three years (1) the native grass species Blue Wildrye (*Elymus glaucus*) and Alaska Brome (*Bromus sitchensis*) will have a combined cover of 75%, and (2) the invasive Orchard-grass (*Dactylis glomerata*) will have less than 5% cover within the restoration area

A not-so-SMART objective: We would like to remove invasive grasses and encourage extensive growth of native grasses.

The SMART objective provides lots of information and direction to the project. It leaves little question about what is to be done and by when. The not-so-SMART objective, on the other hand, provides little concrete direction and leaves many questions: Which grasses to remove? Which grasses to encourage? When is the project to be finished? How will we know when the project is finished or whether progress is being made? This last question is particularly relevant. When you are asking for money or resources, you need to be able to report on progress, and to do that you need to know exactly what you are trying to do. Monitoring the SMART objective is relatively straightforward because it has specific, measurable, and time-bounded targets. Monitoring success will be difficult to impossible for the not-so-SMART objective: what is “extensive growth of native grasses”—30%, 60%, 90%?

It is important to identify any constraints at this stage. The removal or mitigation of any constraints may form the basis for objective(s) that must be achieved for a project to be successful. Biotic or abiotic factors that constrain natural recovery of a site are often called filters. Identification of the filters that are preventing recovery is one of the most important steps in planning a restoration project. It may be that invasive species such as Eastern Cottontail (*Sylvilagus floricanis*) rabbits are preventing the recovery of a diversity of native plant species. Simply planting the appropriate species will not solve the problem—you need to prevent the rabbits from eating them. Similarly, a rare species may do well where foot traffic prevents excessive growth of non-native grasses. Removal of the foot traffic may, in fact, result in a decline in the rare species. In this case, the invasive grasses are the filter and the foot traffic is inadvertently mitigating the impacts of the grasses.

Erickson and Edain's (1995) description of how to plan a restoration project (www.ser.org/sernw/pdf/FROSTY_HOLLOW_restoration_guide.pdf) takes a different approach to the beginning of a restoration project. This approach first identifies the problem, the cause of the problem, and the setting of a goal that will solve the problem. By contrast, the approach proposed in this publication is broader and begins by asking whether we all think there is a problem, and whether we see the same problem.

5.2.2 Stage 2 – Inspection and Inventory

Site inspection and inventory are vital to successful restoration because they provide the raw data to guide decisions about tasks. Site data also provide the basis for further consultation about the restoration plan and recommendations. In short, good comprehensive data lead to a good restoration plan. Poor or general data with gaps result in a poor restoration plan. Good inventories not only identify specific issues that need to be addressed but also may turn up unexpected values, such as an unknown population of a rare species.

> Site inspection and inventory are vital to successful restoration; good, comprehensive data lead to a good restoration plan.

The discussion that follows outlines some general points concerning inventories, and it briefly mentions typical activities or tasks that fall into the inventory stage (much of this information also applies to monitoring). Chapter 7: Inventory and Monitoring provides a comprehensive description of how to carry out an inventory.

General Principles of Inventory

Collect observations in a standard manner using tested methods: You cannot escape the need for collecting data in a standard, repeatable, and credible manner. This may seem like an overwhelming task because of the diversity of data and technical skills required to collect it. It is important to learn (1) what type of information is most useful, and (2) when you should consult experts. It is important to acknowledge your limitations and consult others with more experience. You might consider taking the standard forms in the *Field Manual for Describing Terrestrial Ecosystems* www.for.gov.bc.ca/hfd/pubs/docs/Lmh/Lmh25-2.htm (BC Ministry of Environment, Lands, and Parks and BC Ministry of Forests 2010) and adapting them to your particular part of the world. The Ground Inspection Form from the manual (see Figure 5.1 Ground Inspection Form) is a comprehensive guide to data collection that is especially related to site location and characteristics and the all-important vegetation component.

British Columbia — GROUND INSPECTION FORM

G ☐ vs V ☐	PHOTO	X: Y:	DATE
PROJECT ID.		SURV.	
MAP SHEET		PLOT #	POLY. #
UTM ZONE	LAT. / NORTH	LONG. / EAST	
ASPECT °		ELEVATION	m
SLOPE %	SMR	SNR	
MESO SLOPE POSTION	☐ Crest ☐ Upper slope	☐ Mid slope ☐ Lower slope ☐ Toe	☐ Depression ☐ Level
DRAINAGE - MINERAL SOILS	☐ Very rapidly ☐ Rapidly	☐ Well ☐ Mod. well ☐ Imperfectly	☐ Poorly ☐ Very poorly
MOISTURE SUBCLASSES - ORGANIC SOILS	☐ Aqueous ☐ Peraquic	☐ Aquic ☐ Subaquic	☐ Perhumid ☐ Humid
MINERAL SOIL TEXTURE	☐ Sandy (LS,S) ☐ Loamy (SL,L,SCL,FSL)	☐ Silty (SiL,Si) ☐ Clayey (SiCL,CL,SC,SiC,C)	
ORGANIC SOIL TEXTURE ☐Fibric ☐ Mesic ☐ Humic		SURF. ORGANIC HORIZON THICKNESS ☐ 0–40 cm ☐ > 40 cm	
HUMUS FORM ☐Mor ☐ Moder ☐ Mull		ROOT RESTRICTING LAYER Depth ________ cm Type____________	
COARSE FRAGMENT CONTENT ☐ < 20% ☐ 20–35% ☐ 35–70% ☐ > 70%			

TERRAIN	COMPONENT: TC1 ☐ TC2 ☐ TC3 ☐		
TERRAIN TEXTURE	SURFICIAL MATERIAL	SURFACE EXPRESSION	GEOMORPH PROCESS
1	1	1	1
2	2	2	2

ECOSYSTEM	COMPONENT: EC1 ☐ EC2 ☐ EC3 ☐
BGC UNIT	ECOSECTION
SITE SERIES	SITE MODIFIERS
STRUCTURAL STAGE	CROWN CLOSURE %

ECOSYSTEM POLYGON SUMMARY

	%	SS	SM	ST
EC1				
EC2				
EC3				

TERRAIN POLYGON SUMMARY

	%	Classification
TC1		
TC2		
TC3		

Figure 5.1 Ground Inspection Form (first page) from *Field Manual for Describing Terrestrial Ecosystems* (BC Ministry of Environment, Lands, and Parks and BC Ministry of Forests 2010)

Make multiple visits: Good field observation for restoration purposes requires more than a single visit. In Garry Oak and associated ecosystems, field visits in the early spring to early summer are especially important for observing various herbaceous species (see box page 5-18, Best Practices for Conducting Rare Species Inventory).

Observe how people use the site and consult them about their interests and concerns: Site visits provide an opportunity to survey the wishes and concerns of the local people. It is a good opportunity to learn traditional or folk knowledge about the site and engage the local community (see Chapter 6: Outreach and Public Involvement).

Make a reconnaissance visit and get a general sense of the restoration site: Often the goal of the first field visit is to look around and get a sense of the scope of the site, both biophysically and geographically. Even in this first visit you must be prepared to make notes and sketches and collect preliminary samples, such as specimens of dominant plant species. Some analyses take many weeks and even months, so the sooner you get started, the better.

Be prepared for your main field visit: Take forms, maps, field guides, and a good field notebook. If you have determined that you need to bring along an expert (in soils, for example), the expert should visit the site along with you, if at all possible. Then all observations will be collected at the same time at the same site.

Make arrangements with experts for identifications and analyses before you start: These experts may provide advice about the site visit, including what you should look for in the way of indicators. You need to advise such experts well in advance that you may need their help in identification. Today, taxonomic experts are especially rare, and weeks or months may pass before they have the time to help, even if you have budgeted payment for their services.

During the inventory stage, in addition to assessing what is on the site, you should be looking for physical attributes, biological features or processes, or human activities that constrain natural processes on the site. These constraints will need to be dealt with during restoration and will likely be the focus of one or more objectives in the restoration plan. These constraints can be thought of as filters. Compaction may be a filter that is preventing recovery where an old road runs through a site (abiotic filter). Invasive species such as Scotch Broom (*Cytisus scoparius*) may be a filter that is preventing recovery (biotic filter). The absence of fire is a filter that plagues many Garry Oak ecosystems (see Chapter 3: Natural Processes and Disturbance). Whatever the case, identification of the filters operating at a site will be critical in developing effective strategies for recovery.

Types of Data

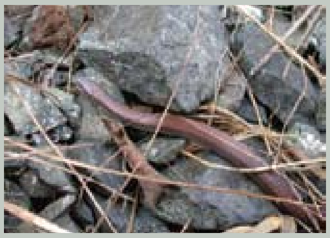
The following point-form summary lists the types of data you can collect, and it provides additional advice on selected points. The list is not comprehensive; however, you can use it to see the tasks that have to be carried out, get a sense of when they can be done, decide what equipment is necessary, and determine if you need to budget for these tasks.

Site description: Location, access, map references, air photo numbers, landforms, drainage characteristics, etc.

Photographs or a video of the site: Images help you recall details of the site after the visit, and they provide a visual baseline condition before the restoration takes place.

Soil description: General depth of soil, coarse fragment or rockiness, texture, drainage, root restricting layer, description of organic material and thickness, presence of earthworms and other biota, moisture regime, nutrient regime, surface Ah horizon depth.

Vegetation description: Vegetation composition often provides an easy way to describe the conditions at the restoration site because it reflects ecological conditions. The plant component of a site can be described simply by preparing a species list. Another approach is to describe plant vigour (how well are the plants growing?). More useful, however, is a description of the abundance and distribution of plant species. A most valuable skill to learn is how to estimate plant species cover by vegetation layer (see Chapter 7: Inventory and Monitoring). If possible, consider collecting data on vegetation composition in an undisturbed site and using it for comparison purposes. This other site may be the reference site, which you would like your site to resemble when restoration has been completed; these comparisons will help you to set your objectives. Also, note the occurrence of weedy invasive species, natural regeneration (a clue to species for restoration), and rare species and their location.



Left: Macoun's Meadowfoam (*Limnanthes macounii*). Photo: Conan Webb

Right: Sharp-tailed Snake (*Contia tenuis*). Photo: Nicole Kroeker

BEST PRACTICES FOR CONDUCTING RARE SPECIES INVENTORY

A qualified person who is familiar with any rare species that are likely to be present in the project area should be hired to conduct inventories. Inventories need to be conducted at the correct time of year. Many rare plants in Garry Oak ecosystems are detectable (or identifiable) only at certain times of the year.

A summer survey, for instance, will miss many of our rare spring flowering plants, such as Threatened Macoun's Meadowfoam (*Limnanthes macounii*), which germinates in the fall and is virtually undetectable by mid-May on most sites. On the other hand, the identification of Endangered Foothill Sedge (*Carex tumulicola*) can be confirmed only in the summer when it is fruiting; at any other time of the year it can be easily confused with more common related sedge species. Red-listed Carolina Meadow-foxtail (*Alopecurus carolinianus*) is a small annual grass that is restricted to vernal pools (small depressions that collect water in the fall, winter, and spring). This species grows very quickly during the summer after the standing water has dried up but before all the soil moisture has evaporated. However, in some years, if conditions are poor, the plants will not germinate.

So, conducting inventories is not as simple as heading out into the field whenever you have the opportunity, because proper surveys need to be planned and performed at the appropriate time of year. Ideally, surveys should be conducted more than once a year at a site to catch the early and the later species, and for more than one year because not all species are visible every year. For some particularly cryptic species it can take a very long time: there are several cases where it took over 50 surveys to detect the Endangered Sharp-tailed Snake (*Contia tenuis*); in one of these cases, it took five years and 62 surveys.

Left: Foothill Sedge (*Carex tumulicola*). Photo: Conan Webb

Right: Carolina Meadow-foxtail (*Alopecurus carolinianus*). Photo: Conan Webb

Measuring tree diameter at breast height (DBH) using a DBH tape. Data about your restoration site must be collected in a standard, repeatable, and credible manner. Photo: Thomas Munson

Weedy species may indicate some form of disturbance that had not been noticed. This disturbance may be as simple as a trail running through the site or the lack of fire. Pay particular attention to why the weeds have established because this will give you clues for designing the recovery systems you will need.

Tree mensuration data: A census of trees, including their size, health, and distribution, note old-growth trees, observe diameter at breast height (DBH), tree height, age at breast height (need an increment borer), signs of disease, scarring, and observed wildlife use.

Weedy species: They may indicate some form of disturbance that had not been noticed. This disturbance may be as simple as a trail running through the site or the lack of fire.

Coarse woody debris: Stumps or logs, which can be a positive indicator of site health.

Wildlife: Presence of animals or sign such as droppings or tracks.

Historical or archaeological features: Shell middens, trees where bark has been stripped, piled rocks that may be cairns, or old building foundations.

Local knowledge: In general, local naturalists and long-time residents may be a particularly rich source of knowledge about wildlife. For example, they may be aware of cougar and bear dens. The birders of a community often keep detailed lists of bird species in an area and may note where nests occur. Nests of raptors are often occupied for many years and become part of the local lore.

5.2.3 Stage 3 – Carry Out Analyses

Once data and any necessary samples are collected, you need to make sense of them to develop the restoration plan. Activities in this stage will vary widely depending on the project and what data have been collected. Some general activities included in this stage are listed below:

- Identify and verify plants and wildlife that were not readily identified in initial inventory visits
- Deposit voucher specimens collected in the field in an appropriate facility (e.g., plants would be deposited in a local herbarium)
- Conduct physical and chemical soil analysis
- Analyze water quality
- Consult experts to interpret results and provide recommendations based on your goals
- Do statistical analyses of survey data/questionnaires

Points 3 ("Site options analysis"), 4 ("Alternatives analysis") and 5 ("Decision") in Erickson and Edain (1995), present a detailed set of suggestions for carrying out an analysis.

5.2.4 Stage 4 – Develop the Restoration Plan

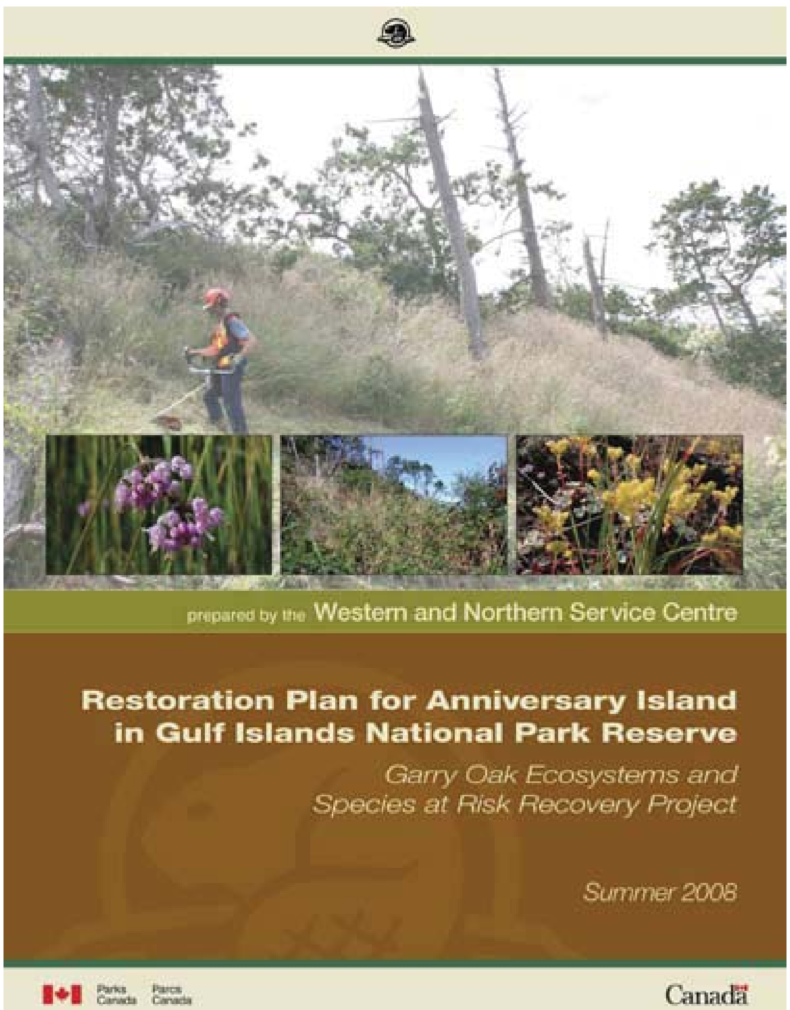
Using the objectives from Stage 1, combined with field data from Stage 2, and analysis from Stage 3, prepare a restoration plan that includes the following:

- Goals and objectives
- Identification of constraints
- Communication plan
- Experimentation and field trials
- Specific detailed restoration instructions and site plan
- Special requirements, such as sources of biological materials
- Consideration of structures to be built or modified
- Monitoring plan
- Schedule of tasks
- Budget, listing costs for each part of process
- A process to verify the budget and a mechanism for monitoring—this step is often forgotten

Erickson and Edain (1995) outline many of the considerations and actions needed when making a restoration plan and beginning to implement it. Think about these when you develop the plan. Also, refer to Appendix 5.1: Restoration Plan for Anniversary Island, which is a full restoration plan for a Garry Oak ecosystem restoration project on Anniversary Island in the Gulf Islands National Park Reserve.

Monitoring is discussed below in Stage 7 but deserves special consideration at Stage 4 as well. Monitoring helps you determine whether you are achieving your objectives. While the actual work of monitoring occurs during or after the work of Stages 5 and 6, it must be planned in advance. A monitoring plan must be fully developed in Stage 4 so that appropriate inventory or baseline data can be collected before any work alters the site. There will not be sufficient money or time to measure everything, so you must choose carefully what you will measure and how. What you measure should be determined by your objectives—you want to determine whether your restoration is achieving your objectives—and if your objectives are SMART, your task will be much easier.

After a draft of the restoration plan has been prepared, it should be shared with all participating parties. This is a chance for consultation and for verifying that everyone agrees on the goals and the tasks. This is also a good time to verify the budget with sponsoring client agencies and interested parties.



Anniversary Island Restoration Plan found in Appendix 5.1 is an example of a restoration plan written for Garry Oak ecosystems.

Monitoring helps you determine whether you are achieving your objectives. It is important to include monitoring in early phases of restoration planning to ensure not only that adequate resources are allocated but also that pre-work data are appropriate for measuring success.

5.2.5 Stage 5 – Carry Out Experiments and Field Trials

Garry Oak ecosystem restoration is still a highly experimental undertaking. We are only now beginning to see the results of some of our efforts after many years of restoration work. Before a large restoration project is implemented, it is wise to check if the proposed treatments will actually work at the site in the manner anticipated. If necessary, run trials for treatments you intend to use but whose effectiveness you are unsure of, consult with others, and thoroughly check the literature to verify the potential for success of your treatment before carrying it out. Many techniques and strategies can be tested on a small scale (e.g., proposed fertilization and planting combinations, fertility/capability of stored topsoil to support seed mixes, germination rates of native species, survival rates of rare species seedlings, resistance of outplantings to herbivores, response of desired species to control of invasive or aggressive native plants, resistance to human use).

Use of a small, well-observed experimental plot might save lots of money and effort in the future and avoid unforeseen results. However, such trials need to be planned in advance and worked into the schedule because their inclusion in the project could push the restoration timeline ahead by several months or even a year into the future.

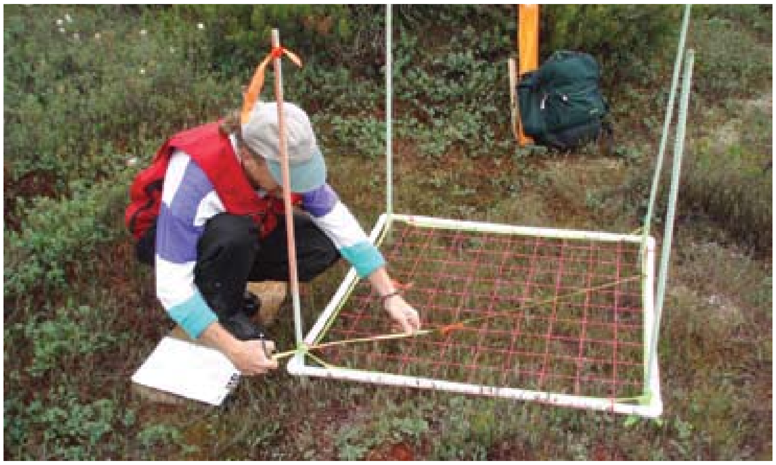
5.2.6 Stage 6 – Carry Out Restoration

The specific tasks involved in a Garry Oak restoration project are covered in several of the chapters in this publication—Chapter 6: Outreach and Public Involvement, Chapter 7: Inventory and Monitoring, Chapter 8: Restoration Strategies, Chapter 9: Alien Invasive Species, and Chapter 10: Species Propagation and Supply. Typical tasks include notifying the participants that work is commencing, preparing the site, and carrying out plantings or removal of invasive species. Be sure to include options in your plan for the schedule or tasks because field conditions change (e.g., atypical site conditions, bad weather, or excessive drought). Large projects should include a specific task to keep track of expenditures and to remain within budget. Having a well thought-out schedule is especially important to ensure that all the resources, such as tools and people, are clearly identified and on-site when required.

All restoration projects should include a plan to communicate progress from the start to the end of the project. Restoration practitioners learn from the mistakes and successes of others, and there is something to learn from any project, no matter how small or unsuccessful. Begin with some sort of pre-restoration notice, then report on progress at some predetermined stage/date during the work. In the end, provide a summary of how the restoration project proceeded and any lessons learned, and an outline for future work once the field work is completed. Even unsuccessful results are important to share with others so they know what has been tried and what techniques to avoid using in their own projects.

5.2.7 Stage 7 – Monitor and Verify Restoration

The importance of monitoring is discussed fully in Chapter 7: Inventory and Monitoring. However, it is worth repeating that in order to determine whether a restoration is successful, observations of the site must continue after the work has been completed. The post restoration data should be compared to the original data and the targets specified by the objectives. To be effective, monitoring must measure critical biological and physical features of the site that indicate whether or not the



A common method of monitoring vegetation involves using 1 m x 1 m quadrat frames. Site observations must continue after restoration activities in order to gauge the success of the restoration project. Photo: Thomas Munson

> Monitoring is the process of making repeated measurements to detect change over time.

objectives of the restoration are being met (Harwell et al. (1999) discuss some of these characteristics). These attributes are often referred to as indicators.

The concept of monitoring is very important because restoration is a long-term activity. However, in practice, there is considerable confusion about what "monitoring" actually means, as well as what is involved in carrying it out.

Two other similar terms—evaluation and assessment—are often used in place of the word monitoring, but they have different meanings. Evaluation is the process of determining whether the work is being done correctly. For example, you can evaluate whether the right number of plants were planted in the prescribed pattern. Assessment is the process of comparing the results or condition of an indicator attribute to a desired condition. For example, a coarse woody debris (CWD) assessment involves carrying out an inventory of CWD and comparing it to the desirable standard or condition (how many pieces or what volume per hectare), which should be specified in the objectives.

> To be effective, monitoring must measure critical biological and physical features of the site that are linked to the restoration objectives.

Monitoring strictly addresses the question "Is the baseline condition changing?" In other words, is the restoration progressing in the direction set out in the goals? Are the objectives being achieved? Monitoring may also be used to determine whether a desired condition is persisting or whether changes are occurring. It involves repeated visits to a site and collecting data in a similar or standard manner on each visit.

A monitoring plan should identify what is to be measured and observed, where and how frequently, and by what standards. Such a plan should be included in the restoration plan prepared in Stage 4. If needed, make sure that any structures and signs for monitoring are installed during this or the preceding stage. After you carry out the monitoring observations, make sure you deposit them in a secure and accessible place where others can use them. Key data have a tendency to disappear if no one is identified as their steward. Part of the process of monitoring involves communicating the results. In effect, the monitoring stage provides an opportunity to report on long-term progress of a project and demonstrate that the project is progressing. If progress is not being made as planned, then the monitoring stage provides an opportunity for taking corrective action. **A key task in developing a monitoring plan is to ensure that there is sufficient budget to monitor for the interval required.**

5.3 Constructing a Plan

Written plans are very important documents, especially for large and complex projects. They can be constructed in many ways, such as flow charts, point-form to-do lists, and text documents.

> A planning table is a straightforward and effective tool for developing a restoration plan.

Many restoration plans not only involve tasks but also integrate schedules and budgets. A planning table is a straightforward and effective tool for developing a restoration plan. In a table you can list the tasks, and for each task, list the required resources and budget. These tasks can then be organized in chronological order to form a schedule. The table serves as a living guide to the project, and helps you check at a glance whether your tasks are organized in a realistic manner, whether or not the tasks are getting done, and how the project schedule and budget are progressing. A planning table can always be adjusted as the project moves forward. It also provides a tool for reporting to project supporters and interested parties.

Because the restoration stages cover the full range of tasks involved in restoration and set out the flow of a project more or less in chronological order, they can be used to help order restoration tasks and ensure that none are missing. For complex projects, such as restoring a native Garry Oak ecosystem in a large park, planning under each of the stage headings is necessary. In smaller projects, such as restoring your backyard, some of the stages, such as carrying out lab analyses, may be omitted. Even if little or no budget is involved and the schedule is mostly up to you, a planning table helps you order your tasks. The columns of a planning table can be filled out as follows and as modelled in Table 5.1. Restoration stages are listed in the first column of the table. They help group project tasks, which are the drivers and measures of a project's progress. They are the things you have to do, and for which you need to find the resources, budget, and time.

Tasks are listed in the second column of the table, grouped by stage. For example, under the first stage, in which you establish the context and objectives for the project, there are typically several tasks that need to be done, such as developing a list of interested parties; gathering background information; facilitating a discussion with the interested people to outline possible targets or end points for the restoration; checking on applicable laws, policies, and strategies; and establishing a means of regular communication. It is not so important to place each task precisely under an appropriate restoration stage, but it is important to list all the tasks that need to be done.

After you list the tasks, you then need to sort out who will do them. The "who" column provides project managers an opportunity to list potential volunteers, funding agencies, and individuals with key expertise. The "who" column also enables you to make sure that for every task there is somebody assigned to complete it. For example, you do not want to get a project underway and discover that nobody checked on municipal bylaws concerning the removal of exotic plant debris or use of noisy machinery.

Once the people or agencies that will complete the tasks are identified, they need to be provided with the tools or resources for the work. For example, in the case of a broom pull by volunteers, somebody has to ensure that the pullers, cutting tools, and collecting tools (tarps), plus perhaps refreshments for the volunteers, are all brought to the site. Even in Stage 1, resources are needed. Gathering interested parties together requires arranging a meeting place and providing refreshments. The task of obtaining background information may require access to a vehicle or other travel means. Stage 2 may require all sorts of field sampling equipment, according to the nature of the inventory. These resources can be entered in the fourth column.

The "who" column provides project managers an opportunity to list potential volunteers, funding agencies, and individuals with key expertise.

Based on the resources required for each task, you can fill out the fifth column with the estimated cost. For example, funds will be required to purchase or rent resources such as tools, and expert consultants generally charge a fee for their time. You can estimate the value of volunteer time and that of donated expert services, equipment, and facilities. Many granting agencies specifically require an estimate of in-kind materials and volunteer time. These in-kind contributions demonstrate commitment of the community or participants to the project. The budget column ensures that you have a full cost accounting, and it can help you justify or explain the cost of the project and develop a grant application. The budget entries also allow you to keep track of expenditures by category as money is being spent.

The budgeting exercise helps project leaders see whether they have distributed the costs realistically (e.g., Stage 7, monitoring and making adjustments, often receives insufficient or no funding). If you invest all or most of your funding in Stages 2 and 6 and very little in monitoring, you may never know whether or not you achieved the restoration objectives. As well, if things go wrong, there will be no money or few resources to make corrections. As a guideline, the monitoring stage should be at least 10% of the overall budget, and in some cases even 15–20%, particularly if detailed observations are required for several years and/or the treatment is highly experimental.

As a guideline, the monitoring stage should be at least 10% of the overall budget, and in some cases even 15–20%.

Having a well thought-out schedule is critical for achieving success with the restoration project. Filling out the final column of the planning table allows you to schedule each task. The drafting of a schedule, even if only by season, reveals how long a project may realistically take to complete. If permits and various meetings are required, time needs to be allocated for these tasks before any ground work is initiated. Furthermore, certain types of tasks are constrained by the season. For example, a full inventory and mapping of rare plants in Garry Oak ecosystems should be conducted from mid-spring to early summer. Also, the removal of invasive plants at a time when rare plants are not visible could be disastrous if the locations of rare species have not been identified. Conversely, many rare plants are less sensitive to disturbance in the summer when they are dormant. Therefore, scheduling must be assessed on a site-by-site basis using the expertise of your project team. Planting of seedlings or sowing of seeds can be more successful when carried out in the fall and winter; therefore, the schedule needs to be built around these constraints. Often this means working back in time from a critical season so that Stage 1 begins early enough before the actual work in the field is required. This means that community consultation meetings may need to be held many months (or years in the case of large, complex projects) before any on-the-ground work begins.

The specific information you need to develop a planning table is provided in many chapters of this publication. Remember, tasks do not have to occur in a specific stage; they may occur in various stages of the project. It is up to the project planner or team to determine where they fit best in the table.

TABLE 5.1 Example Restoration Planning Table

Restoration Stage	Task	Who	Resources	Budget	Schedule
Stage 1	Talk to stakeholders (neighbours, site users, owners)	John	Pen and paper, background information	1 day	January–March
Stage 1	Determine goals	John/Lisa			January–March
Stage 2	Inventory site	John, Botanist, Restoration practitioner	Camera, notebook, plant press	2 days consultant fees in-kind	April
Stage 4	Write restoration plan	John/Lisa	Computer lab/office space	5 days	May
Stage 4	Consult with experts and stakeholders	John/Lisa		2 days	May–June
Stage 6	Recruit volunteers	John/Lisa	Print shop	$25 (poster printing)	August
Stage 6	Source tools to borrow	Lisa	Borrowed tools		June–August
Stage 7	Collect before photo-point photos	John/Lisa	Camera, notebook, scale pole, tripod, compass, chalkboard, chalk	1 day	August
Stage 6	Pick up lunch for volunteers	John	Car	$50	August
Stage 6	Meet volunteers and remove broom	John/Lisa	Borrowed tools, food	1 day	August 25
Stage 7	Collect after photo-points	John	Camera, notebook, scale pole, tripod, compass, chalkboard, chalk	0.5 days	August 26
Stage 7	Write summary report	John/Lisa	Computer lab/office space	1 day	September 1

5.4 Conclusions

Whether a Garry Oak ecosystem restoration project is small or large, planning will always be vital. It will help you grasp the full scope of the project and identify what needs to be done and by whom. Furthermore, the plan will help you develop a realistic schedule and budget. Without some sort of systematic planning, the project may end up being unrealistic, have gaps, run into problems in the community or on the ground, and lead to unnecessary effort, costs, and even failure. Considering the great task we have before us, it is an absolute must to work in a well-organized and effective manner.

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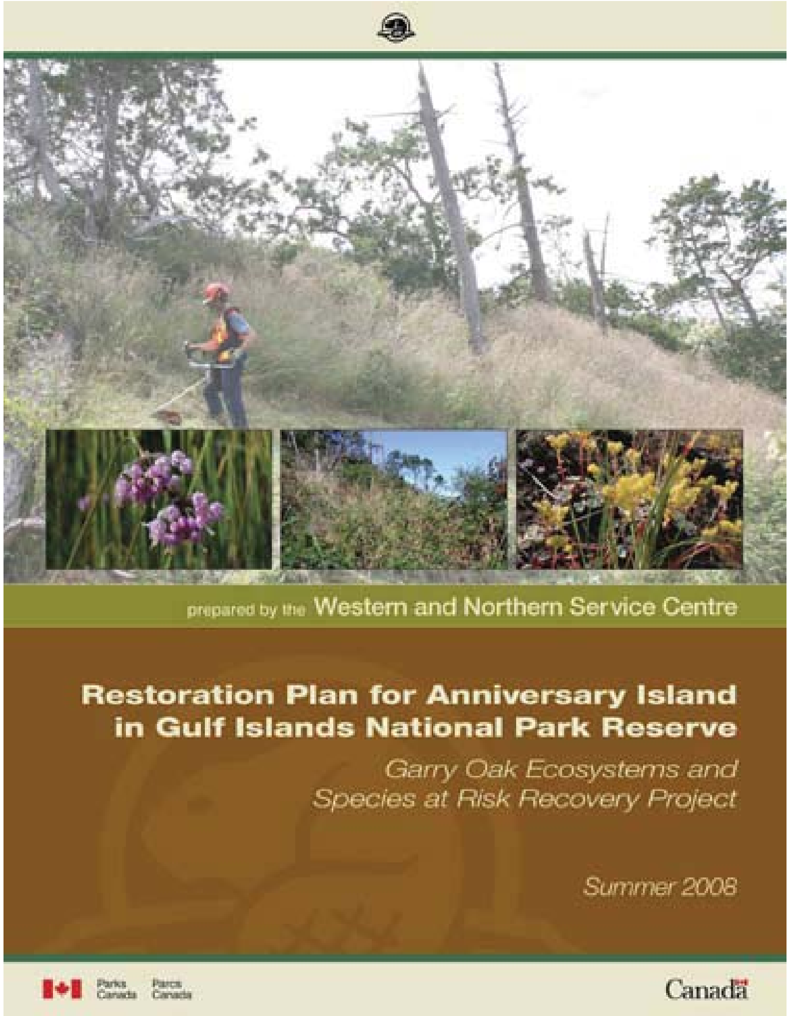
Appendix 5.1

Restoration Plan for Anniversary Island in Gulf Islands National Park Reserve

Report prepared by Marian McCoy and Nicole Kroeker, Western and Northern Service Centre, Parks Canada, with input from the Garry Oak Ecosystem and Species at Risk Recovery Project (GOESARR) Coordinating Committee, Conan Webb, and Phil Lee.



Plan begins on following page.

prepared by the Western and Northern Service Centre

Restoration Plan for Anniversary Island in Gulf Islands National Park Reserve

Garry Oak Ecosystems and Species at Risk Recovery Project

Summer 2008

Parks Canada Parcs Canada

Canada

Approval signatures

Signature: _Brian Reader_ Aug. 21/08

Brian Reader	Species at Risk Ecologist	
Name	Title	Date

Signature: _R. Hamilton_ AUG 26, 2008

Ron Hamilton	GINPR Superintendent	
Name	Title	Date

Cover photo

Main: Species at Risk field crewmember cutting agronomic grasses in polygon B on the northeast side of Anniversary Island.

Left inset: Native nodding onion (*Allium cernuum*) is scattered throughout exposed grassy areas on Anniversary Island.

Centre inset: Photo of Himalayan blackberry infestation along the bottom bench in polygon B taken in 2005. The blackberry was subsequently removed.

Right inset: Native broad-leaved stonecrop (*Sedum spathulifolium*).

Report content

Report prepared by Marian McCoy and Nicole Kroeker, Western and Northern Service Centre (WNSC), with input from the GOESARR Coordinating Committee, Conan Webb (WNSC Ecosystem Scientist), and Phil Lee (WNSC Monitoring Ecologist).

A concept report by Dave Polster (Polster Environmental Services, 2007) provided the basis for the approach to controlling agronomic grasses adopted in this restoration plan.

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Figures

Tables

1.0 Restoration plan overview

This document describes the restoration plan for Anniversary Island for implementation under the Garry Oak Ecosystems and Species at Risk Recovery (GOESARR) project, as funded by Priority Investment Fund for Species at Risk Recovery. It is designed to extend to 31 March 2009; however, some elements will continue beyond that timeframe.

This restoration plan elaborates upon the activities described in the Environmental Assessment Screening Report form GI07-05 *Restoration Plans for Anniversary Island and Eagle Island*, which was submitted to the First Nations committees for comments and subsequently approved by the Gulf Islands National Park Reserve management team. This plan covers the same elements presented in the environmental assessment report, but provides more detail, a monitoring protocol, communications and outreach plan, and a workplan. This plan is also based in part on a report submitted by Polster Environmental (2007) that discusses restoration concepts for Anniversary Island and Eagle Island. Readers are invited to refer to these documents to see the contents in their original form.

This restoration plan follows an ecosystem-based adaptive management approach (*sensu* Johnson 1999). Adaptations to the plan will be made as we apply treatments, monitor using ecologically sound methods, and learn. Changes to this restoration plan, all data collected, results of monitoring, and modifications to methods will be recorded routinely and reported annually to Parks Canada staff. Significant revisions to the plan must be vetted by the GOESARR Coordinating Committee.

2.0 Goals

The overarching goal of this restoration plan is to improve the ecological integrity of Anniversary Island. With respect to Canada's national parks, ecological integrity means, "…a condition that is determined to be characteristic of its natural region and likely to persist, including abiotic components and the composition and abundance of native species and biological communities, rates of change and supporting processes (Canada National Parks Act 2000)".

At Anniversary Island, where "natural region" includes coastal Douglas-fir, Garry oak and associated coastal bluff ecosystems of the Strait of Georgia Lowlands, ecological integrity is relatively intact. Native plant communities are estimated through informal survey to comprise at least 75% of the total cover (C. Webb pers. comm. 2008); however, advancing infestations of agronomic invasive grasses and Himalayan blackberry are threatening the native communities and are establishing a new steady state in the vegetation (Polster 2007). Achieving the restoration goal therefore involves removing the key threats to ecological integrity so that existing native plant communities can persist with a minimum of human intervention. As such, this restoration plan does not aim to modify all of the island's ecosystems. Rather, activities are focused on repairing specific degraded areas using an integrated pest management approach and methods that are sensitive to the presence of native flora and fauna, and cultural features. The objectives, targets, and monitoring protocols described in the next sections are directly linked to the restoration goal.

3.0 Site description

3.1 Overview

Anniversary Island is a 1.8 hectare islet located about one kilometre northwest of Saturna Island, within the Belle Chain Islets, in the Strait of Georgia at N48°49’00” W123°11’00” (NAD83) (Figure 1). At its widest point, Anniversary Island is ~ 47 m across. Its long NW-SE axis is ~ 449 m excluding the un-vegetated rocky shoreline. This narrow islet is a mosaic of rocky outcrops with thin soils and patches of deeper soils that are sufficient to support dense shrub thickets and some trees throughout the middle section. Both sides of the islet drop steeply to the bedrock shore.

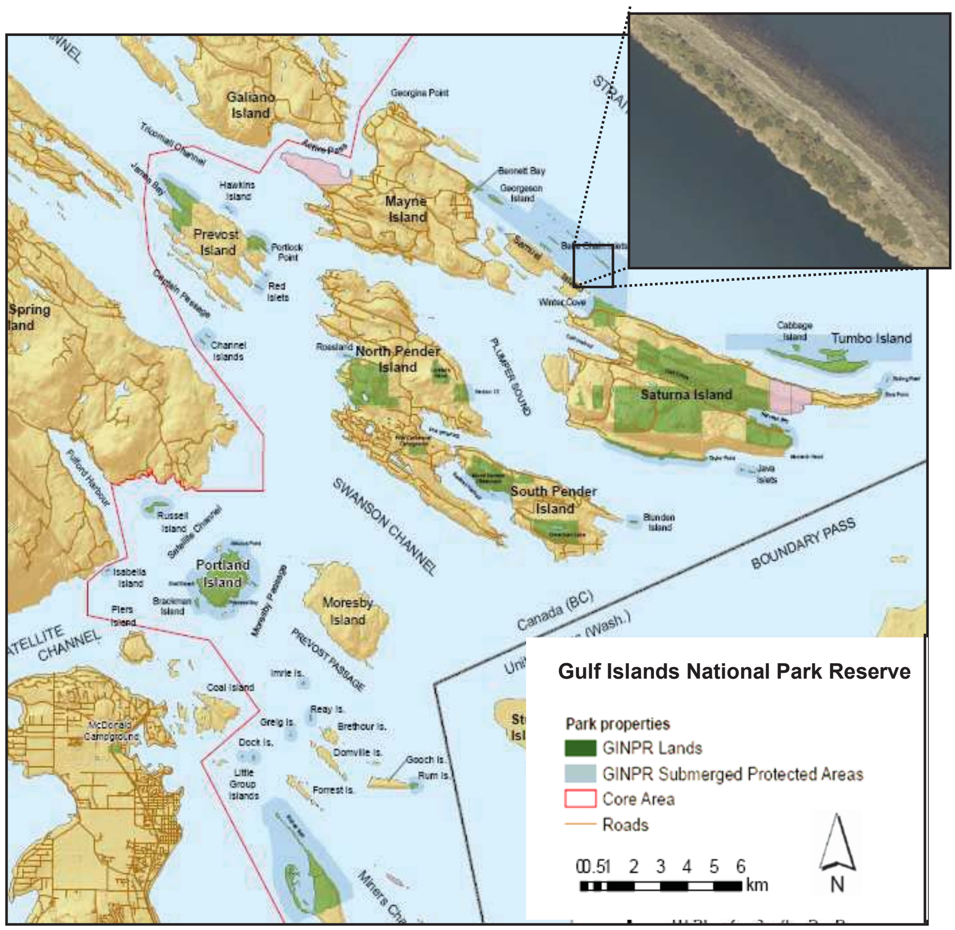

Figure 1. Map showing location of Anniversary Island in Gulf Islands National Park Reserve.

3.2 Ecological conditions

Anniversary Island lies within the moist maritime subzone of the coastal Douglas-fir (CDFmm) biogeoclimatic zone. It is primarily a coastal bluff ecosystem dominated by dense, shrubby Garry oak (*Quercus garryana*), snowberry (*Symphoricarpos albus*), Nootka rose (*Rosa nutkana*), and mature seaside juniper (*Juniperus maritima*)[1]. Several stunted Douglas-fir (*Pseudotsuga menziesii ssp. menziesii*) and once-mature snags are also present. Coastal bluff ecosystems are naturally rare throughout eastern Vancouver Island and the southern Gulf Islands. These ecosystems are of increasing concern due to development pressure, increased recreational use, and exotic species infestations. Anniversary Island is designated as Zone 1 (Special Preservation), meaning that only authorized access is permitted [2]. Among animal species that utilize Anniversary Island, of special interest in this restoration plan is the black oystercatcher (*Haematopus bachmani)*.

Seven plant community types have been identified on Anniversary Island. Rather than occurring as discrete units on the landscape, these plant communities tend to exhibit common elements and often grade into one another, although some may occur in clearly defined pockets depending on micro-site variations. Details regarding these plant community types and how they were classified are provided in Appendix 1. Figure 2 shows the plant community types identified for Anniversary Island by Blackwell *et al*., (2007) using a terrestrial ecosystem mapping methodology.

Despite infestations of agronomic grasses—primarily common velvet-grass (*Holcus lanatus*), sweet vernalgrass (*Anthoxantham odoratum*), Kentucky bluegrass (*Poa pratensis*), orchard grass (*Dactylis glomerata*), and Himalayan blackberry (*Rubus armeniacus*), Anniversary Island is generally ecologically intact. Sufficient native species diversity and cover (estimated ~75%, C. Webb, pers. comm. 2008) remain to warrant restoration of the degraded areas.

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[1] Described in Adams, R. P. 2007. *Juniperus maritima*, the seaside juniper, a new species from Puget Sound, North America. Phytologia 89: 263 - 283.

[2] Access is permitted for such activities as research or restoration work, or when authorized by the park superintendent in advance.

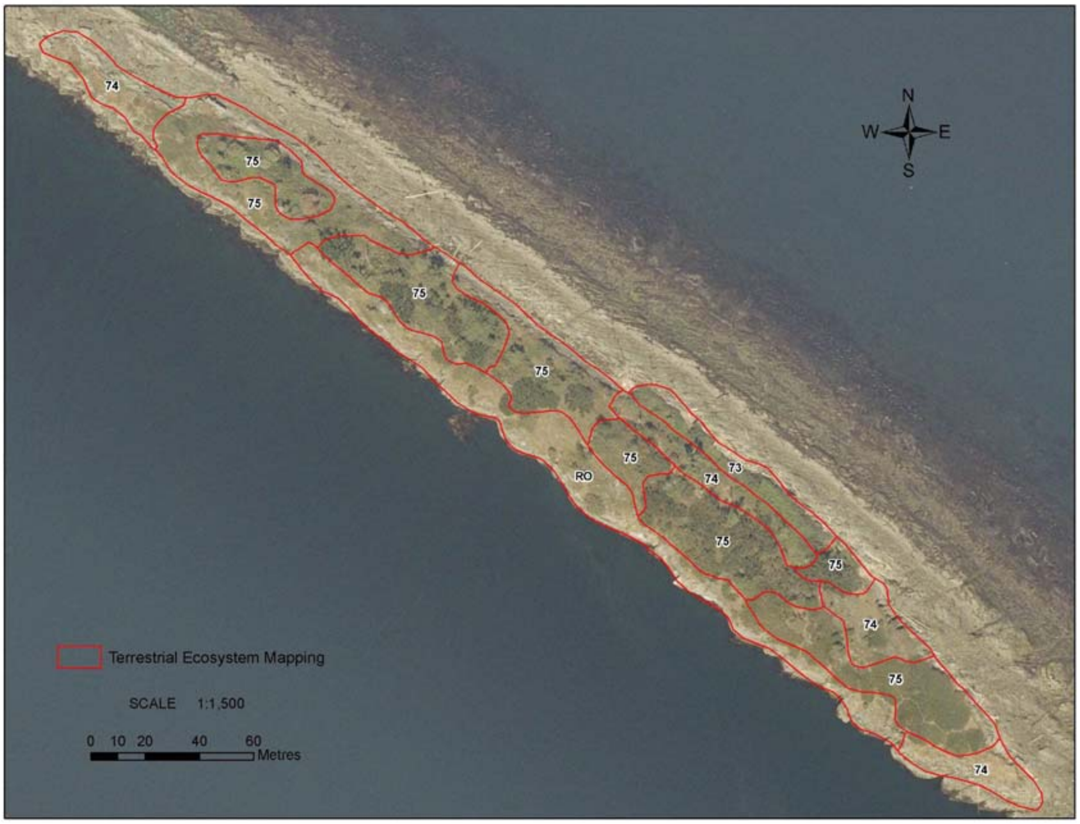

Figure 2. Plant community (site) types identified for Anniversary Island by Blackwell (2007) using terrestrial ecosystem mapping methodology. Site types are described in Appendix 1.

3.3 Ecological degradation

Infestations of invasive exotic plant species noted above are considered the primary cause of ecological degradation on Anniversary Island and are the focus of this restoration plan. Between 2003 and 2006, volunteers devoted several days of work to clear two areas of Himalayan blackberry by hand-cutting and some root ball removal (Figure 3). Due to these efforts, by 2008 native shrubs within and around the perimeter of this area have expanded by more than a metre in height and breadth.

Unfortunately, agronomic grasses that were present around and among the blackberry (Figure 4) have also expanded. Common velvet-grass now dominates in the bench and up the slope seen in Figure 3, and in other locations where Himalayan blackberry was removed. Native shrubs can be expected to continue advancing. In time, they may out-compete the agronomic grasses. This restoration plan aims to ensure and expedite that process through an integrated pest management approach of repeat cutting and re-vegetation with appropriate native species as recommended by Polster (2007).

Figure 3. June 2004 photo of Himalayan blackberry removal area on southeast side of Anniversary Island. This area is now the primary agronomic grass treatment area (polygon B) in this restoration plan. (Photo: Parks Canada).

Figure 4. June 2004 photo of Himalayan blackberry removal area on southeast side of Anniversary Island. Agronomic grasses are visible in background and lower right. This area is now part of the primary agronomic grass treatment area (polygon B) in this restoration plan. (Photo: Parks Canada).

3.4 Cultural features

In July 2007, an archaeological crew spent a half-day conducting a reconnaissance of Anniversary Island. This cursory survey indicated that the island was most certainly used by First Nations. While some features were detected on the southern half of the island, dense shrub oak, rose, and Himalayan blackberry thickets limited visibility and other features could have been missed. There are camas patches on the island, including two small meadows that appear to have been cleared of rock. These have been recorded as archaeological sites. Areas with clear evidence of intense burning are also present, and these may be the remains of camas roasting pits. Significant fire scars are also evident on some of the older juniper trees but these scars have not been dated or otherwise analyzed.

3.5 Disturbance

Ecosystem structure and function are influenced over time not only by natural disturbance processes, such as soil disturbance by mammals, but also by pre-historic and historic influences such as managed fires, digging for camas, and the introduction of exotic species.

Today, primary disturbance processes include wind-throw, exotic plant species, slides and runs created by northern river otters (*Lontra canadensis*), and by people using or creating pathways. While disturbance has an important influence on Anniversary Island plant communities, edaphic factors (primarily soil depth and moisture) appear to control the general plant community structure. Once target exotic plant species are controlled, edaphic factors are expected to maintain an ecologically acceptable vegetation structure. One exception (there may be others) is a cultural feature at the south end of the island. In the absence of site-specific management, it is possible this feature will succeed to native shrub thickets; however, monitoring and research are needed to determine which management actions are appropriate (see recommendations in section 7.2).

4.0 Objectives and targets

With the exception of exotic species infestations described previously, native plant communities on Anniversary Island are relatively intact. There are no plans to modify these communities within the timeframe of this project. The objectives of this restoration plan are therefore focused on removing Himalayan blackberry, replacing agronomic grasses with native shrub species in specific treatment areas, and removing isolated occurrences of other target exotic plants. This will facilitate a return to higher native species diversity and ecological integrity on Anniversary Island. The target treatment areas (polygons) are shown in Figure 5, below. All treatment and monitoring methods are described in Section 5.

This restoration plan has three objectives:

1. Replace infestations of agronomic grasses (polygons A and B) with native shrubs;
2. Permanently remove large Himalayan blackberry thickets (polygons A, B, C, D, E, F);
3. Permanently remove smaller Himalayan blackberry occurrences and other high priority invasive exotic plants that occur incidentally throughout the island.

Figure 5. Orthophoto of Anniversary Island annotated with polygons showing treatment areas.

4.1 Objective 1—Replace agronomic grasses in polygons A and B

As described above, polygons A and B are areas where Himalayan blackberry was removed and existing agronomic grasses subsequently expanded. The density of these two infestations has reduced the available habitat for native flora, and possibly fauna, on the island. In polygon A, the grass infestation has been limited by re-infestation of Himalayan blackberry and an expanding patch of stinging nettle (*Urtica dioica*). In polygon B, the grass infestation is most dense along the lower part of the slope and along the bottom bench where blackberry was previously removed.

The target for objective 1 is to establish > 80 percent native species cover in polygon A and along the bottom bench in polygon B. Nootka rose, wild clustered rose, snowberry, oceanspray, and krummholtz Garry oak are the predominant native shrub species on Anniversary Island. Because rose and snowberry tend to form dense layers beneath which agronomic grasses do not dominate, and because they are most easily propagated from cuttings, these species will be used for re-vegetation. There is no intent to use pesticides on the agronomic grasses on Anniversary Island. Longer term plans to restore native plant biodiversity in polygon B are discussed in section 7.1. Indicators and management prescriptions are summarized in Table 1. Management effectiveness will be monitored and evaluated by sampling plant species percent cover.

Table 1. Objective 1 indicators and management prescriptions

Indicator	Management
Total native species cover in polygons A and along the bottom bench in polygon B > 80% within 4 years after baseline.	On-going monitoring; adapt treatment if required after 4 years.
Total native species cover in polygons A and B < 80% at 4 years after baseline.	Adapt to problem areas using different methods of treatment, e.g., carpet knife to cut out strongly tufted species, change planting density/species mix. Apply more aggressive on-going maintenance as appropriate.

4.2 Objective 2—Remove Himalayan blackberry in all polygons

In summer 2007, a survey for exotic invasive plant species was carried out and polygons delineating infestations were mapped using a GPS. This and other surveys revealed Himalayan blackberry thickets of varying size throughout the island and particularly in the treatment polygons (A, B, C, D, E, F). Polygons A and B have been partially re-invaded with blackberry after previous removal efforts; Polygons C and F comprise blackberry thickets among a native shrub community; Polygon D is comprised of roughly 90 percent blackberry; and Polygon E is comprised of intermediate sized thickets scattered along an open meadow on the west side of the island.

Thickets and patches will be controlled through cutting and treating stems with a pesticide in accordance with a Parks Canada Integrated Pest Management Plan (IPM) approved in March 2008. Where necessary to ensure that one exotic species is not replaced with another, bare patches and/or agronomic grasses that might exist under the thickets will be re-vegetated with native plants using methods appropriate to the site, but generally following those used in polygon B.

The target for objective 2 is to replace large and medium Himalayan blackberry thickets with native species within two years of baseline (Aug 2008). Indicators and management prescriptions are summarized in Table 2. Management effectiveness will be monitored and evaluated by sampling plant species percent cover.

Table 2. Objective 2 indicators and management prescriptions

Indicator	Management
Total occurrence of Himalayan blackberry in all polygons decreases by 75% or more within 2 years from baseline.	On-going monitoring.
Total occurrence of Himalayan blackberry has decreased by less than 75% at 2 years from baseline.	If re-sprouting occurs within 6 months, follow up with repeat cutting or pesticide treatment. Dig out root ball as last resort and immediately replant. with fast-growing native species suited to site.

4.3 Objective 3—Remove incidentally occurring exotic plants

Outlying occurrences of single plants or patches of Himalayan blackberry and other invasive exotic plant species on Anniversary Island have the potential to spread and displace native species; however, not all exotic species demonstrate invasive tendencies. This makes it neither necessary nor effective to treat all exotics equally. Prioritizing when and which species to treat facilitates effective treatment and allocation of resources.

Table 9 in Appendix 2 lists the known exotic plant species on Anniversary Island as of 2007. Species identified as top priority for treatment (highlighted in grey) were selected based on each species' degree of infestation, relative ease of treatment, and significance of impact on the ecosystem, using past experience and the *General Decision Process for Managing Invasive Plant Species Garry Oak and Associated Ecosystems* (GOERT 2007) as guides. This list should be revised as new data are collected and treatments applied.

Although common velvet-grass, sweet vernal-grass and orchard grass are identified as top priority species, their predominance and difficulty in controlling them precludes them from being treated outside the treatment polygons. See recommendations in section 7.1 regarding longer-term agronomic grass management.

The target for objective 3 is to reduce the total number of priority exotic plant occurrences (excluding agronomic grasses) on Anniversary Island by at least 75 percent relative to the baseline (July 2008). Table 3 summarizes the indicators and management prescriptions for objective 3. If new methods are found that have proven effective for treating agronomic grass species elsewhere, and these are appropriate to Anniversary Island, they will be considered for use.

Table 3. Objective 3 indicators and management prescriptions

Indicator	Management
Total occurrence of priority exotic species decreases by 75% or more within 3 years from baseline.	On-going monitoring and maintenance as needed.
Total occurrence of priority exotic species has decreased by less than 75% at 3 years from baseline.	Assess and adapt treatments to address either an increasing rate of infestation or methods that are ineffective for existing occurrences (e.g., same plants are re-sprouting).

5.0 Methods and materials

5.1 Protection of cultural features

This restoration plan takes into account the presence of cultural features on Anniversary Island. Details regarding the nature and location of known features are provided in Appendix 4, which must be referred to prior to commencement of any work. A thorough archaeological survey will take place in August 2008, after blackberry thickets have been removed thereby making it possible for archaeologists to see the ground. Cultural features will then be accurately mapped and future work planned accordingly.

Throughout the work described below, a key consideration is to avoid damaging or altering cultural features. As such, non-mechanical methods will be used whenever feasible (e.g., hand sheers, rakes, loppers). The use of gas-powered equipment will be kept to a minimum and will not be used to cut close to the ground.

5.2 Mitigating wildlife interactions

Islets within GINPR are home to a number of sensitive wildlife species. Of special interest is the black oystercatcher (*Haematopus bachmani).* Because they are confined to a narrow band of shoreline habitat, populations of this large shorebird are vulnerable to natural and human disturbances including predation of eggs and young by native and introduced predators, coastal infrastructure development, and human disturbances such as induced nest abandonment and trampling. This species is an important indicator of rocky inter-tidal community health and is part of the Parks Canada Ecological Integrity Monitoring Program (Parks Canada 2008). Black oystercatchers are present on Anniversary Island (Butler and Golumbia 2008 [in press]).

This restoration plan takes into consideration the presence and activities of the black oystercatcher. A survey will be undertaken in June 2008 to evaluate this species' presence and nesting activity. Findings will be reported to the park ecologist and activities planned to avoid nest areas. Gas-powered equipment such as a brush saw and a weed whip will not be used within 20 m of black oystercatcher nests. Workers will avoid traversing inter-tidal areas unless necessary for personal safety.

5.3 Exotic vegetation treatment

The following sections describe treatment methods for specific vegetation. Whenever possible, vegetation will be cut/removed using hand tools. A gas-powered brush saw and a weed whip will be used to cut grasses in parts of polygons A and B. A brush saw with a blade may be used to cut the upper portions of Himalayan blackberry thickets. Use of gas-powered equipment will follow safety requirements (i.e., appropriate face and leg protection, and steel-toed boots), and with respect to cultural features as discussed above.

5.3.1. Agronomic grasses (objective 1)

Control of agronomic grasses will focus primarily on parts of polygons A and B. The most abundant exotic grass species in those polygons is common velvet-grass, although orchard grass, sweet vernal-grass, and Kentucky bluegrass (*Poa pratensis*) are present in high numbers.

Common velvet-grass forms dense stands that exclude other plants and reduce species diversity, and there is evidence that it may have an allelopathic effect on other plant species (Bond et al., 2007). Common velvet-grass can be controlled by intensive mowing or grazing. Seed persistence varies depending on seed depth in soil, but can be as long as ten years (*Ibid*), while sweet vernal-grass seeds do not remain viable for more than a year. Because of these and other characteristics, agronomic grasses can be difficult to control without broadcast spraying with non-selective pesticides such as glyphosate. Due to the ecological sensitivity of Anniversary Island and the nature of non-selective pesticides, their use is not desirable. Instead, grasses will be repeatedly cut to deplete their energy reserves, and native shrubs planted to out-compete them, as recommended by Polster (2007).

Starting in June 2008, exotic grasses in polygons A and B will be cut, mulched, and left to decay *in situ* to suppress re-infestation until native shrub cuttings and live stakes are planted in the fall. For safety and to avoid damage to native species and features on the ground, hand shears will be used where possible. In some cases, hand-pulling is necessary to avoid damaging co-occurring native grasses. In flatter areas where native species can be avoided, a gas powered weed whip will be used.

The first cutting will be at the time of anthesis [3] (typically early June depending on seasonal weather), and repeated through the summer when grasses are at maximum re-growth. The same protocol will be required in 2009 prior to native shrub planting, and possibly again in 2010. Where native species already occur or have been planted, grass cutting will be done by hand to avoid damage.

5.3.2. Woody shrubs (objectives 2 and 3)

Himalayan blackberry is the main woody shrub of concern on Anniversary Island. In July 2008, blackberry thickets and patches will be cut and then spot-treated with a selective pesticide following the methods described in the approved IPM. The method for cutting

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[3] The period during which a flower is fully open and functional.

thickets will follow the protocol that was described in the approved Environmental Assessment Screening Report form, i.e.: as required, an experienced operator will use a brush saw to carefully remove the exterior canes from one side of the thicket, working from the top down. This will allow the operator to see to the ground for objects. The operator will continue to cut, but no lower than 50 cm above ground. Immediately before pesticide application, hand loppers will be used to open a fresh cut to receive the pesticide. Smaller blackberry plants (objective 3) will be cut following the same protocol except loppers and rakes will be used instead of a brush saw. The initial cutting does not need to take place on the same day, as long as stems are re-cut immediately before pesticide treatment.

Other invasive exotic woody shrubs such as Scotch broom (*Cytisus scoparius*) or gorse (*Ulex europaeus*) are not present on Anniversary Island. Two paradise apples (*Malus pumila*), an exotic species with invasive tendencies, have established at the north end of the island. In June 2008, both trees were heavily infested with a defoliating insect and were in poor condition. They will be monitored and repeatedly cut if necessary.

5.3.3. Forbs (objective 3)

Target forb species listed in Appendix 2 (Table 9) will be removed by hand, by either cutting or careful hand-pulling. Re-vegetation will be carried out in accordance with the guidelines described in section 5.4.6.

A small patch of burr chervil (*Anthriscus caucalis*) was identified at the north end of the island in 2007 and may be a recent arrival. An exotic winter annual that is a prolific seed producer, burr chervil spreads rapidly and can choke native spring forbs if not diligently managed. It must be hand-pulled in early spring before seeds mature (10-12 weeks after flowering). This will start in 2009 and should be maintained indefinitely to ensure this species does not establish on Anniversary Island.

Bull thistle (*Cirsium vulgare*) is another target species that is present on Anniversary Island. This species reproduces entirely by seed, so control prior to seed production is critical. Once plants bolt but before they flower, they will be pulled if possible to get the taproot, or cut ~ 3 cm below the soil surface. This will stop the plant from re-sprouting. Small rosettes will be carefully dug up and the tap-root removed if possible without significantly disturbing the soil.

5.3.4. Plant material management

Himalayan blackberry thickets—If there is little native vegetation growing among the thicket, stems will be cut and removed. If there is a substantial amount of native vegetation, such as *Lonicera* spp., growing up among the stems, the stems will be cut into smaller pieces and left in place to decay to reduce the potential for damage to the beneficial native plants.

Other plant material—Small amounts of material from plants other than Himalayan blackberry will be left to decay in place if there are no seeds or viable roots attached. Fruits and flower heads that could produce seed will not be left to decay *in situ*. Stems with viable roots will be hung in surrounding vegetation to desiccate. Note: The Capital

Regional District's Hartland Landfill does not accept noxious weeds because they cannot be composted.

Storage and removal—Cut plant material that is not left to decay *in situ* will be stored on rock above the inter-tidal, well away from sites that are frequently used by black oystercatchers. Under the guidance of park staff, the material will be burned when conditions are appropriate, most likely in the fall. The Saturna and Mayne Island Fire Departments, and the public will be notified in advance when burning is planned (see section 6.0—Communication and outreach).

5.4 Re-vegetation

Re-vegetation will focus on the six treatment polygons and, only if required, in incidental patches where exotic plants are removed. At this time, no replanting or other management activities are planned for the meadow at the south end of Anniversary Island, although see recommendations in section 7.2. All six polygons contain some combination of agronomic grasses and/or Himalayan blackberry. Polygons A, B and D will require re-vegetation after treatment whereas polygons C, E and F may not require re-vegetation due to the presence of native species. In fall 2008, after agronomic grasses are repeatedly cut and the blackberry is treated, snowberry and rose will be planted. This approach will successionally shift the sites back to the woody shrub stage (Polster 2007).

In June 2008, several hundred cuttings were collected from Anniversary Island and sent to a professional nursery for propagation into plugs. These cuttings were to be the primary source of re-vegetation material, but yielded far fewer viable plants than anticipated, thereby limiting the area that can be adequately re-vegetated in 2008 [4]. For this reason, and so that we do not rely on only one method, a combination of native shrub plugs, live stakes, and layering will be used to re-vegetate the treatment areas. Appendix 3 provides collection, propagation and planting details for each of these methods.

Plugs from cuttings are 10 cm long and 4 cm wide and although they have a root system they will take longer to establish in the ground than live stakes. For this reason, and to allow for some mortality, plugs will be planted to a density of five per m^2.

Live stakes are similar to cuttings but are longer (80–100 cm) and, after collection, are planted directly in the ground without rooting hormone. Snowberry and Nootka rose are both known to establish well from live stakes (Darris 2002a, 2002b, WSU 2007). Because of their length, diameter, and sturdiness, live stakes reach competitive size sooner than cuttings and hence require a lower planting density—two per m^2 is recommended. If necessary once stakes establish, they may be carefully thinned to a lower density to reduce competition with one another. Removed stakes can be moved to another planting site on the island.

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[4] Actual plug yields in June 2008 were 782 for rose and 896 for snowberry. At a planting density of five plugs per m^2, if there is no mortality in the greenhouse, these will cover ~335 m^2 of treatment area. Allowing for 25 percent mortality in the greenhouse, anticipated plug yields are 585 for rose and 672 for snowberry, covering only ~250 m^2 of treatment area.

Plugs and live stakes will be planted in species clusters to emulate natural dispersal patterns (Robinson and Handel 1993). If possible, species will be planted in proportions that emulate the 60/40 snowberry to rose abundance ratio that occurs on Anniversary Island.

5.4.1. Polygon A

Polygon A is classified as a Juniper-Oak association (site type 75, Blackwell 2007), a somewhat closed community with snowberry, Nootka rose, and Garry oak as dominant shrub species. Because the soil in polygon A is shallow, cuttings and layering rather than live stakes will be used. Planting will be in October 2008, after agronomic grasses have been repeatedly cut and Himalayan blackberry has been treated and the biomass removed. Polygon A is approximately 100 m^2; however, agronomic grasses have invaded no more than half of the polygon thus requiring ~250 plugs to achieve a density of five per m^2. Stinging nettle will continue to expand and the removal of Himalayan blackberry will alleviate suppression of the existing native shrub community. To reduce the number of plugs needed, layering of snowberry that exists on the perimeter of the polygon is recommended. Snowberry establishes well by layering (King County 2004) and is a viable option in shallow soils. The amount of layering and plugs needed will be determined after the exotic plants have been treated.

5.4.2. Polygon B

Polygon B is classified as two site types, a Camas-Herb association at the top of the slope and a snowberry association on the bottom bench of the polygon (site types 73 and 74 respectively per Blackwell 2007; see Appendix 1 for characteristics). Although agronomic grasses will be cut in all of polygon B, re-vegetation will focus on the bottom bench area where Himalayan blackberry was previously removed. This bench receives more moisture and has deeper soil than the steeper slope above. Better soil conditions should improve cutting survival. Even without re-vegetation, repeat cutting of agronomic grasses on the slope above will release existing native vegetation from some competition and facilitate natural regeneration. Vegetation data collected in June 2008 indicates higher native species diversity exists near the top of the slope compared with the bench area. Restricting re-vegetation to the bench at the bottom will maintain the existing Camas-Herb and snowberry associations.

The lower portion of polygon B is about 350 m^2 and requires ~1750 cuttings to meet the recommended density of five per m^2. To mitigate jeopardizing the vigour of existing native shrubs, and to reduce logistical challenges, the lower portion of polygon B will be re-vegetated in sections over two years: half in 2008 and half in 2009. Phasing this work also allows the treatment approach to be monitored and modified in the subsequent phase, if necessary. The re-vegetation area is approximately 5 m wide[5] and excludes a 1m buffer between the lower perimeter of the polygon and the expanding line of existing native shrubs. As cuttings and existing shrubs grow, this buffer will be over-topped. This

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[5] The re-vegetation area along the bottom bench in polygon B will vary in width according to edaphic factors along the slope thus emulating natural succession.

buffer is also routinely used by otters, and this will help destroy the common velvet-grass, which is susceptible to trampling (Bond *et al*., 2007).

5.4.3. Polygon C

Like polygon F, polygon C comprises a large thicket of Himalayan blackberry among an existing native shrub community; however, the re-vegetation approach differs between these two sites due to edaphic and physical factors. Polygon C is at the bottom of a northeast facing slope and is classified as a snowberry association (site type 73, Blackwell 2007; see Appendix 1 for characteristics) which typically has more moist and deeper soils than elsewhere on the island. Because of these characteristics, and because the number of cuttings available for fall 2008 is limited, live stakes rather than cuttings will be planted in this site. Live stakes also have a better competitive advantage than cuttings against re-sprouting blackberry and agronomic grasses.

5.4.4. Polygon D

Facing southwest at the top of a hyper-steep slope, polygon D is classified as a Juniper-Oak association inland and bedrock along the edge of the island (site types 75 and RO per Blackwell 2007; see Appendix 1 for characteristics). Once the blackberry is cut, polygon D will be evaluated and the most effective re-vegetation approach applied. Fast-growing native forbs such as sea blush *(Plectritis congesta)* for open micro-sites and native grass species (e.g., *Elymus glaucus*) that occur in the adjacent meadows are recommended for the Juniper-Oak association. The goal is to minimize opportunities for agronomic grasses and other exotic species to dominate in the absence of Himalayan blackberry.

5.4.5. Polygon E

Facing southwest along a hyper-steep slope, and classified as bedrock (site type RO, Blackwell 2007), Polygon E supports stunted seaside juniper and arbutus among shallow soil and open meadow dominated by grasses and native forbs. Himalayan blackberry thickets in polygon E vary in size from small (< 1 $m^{2)}$ to medium (> 1 m^2 and < 5 $m^{2)}$ throughout the polygon. Once the blackberry is removed, polygon E will be evaluated and the most effective re-vegetation approach applied. Fast-growing native forbs such as sea blush *(Plectritis congesta)* for open micro-sites and native grass species (e.g., *Elymus glaucus*) occurring in the adjacent meadow are recommended. If necessary, plugs will be grown from seed collected nearby and planted in fall 2008 or spring 2009 depending on species. Bare patches greater than about 20 cm x 20 cm or that lack native plants nearby will be re-vegetated using suitable native species.

5.4.6. Polygon F

Like polygon C, polygon F comprises a large thicket of Himalayan blackberry among an existing native shrub community. Polygon F is classified as a Juniper-Oak association (site type 75, Blackwell 2007), a somewhat closed community with snowberry, Nootka rose, and Garry oak as dominant shrub species. Once the blackberry is cut, polygon D will be evaluated and the most effective re-vegetation approach applied.

5.4.7. Forbs and grasses—general guidelines for re-vegetation

Collection and propagation of forb and grass seed varies significantly depending on species. Seed availability, site needs and conditions (e.g., relative densities of existing native species, soil depth, moisture) will determine which and how much native grass and forb seed will be collected. If there is a lack of propagules or a risk of genetic depression due to collection from Anniversary Island, propagules will be collected from a nearby GINPR site following established seed collection protocols (primarily GOERT 2007). Seed will be grown in a nursery or directly broadcast where needed and as appropriate, based on the guidelines described above. Preference will be given to fast growing / early seral stage native forbs.

Outside of the treatment polygons, small bare patches of soil that remain after exotic vegetation removal will in most cases be left to re-vegetate naturally, provided suitable native vascular plants as noted above occur immediately adjacent. Bare patches greater than about 20 cm x 20 cm or that lack native plants nearby will be re-vegetated using suitable native species. Where native grasses are appropriate, grass plugs will be planted at 25 cm spacing. Forbs are typically planted at lower densities than grasses. Plug planting requires simply opening a slit in the soil no more than 10 cm deep and inserting the plug.

5.5 Monitoring

Formal monitoring of restoration efforts on Anniversary Island will focus on the treatment polygons, although island-wide systematic surveys for target exotic species will also be carried out. All observations, data, and results will be recorded when collected. All data will be reported annually, or upon request. Monitoring will initially be carried out by GOESARR staff, and later by park staff once the GOESARR project comes to an end.

5.5.1. Objective 1 - Replace agronomic grasses in polygons A and B

The target for objective 1 is to achieve greater than 80 percent cover of native vascular plant species in polygons A and B after four years from baseline in 2008. The target for objective 1 will be evaluated using a transect method.

Eight parallel transects 10 m apart and perpendicular to the slope will be established in polygon B. Each transect will be sampled every 50 cm starting from the bench to the top of the slope along two strata at 50 cm and 130 cm above ground. Any plant that intercepts either height is identified and recorded. The data are later analyzed to yield percent cover in the polygon for each species detected. Two transects 2 m apart and parallel to the long axis of the treatment area will be established in polygon A. The sampling method used in polygon B will be applied in polygon A. Sampling will be repeated each year in June, before the first grass cutting and exotic species removal of the season, for at least four years, until the desired successional stage is achieved.

Photos will be captured as a qualitative record of change in each polygon over time. Photos will be taken from the centre of each polygon in the four cardinal directions using a surveyor's barber pole for scale. Photos will be captured before the first grass cutting and subsequently twice per year in spring and fall.

5.5.2. Objective 2 - Remove Himalayan blackberry in all treatment polygons

The target for objective 2 is to achieve decreases of Himalayan blackberry in polygons A, B, C, D, E and F by 75 percent or more within 2 years from baseline. Sampling will be repeated each July, before treatment, for at least two years

For all polygons objective 2 will be evaluated by measuring the extent and intensity[6] of Himalayan blackberry infestations. The extent of each infestation will be determined by defining the boundary using a GPS unit whereas a crude estimate of percent cover will be recorded to determine intensity. The size of each blackberry infestation will be calculated and analysed to determine the total extent across the entire island.

Photos will be captured as a qualitative record of change in each polygon over time. Photos of the Himalayan blackberry infestations will be taken from an elevated point along the perimeter of the infestation pre- and post-treatment.

5.5.3. Objective 3 - Systematic monitoring for exotic species occurrences

Starting in early May 2008 and thereafter each May and October, a field crew will systematically survey Anniversary Island to search for and remove exotic plants. Because of the density of vegetation, this may take up to two person-days per survey. An air photo should be used to help ensure complete coverage without overlap. A tally sheet will be used to record total occurrences for each species.

Occurrences will be defined as follows: for forb species, any individual more than 2 m from its nearest neighbour will be considered a separate occurrence; for shrub species, any individual more than 5 m from its nearest neighbour will be considered a separate occurrence. Data will be used to modify the treatment approach if necessary.

5.5.4. Re-vegetation monitoring

Although establishment of native species in the re-vegetation areas will be sampled by the percent cover transects, it is also important to monitor general health and survival of cuttings, live stakes, and layered stems. Each re-vegetation area will be checked in spring 2009, and thereafter during each visit to the island. Plant condition and mortality will be evaluated and recorded. A survival rate of $\geq$75 percent will be considered a success. Data will be used to adapt methods for establishing future plantings.

6.0 Communication and outreach

Anniversary Island restoration activities will provide opportunities for public education and enhanced visitor experience. Various initiatives will help the public learn about Parks Canada's commitment to improving ecological integrity, and gain knowledge about ecological restoration methods that can be applied elsewhere. When the restoration plan is approved, it will be made available to interested community and restoration groups.

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[6] Intensity meaning a crude percent cover estimate of Himalayan blackberry in each treatment polygon.

Public education will be achieved through interpretation activities delivered by park staff, with contributions from GOESARR staff, through several means:

- from the vantage point at nearby Winter Cove, through non-personal media (e.g., signs) and as a stop on guided walks where the viewscape looks out to Anniversary Island;
- a website feature that utilizes the on-going monitoring photos of the restoration activities;
- articles in local newspapers/island newsletters;
- information provided during the park's participation in local markets and fairs.

When specific restoration activities, such as plant material disposal and burning, are planned, GOESARR staff will ensure park Communications staff are briefed so they can inform the public in a timely manner.

Although Anniversary Island is Zone 1, removing Himalayan blackberry thickets and agronomic grasses and restoring some of the former native species diversity may enhance visitor experience for boaters and kayakers who pass by.

7.0 Planning beyond the GOESARR project

The GOESARR project has a finite timeframe that extends to 2010, and possibly longer. During the project timeframe, GOESARR staff and contractors will carry out most of the work, with support from GINPR and the Western and Northern Service Centre staff, depending on the nature of the work and staff availability. Beyond the GOESARR timeline, some of the work requires continuity if the objectives are to be reached and desired ecological conditions maintained.

Below is a description of work that needs to be continued, and recommendations for the park to consider incorporating into its Management Plan to further improve ecological integrity and visitor experience.

7.1 Required work

7.1.1. Exotic plant species monitoring and control—7.5 person-days per year

Monitoring and control of exotic plant species should be continued indefinitely. Work completed under the GOESARR project will substantially reduce the percent cover and occurrence of target species, thus minimizing the amount of work required by park staff; however, gains will be temporary unless on-going maintenance is carried out as part of the park's Integrated Pest Management Plan. Two activities are required:

1. Systematic surveys for exotic plant species occurrences and manual removal should be continued twice annually, in spring and at the onset of fall rains. Two surveys are needed to capture different species phenologies. The timing facilitates removal when soils are moist, to minimize disturbance. Estimated resource requirements: 1 day x 4-person crew plus 1 day x 2-person crew plus 0.5 day x 1 person for data entry = 6.5 person-days per year. Refer to Table 9 for current exotic species list.
2. The list of target exotic plant species should be re-evaluated each year using the GOERT Decision Support Process (2007) or similar invasive species evaluation method to determine if new species should be added or others downgraded due to successful treatment. Estimated resource requirements: 1 day x 1 person = 1 person-day per year.

7.1.2. Vegetation monitoring—5 person-days every year

Sampling of vegetation transects should continue every two years. The monitoring protocol established in this plan should be continued. Estimated resource requirements: 2 days x 2-person crew per survey = 4 person-days every year.

Photos of all six polygons from an identified photo point should be captured every year at the same time of year to provide a visual record of changes. Estimated resource requirements: 0.5 day x 2-person crew every year = 1 person-day per year.

7.2 Recommendations

Shrub and tree encroachment—Succession to dense native shrub understorey and closed forest due to fire exclusion is rendering Garry oak meadows and woodlands increasingly rare (Gould and Harrington 2008). On Anniversary Island, encroachment by krummholz [7] Garry oak, Nootka rose, and snowberry may be occurring in the camas meadow site at the south end, and perhaps elsewhere; however, monitoring is needed to confirm this. If the park decides to proceed with camas meadow management, objectives should be clearly defined before any methods are employed.

Although prescribed fire may seem an obvious control method, both Garry oak and snowberry are fire resistant and sprout vigorously after a low-intensity fire (Gucker 2007). Nootka rose and other Rosa species found in BC usually initially decrease in cover after wildfire. Thereafter, cover gradually increases, and then declines as the canopy closes. In a study of Nootka rose in Washington and Oregon, burning had little effect on abundance, although multiple fires can significantly reduce cover of rose species (Haesseler et al., 1990).

The park might consider working with First Nations to maintain the meadow feature using traditional methods that do not include fire, such as camas harvesting, or employing harvesting along with repeated prescribed fires. Relying on one single fire event will almost certainly result in increased shrub and exotic plant species cover.

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[7] Low-growing shrub form of tree caused by strong and persistent wind or other factors. that influence rate of growth and form.

Agronomic grasses—While eradication of agronomic grasses from Anniversary Island is unachievable, the park needs to decide to what degree these grasses are acceptable and whether focused control is desirable. Again, potential control methods should be carefully evaluated before applied. In a five-year field experiment in a degraded oak savanna, MacDougall and Turkington (2007) tested the impacts of fire, cutting and raking, and weeding on two factors critical for restoration: controlling dominant invasive grasses and increasing subordinate native flora. They manipulated the season of treatment application and used sites with different soil depths because both factors influence fire behavior. They found no significant difference among the treatments: all were similarly effective at suppressing exotics and increasing native plant growth. This occurred because light is the primary limiting resource for many native species and each treatment increased its availability. The effectiveness of disturbance for restoration depended more on the timing of application and site factors than on the type of treatment used. Summer disturbances occurred near the reproductive peak of the exotic grasses, so their mortality approached 100 percent. Positive responses by native species were significantly greater on shallow soils because these areas had higher native diversity prior to treatment.

Native species diversity—Planting rose and snowberry in the treatment areas is an interim measure designed to expedite treatment of agronomic grass infestation. If this measure is successful, the park might consider restoring native species diversity by planting other species from the corresponding site type (see Appendix 1). Native species already occur in these sites and could easily provide propagules.

Volunteer stewardship—The engagement of volunteers to act as stewards of Anniversary Island is encouraged. The BC Parks' Volunteer Warden Program that was established in 1980 for ecological reserves could provide a model. The role of volunteer stewards could be limited to observing, recording, reporting, and recommending on conditions and issues pertaining to ecological integrity of the site. The volunteer(s) could work with the Parks Canada ecologist and act as a liaison with the Park Interpreter program to help enhance visitor experience and the public's understanding and appreciation of the Species at Risk program and Parks Canada's role in improving ecological integrity. The Saturna and Mayne Island communities could be consulted to help find people who would be interested and willing to make a long-term commitment to this role.

8.0 Project work plan

A project work plan for 2008/09 and 2009/10 is presented in Table 4. The GOESARR project will directly contribute approximately $11,000 to the restoration of Anniversary Island in 2008/09. This effort will be enhanced with communications and outreach activities. The investments made by the GOESARR project will result in completion of the more expensive initial stages of improving ecological integrity on this island (e.g., monitoring set-up, invasive species removal, re-vegetation).

Table 4. Anniversary Island restoration project workplan to Dec 2010.

Anniversary Island Workplan		2008									2009												2010											
Actvity	**Tasks**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Field work																																		
Monitoring & surveying																																		
Objectives 1 & 2— Percent cover of vascular species	Collect fixed transect data			●												●												●						
Objective 3—Systematic monitoring for exotic species occurrences	Collect exotic species occurrence data and remove plants				●			●							●					●							●							
Photos	Before first grass and H. blackberry cutting			●												●										○								
	After grass and H. blackberry cutting				●	●											●	●																
Re-vegetation	Check cutting, layering, and live stake condition; estimate mortality														●												●							
Archaeological survey	Complete survey after Himilayan blackberry removed and treated					●																												
Exotic Plant Treatment																																		
Agronomic grass cutting	Polygons A & B - Cut at first anthesis			●												●												●						
	Repeat as needed at maximum regrowth through summer				○	○	○										○	○	○										○	○	○			
Himalayan blackberry	All 5 treatment polygons - Cut thickets with brush saw and/or by hand				●	●																												
	Treat all with pesticide					●																												
	2009/2010: Treat new plants; re-treat old, re-sprouting plants that have long runners															○												○						
Other occurrences	Burr chervil (*Antrhiscus caucalis*) - remove by hand in early spring													●												●								
	Bull thistle (*Cirsium vulgare*) - remove when bolting but not flowering				●											●												●						
	Other exotics - remove by hand as needed		○	○	○	○	○								○	○	○	○	○								○	○	○	○	○			
Plant material management	Stockpile above intertidal				○	○	○										○	○	○										○					
	Burn in fall once authorized by park and Fire Depts.							●												●												●		
Propagation & planting																																		
Native shrub cuttings	Collect & ship whips for cutting propagation		●												●																			
	Collect and plant live stakes							●												●														
	Plant cuttings							●												●												●		
Data management																																		
	Input transect data						●												●												●			
	Create attribute tables						●																											
	Create output maps						●												●												●			
Outreach & Reporting																																		
Report	Prepare summer work report					●												●												●				
	Prepare & submit annual workplan to GOESARR committee for info	●				●							●					●							●					●				
Outreach	Present update to Saturna Island–PCA Liaison Committee	○				○								●				●								○				●				

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Appendix 1—Plant community descriptions

Two methods were used to describe vegetation communities on Anniversary Island:

1) Plant community classification using relevé data collected in April 2007 (Polster 2007). See Table 6.
2) Terrestrial ecosystem mapping, whereby polygons encompassing similar ecological properties are delineated on air photos, and data characterized based on photo interpretation and field sampling. Using these data a set of attributes is then assigned to each polygon. Site classification is based on the biogeoclimatic ecosystem classification (BEC) for British Columbia (Meidinger and Pojar 1991) and enhanced to reflect units encountered on Anniversary Island and elsewhere that are not recognized in the BEC system (Blackwell 2007). See Table 7.

Using the first method, Polster identified two plant species-relevé groups on Anniversary Island: a Quercus group, which includes oceanspray (*Holodiscus discolor*) and Pacific sanicle (*Sanicula crassicaulis*) as dominant species; and a Triteleia group is characterized by hyacinth broadiaea (*Triteleia hyacinthine)*, Idaho fescue (*Festuca idahoensis* ssp roemeri), and ribwort plantain (*Plantago lanceolata)*. Within these species-relevé groups Polster identifies four vegetation types (1, 2, 3, and 6) comprising 16 species and 77% of the cover on the islet.

Vegetation type 1 is defined by a strong occurrence of Garry oak (*Quercus garryana),* along with snowberry (*Symphoricarpos albus)* and greater camas (*Camassia leichtlinii)*. The relatively low number of species may allow this vegetation type to easily establish, and the density of cover when the vegetation is mature may assist in preventing invasion by exotics, making this type a potentially strong competitor against blackberry, orchard grass and common velvet-grass (Polster 2007).

Vegetation type 1 is similar to the Juniper-Oak association (site type 75) described by Blackwell (2007). Site type 75 occurs on the margins of rocky outcrops on Anniversary Island, with a short canopy of Garry oak, sparse stunted Douglas-fir, and seaside juniper. The shrub layer comprises 50-70% cover and includes snowberry, oceanspray, Nootka rose and tall Oregon-grape. The herb layer provides about 70-100% cover and includes camas, native bunchgrasses (e.g., Idaho fescue), cleavers *(Galium aparine*), miner's-lettuce (*Claytonia perfoliata*), and Pacific sanicle. Polygon C is classified as site type 75.

Vegetation type 2 is similar to type 1, but has fewer species (17 total) and slightly less cover, suggesting a more open structure.

Vegetation type 3 is defined by the presence of the Triteleia species-relevé group. This type has the highest number of species with camas, Western buttercup (*Ranunculus occidentalis*), Idaho fescue, blue wild-rye (*Elymus glaucus*), white fawn lily *(Erythronium oregonum*), and smooth cladonia *(Cladonia gracilis)* as predominant species. Type 3 also has a lower average percent cover relative to the other five vegetation types. While this open community is a valued ecosystem type, it is difficult to establish and makes a poor competitor against invasive exotic species (Polster 2007).

Vegetation type 6 is a more open community type and is the most commonly occurring community that Polster identifies on Anniversary Island. It includes seaside juniper, snowberry, tall Oregon-grape, Saskatoon berry *(Amelanchier alnifolia)*, California brome *(Bromus* *carinatus*), and Kentucky bluegrass (*Poa pratensis,* an exotic agronomic grass), with greater camas as a predominant species.

Vegetation types 3 and 6 are similar to the Camas-Herbs association (site type 74) described by Blackwell (2007). Site type 74 is predominantly an herb community comprising 70-100% cover. The few trees present are typically stunted Garry oak. A sparse shrub layer consists primarily of Nootka rose, dull Oregon-grape, Saskatoon berry, oceanspray, and snowberry. Camas-Herb communities are present throughout the island and also in pockets on the hyper-steep bedrock slope along the island's southwest edge (e.g., polygon D).

Blackwell (2007) also describes a snowberry community (site type 73) that is similar to site type 75 but which occurs in areas with higher soil moisture and deeper soils. This community has a higher shrub cover (80-100%) than site type 75, and a reduced herbaceous cover (30-50%). Blackwell identifies the east-facing slope of Anniversary Island (polygon B) that is currently infested with agronomic grasses as site type 73.

Table 5. Physiognomic vegetation classification table for Anniversary Island (Polster 2007). Vegetation types 1, 2 and 3 are non-forested, with increasing diversity and shrub cover. Type 6 plots are non-classified outliers with some shrub cover. Cover values are indicated in percent. R indicates much less than 1%; + indicates rare).

	Ann 018 Plot 16	Ann 007	Ann 013 Plot 11	Ann 008 Plot 6	Ann 019 Plot 17	Ann 014 Plot 12	Ann 010 Plot 8	Ann 009 Plot 7	Ann 016 Plot 14	Ann 017 Plot 15	Ann 012 Plot 10	Ann 020 Plot 18	Ann 011 Plot 9	Ann 015 Plot 13	Ann 002	Ann 003	Ann 006 Plot 5	Ann N End	Ann 005 Tower Base	Ann 004
Vegetation Type	1					2		3				6								
Trees																				
Arbutus menziesii							1													
Juniperus scopulorum							25	1					30			1				10
Pseudotsuga menziesii				R										5						
Quercus garryana	5	40	25	60	20		5				5									
SHRUBS - native																				
Amelanchier alnifolia		+						1			1		20	5		1				
Arctostaphylos uva-ursi		R																		
Holodiscus discolor						5	1	+									1	1	+	
Mahonia aquifolium	5		+		5	1			1		+	15	1							
Symphoricarpos albus	15	15	40	10	15	40		5	5			10	10	30	+	5				
SHRUBS - exotic																				
Malus pumila															5					
Rubus armeniacus																		1		5

Table 6 cont'd

Vegetation Type	1					2		3				6								
HERBS – native																				
Achillea millefolium	5									5					1		5		1	
Allium cernuum			1				5	1					1							
Bromus carinatus			10		1	10			5		1	10		10		1				40
Camassia leichtlinii	45	40	30	25	15	15	40		30	70	60	40	15	10	40	20	60	R		
Cardamine oligosperma													1	1						1
Castilleja hispida								1	+											
Cerastium glomeratum	5	1		5			5		1		1									
Cladonia gracilis								15												
Claytonia rubra ssp depressa																		1		
Collinsia parviflora								1	R		+							+	+	
Delphinium glaucum														R						
Distichlys spicata																		1		
Elymus glaucus	15							10	5	1			20							
Erythronium oregonum			5		5			15	+				10	1						+
Festuca idahoensis ssp. roemeri		R						10	5	5	5				1			1		
Fragaria virginiana									R											
Fritillaria affinis													R		+		1			
Galium aparine													1							
Grindelia integrifolia																		5	5	
Heuchara micrantha																	+			
Koeleria macrantha																+				
Leymus mollis				10													1		1	
Lomatium nudicaule									R	R								+	1	
Lonicera ciliosa			R										1	5						R
Lonicera hispidula				1	5		5				1									
Luzula multiflora								+												
Mimulus alsinoides										+										
Plectritis congesta	5							1	5	5	+	5		+	+	1				1
Poa pratensis												1			5	1	20	1	1	
Polypodium glycerhiza																1				
Ranunculus occidentals	5			1			1	5	25		5		1			1				
Rosa nutkana		1	15											5	+	60				+
Rubus ursinus					5				1					1	1					
Sanicula crassicaulis							5								+		20			
Sedum lanceolatum var. nesioticum										+	1									
Sedum spathulifolium								1												
Selaginella wallacei		1						+	1											
Stellaria media																+				
Trisetum spicatum								1												

Table 6 cont'd

Vegetation Type	1					2		3				6								
HERBS – native cont'd																				
Triteleia hyacinthine								1	1	10	1									
Urtica dioica																				10
Vicia americana		5						1												
Zygadenus venenosus									R											
HERBS – exotic																				
Cynosurus echinatus							10				5									
Dactylis glomerata		R	R			5								15						
Daucus carota															5					
Holcus lanatus				5								15								
Hypochaeris radicata								R												
Plantago lanceolata								R	R	R										
Rumex acetosella																		1		
Senecio vulgaris							+				R			+	+					
Vicia sativa							+		1						+		+			

Tables 6, 7 and 8 provide lists of constituent plant species, typical percent cover by strata and, in some cases, general edaphic qualities of the three terrestrial plant associations defined by Blackwell (2007) that occur on Anniversary Island.

- CDFmm/Snowberry (site type 73) (Table 6)
- CDFmm/Camas-Herbs association (site type 74) (Table 7)
- CDFmm/Juniper-Oak (site type 75) (Table 8)

Table 6. Site type 73: Snowberry association (Blackwell 2007).

	Typical Vegetation
Strata	Spp
A	*Quercus garryana*
B	*Symphoricarpos albus*
B	*Rosa nutkana*
B	*Amelanchier alnifolia*
B	*Holodiscus discolor*
B	*Mahonia aquifolium*
B	*Quercus garryana*
B	*Arbutus menziesii*
B	*Pseudotsuga menziesii*
B	*Rosa gymnocarpa*
B	*Salix scouleriana*
B	*Salix sp.*
C	*Camassia quamash*
C	*Erythronium oregonum*
C	*Grasses*
C	*Lathyrus japonicus*
C	*Allium cernuum*
C	*Cardamine oligosperma*
C	*Claytonia perfoliata*
C	*Collomia grandiflora*
C	*Fritillaria affinis*
C	*Lathyrus nevadensis*
C	*Leymus mollis*
C	*Lycopodium annotinum*
C	*Polypodium glycyrrhiza*

Plot	
Biogeoclimatic Zone	CDF
SubZone	mm
Elevation(m)	2-10
Slope Gradient(%)	0
Aspect (degrees)	999
Meso Slope Position	Level to Crest
Moisture Regime	2-3
Nutrient Regime	D
Root Restricting Depth(cm)	60
Soil Drainage	well
Humus Form (MOF 81)	Mull
Structural Stage	3
Strata Cover Tree(%)	0-10
Strata Cover Shrub(%)	80-100
Strata Cover Herb(%)	30-50
Strata Cover Moss(%)	0
Terrain	zsWGv/Rm
Root restricting type	Lithic Contact
Texture	Sandy Loam
OrgThick	1-2

Table 7. Site type 74: Camas-Herbs association (Blackwell 2007).

Strata	Typical Vegetation Spp
B	*Rosa nutkana*
B	*Mahonia aquifolium*
B	*Amelanchier alnifolia*
B	*Holodiscus discolor*
B	*Symphoricarpos albus*
B	*Quercus garryana*
C	*Grasses*
C	*Camassia quamash*
C	*Achillea millefolium*
C	*Grindelia integrifolia*
C	*Plectritis congesta*
C	*Sanicula crassicaulis*
C	*Collinsia parviflora*
C	*Fritillaria affinis*
C	*Plantago lanceolata*
C	*Rumex acetosa*
C	*Allium cernuum*
C	*Lomatium nudicaule*
C	*Triteleia hyacinthina*
C	*Vicia americana*
C	*Claytonia rubra*
C	*Geranium molle*
C	*Polypodium glycyrrhiza*
C	*Sedum spathulifolium*
C	*Trifolium microcephalum*
C	*Claytonia perfoliata*
C	*Erythronium oregonum*
C	*Ranunculus occidentalis*
C	*Ranunculus uncinatus*
C	*Sedum integrifolium*
C	*Selaginella wallacei*
C	*Trifolium willdenowii*
D	*Racomitrium canescens*
D	*Cladina rangiferina*
D	*Dicranum scoparium*
D	*Polytrichum juniperinum*
D	*Trachybryum megaptilum*

Site Characteristics	
Biogeoclimatic Zone	CDF
SubZone	mm
Elevation(m)	2-12
Slope Gradient(%)	0-20
Aspect (degrees)	S
Meso Slope Position	Level to Crest
Moisture Regime	0-1
Nutrient Regime	C-D
Root Restricting Depth(cm)	10-30
Soil Drainage	Very rapid to well drained
Humus Form (MOF 81)	Rhizomull
Structural Stage	2-3
Strata Cover Tree(%)	0
Strata Cover Shrub(%)	0-20
Strata Cover Herb(%)	70-100
Strata Cover Moss(%)	0-10
Terrain	silty/sandy weathered bedrock over rolling bedrock (sandstone)
Root restricting type	Lithic contact
Texture	sandy loam
OrgThick	1-10

Table 8. Site type 75: Juniper-Oak association (Blackwell 2007).

Strata	Typical Vegetation Spp
A	*Pseudotsuga menziesii*
A	*Quercus garryana*
B	*Symphoricarpos albus*
B	*Juniperus scopulorum*
B	*Rosa nutkana*
B	*Quercus garryana*
B	*Holodiscus discolor*
B	*Mahonia aquifolium*
B	*Amelanchier alnifolia*
B	*Arbutus menziesii*
B	*Lonicera ciliosa*
B	*Lonicera involucrata*
B	*Pseudotsuga menziesii*
C	*Camassia quamash*
C	*Grasses*
C	*Galium aparine*
C	*Sanicula crassicaulis*
C	*Claytonia perfoliata*
C	*Plectritis congesta*
C	*Vicia Americana*
C	*Sedum spathulifolium*
C	*Allium cernuum*
C	*Erythronium oregonum*
C	*Fritillaria affinis*
C	*Grindelia integrifolia*
C	*Polypodium glycyrrhiza*
C	*Sanicula bipinnatifida*
C	*Achillea millefolium*
C	*Cardamine angulata*
C	*Collinsia parviflora*
C	*Zigadenus venenosus*
C	*Allium acuminatum*
D	*Eurhynchium oreganum*
D	*Dicranum scoparium*
D	*Racomitrium canescens*

Site Characteristics	
Biogeoclimatic Zone	CDF
SubZone	mm
Site Series	
Elevation(m)	
Slope Gradient(%)	0-5
Aspect (degrees)	999
Meso Slope Position	Level to Crest
Moisture Regime	0-1
Nutrient Regime	D-E
Root Restricting Depth(cm)	15-50
Soil Drainage	rapid
Humus Form (MOF 81)	Mullmoder
Structural Stage	3
Strata Cover Tree(%)	0-10
Strata Cover Shrub(%)	50-70
Strata Cover Herb(%)	70-100
Strata Cover Moss(%)	0-10
Terrain	sDv/Rm
Root restricting type	Lithic Contact
Texture	Loamy sand
OrgThick (cm)	4-12

Appendix 2—Exotic plant species on Anniversary Island

Table 10 lists known exotic plant species on Anniversary Island as of 2007. Although agronomic grasses (e.g., common velvet-grass, orchard grass) are target species in the treatment polygons, there are no plans to control them throughout Anniversary Island during this project.

Table 9. Known exotic plant species on Anniversary Island as of 2007. Highlighted species have top priority for treatment. Plant occurrences from Roemer 2003, except as noted.

Common name	Scientific name	Common name	Scientific name
yellow hairgrass	*Aira caryophyllea*	paradise apple	*Malus pumila*
silver hairgrass	*Aira praecox*	English/ribwort plantain	*Plantago lanceolata*
sweet vernal-grass	*Anthoxanthum odoratum*	annual bluegrass	*Poa annua*
burr chervil [a]	*Anthriscus caucalis*	Himalayan blackberry	*Rubus armeniacus*
soft brome	*Bromus hordeaceus*	sheep sorrel	*Rumex acetosella*
ripgut brome	*Bromus rigidus*	curly dock	*Rumex obtusifolius*
poverty brome	*Bromus sterilis*	common groundsel	*Senecio vulgaris*
white goosefoot	*Chenopodium album*	spiny sowthistle	*Sonchus asper*
bull thistle	*Cirsium vulgare*	common sowthistle	*Sonchus oleraceus*
hedgehog dogtail	*Cynosurus echinatus*	common dandelion	*Taraxacum officinale*
orchard grass	*Dactylis glomerata*	small hop-clover	*Trifolium dubium*
Queen Anne's lace [b c]	*Daucus carota*	corn speedwell	*Veronica arvensis*
redstem stork's bill	*Erodium cicutarium*	tiny vetch	*Vicia hirsuta*
dove's-foot geranium	*Geranium molle*	common vetch	*Vicia sativa*
common velvet-grass	*Holcus lanatus*	brome fescue	*Vulpia bromoides*
hairy cat's-ear	*Hypochaeris radicata*	rat-tail fescue	*Vulpia myuros*
purple dead-nettle	*Lamium purpureum*		

[a] Hockin *et al* 2007; [b] Polster 2007

[c] A *Daucus carota* observed in April 2007 at the north end of the island will be removed in June 2008.

Appendix 3—Shrub propagation and planting methods

The following methods will be used for propagating and planting native shrubs on Anniversary Island. Regardless of method used, all collection will be done using sharp, clean tools. Unless stated otherwise, all cuts should be at a 45° angle.

Cuttings

Cuttings are roughly 10 cm long sections cut from whips that are collected from the site and propagated into plugs. Whips should be collected in mid to late May, when shrubs are still leafing out. Whips should be at least 30 cm long, and cut from current year growth that is firm but not rigid. Once collected, whips should be bundled with damp peat moss and stored in a cooler on top of a layer of newspaper with ice beneath and shipped immediately to the nursery. Nursery staff are responsible for making cuttings and planting the plugs. Roughly three cuttings can be made from one whip. Each cutting becomes a plug. To estimate the number of cuttings required, allow for 35% “let down” in the greenhouse and up to 25% mortality once planted.

Live stakes

The following steps are adapted from http://dnr.metrokc.gov/wlr/pi/cutting.htm [accessed 2 April 2008]). Planting on Anniversary Island is planned for late October to early November 2008. This timeframe allows for poor weather conditions and difficulty accessing the island. The best time to plant live stakes is during our region’s dormant season, from October to March http://www.soundnativeplants.com/livestake.htm [accessed 28 May 2008]. Even if planted during the growing season, live stakes planted into sites that remain moist will establish, but survival will be lower. Regardless of when planted, stakes will survive initially by rooting, but eventually leaves will sprout from the exposed ends.

1. Find mature, healthy shrubs that have long, upright branches. These will be cut to make the live stakes. **No more than 5% of branches should be cut from each plant**. Select stems that can yield 50 to 60 cm long stakes. This length is necessary to ensure sufficient energy is available in the stake, and because stakes will not tolerate much shade while leafing out. Rose stakes should be at least 2 cm in diameter; snowberry may be thinner (~ 1cm).
2. Locate a spot along the lower end of the stem and make an **angled** cut for the bottom end of the stake. The angled cut makes it easier to drive the correct end into the ground; stakes planted upside down will die. You should now have a length of older, woody stem that includes flexible new growth at the top. Select a place at the upper end of the older wood to create a cut for the top of the stake. There should be at least two buds on the upper 15% of the stake. Make a **straight** cut above these buds for the top end. The flexible tip of newer growth can also be retained for planting. Figure 6 shows a schematic diagram of established live stakes and illustrates the difference in angles for the top and bottom cuts.
3. To keep stakes from drying out, remove most leaves and small branches as soon as possible after cutting. Keep stakes moist in a bucket of fresh water or wet burlap sacks until ready to plant. Plant stakes within 24 hrs of collecting. If it is hot, keep them in shade until planted.

4. Use a rubber mallet to drive the angled end of the stake into the soil, perpendicular to the slope, at least 30 cm deep (the deeper the better, without burying the two top buds). Leave 15 to 20 cm above ground so stakes can sprout leaves from the buds. Because planting will take place once fall rains have started, the soil should be moist and pliable; if it is hard, use a length of rebar or planting stick to start the hole.

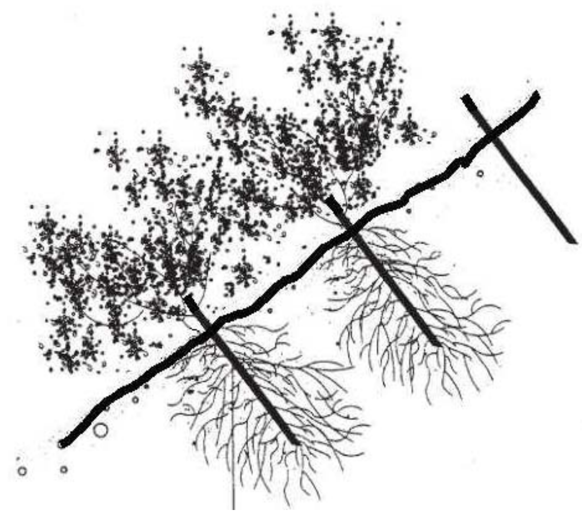

Figure 6. Diagram of live stakes (adapted from Gray and Sotir 1996, and Minnesota Dept of Natural Resources).

Layering

To propagate by layering from an existing plant, a low growing, flexible and living stem is bent to the ground. Part of the stem is then covered with soil, leaving the remaining 15 to 30 cm above the soil. The tip is then bent into a vertical position and staked in place (Figure 7). The sharp bend will often induce rooting, but wounding the lower side of the bent branch may help also.

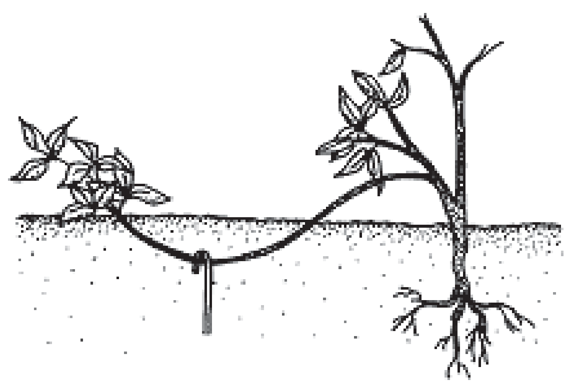

Figure 7. Method for layering snowberry (Evans and Blazich accessed 2008).

Appendix 4—Cultural features on Anniversary Island

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