Parks Canada has led the development of draft Principles and Guidelines for Ecological Restoration in Canada's Protected Natural Areas on behalf of Canadian federal, provincial, and territorial parks and protected areas agencies. These principles and guidelines represent the first-ever Canada-wide guidance for ecological restoration practices. They are the result of a major collaboration of specialists from the Society for Ecological Restoration International (SER), SER's Indigenous Peoples Restoration Network Working Group, the US National Park Service, Parks Canada Agency, Environment Canada, Fisheries and Oceans Canada, Alberta Tourism Parks Recreation and Culture, Ontario Parks, Yukon Parks, University of Victoria, University of Waterloo, Texas A&M University, and Cranfield University, UK.

These Principles and Guidelines build on the important foundation provided by SER, particularly its Primer on Ecological Restoration and the SER Guidelines for Developing and Managing Ecological Restoration Projects. This draft document sets out national principles for restoration that is ecologically effective, methodologically and economically efficient, and socio-culturally engaging. The principles are complemented by practical guidelines for a range of interventions as well as by a planning and implementation framework that serves as the basis for making consistent, credible and informed decisions regarding ecological restoration in protected natural areas.

The draft Principles and Guidelines were produced by a multi-jurisdictional and multi-disciplinary working group whose members volunteered their time and expertise. They have been widely reviewed in Canada and internationally. They will be presented to the Canadian ministerial council responsible for parks and protected areas in September 2007, as a national approach that may be applied as appropriate to the mandates, policies and priorities of individual protected areas jurisdictions.

Parks Canada would like to make a special acknowledgement of SER members Jim Harris, Eric Higgs, Dennis Martinez, Stephen Murphy, John Volpe, and Steve Whisenant, whose contributions made this product possible.

During 2007 and 2008, a companion document will be prepared that showcases ecological restoration best practices and, in so-doing, illuminates the principles and guidelines. The development of this document will be initiated at a workshop in Waterton Lakes National Park, Alberta, October 2-4, 2007.

For additional details, please contact:

Mike Wong
Executive Director
Ecological Integrity Branch
National Parks Directorate
Parks Canada
25 Eddy St, 4th Floor
Gatineau, QC K1A 0M5
Mike.Wong@pc.gc.ca
Tel: (819)994-2639

or

Karen Keenleyside
Ecosystem Scientist
Ecological Integrity Branch
National Parks Directorate
Parks Canada
25 Eddy St., 4th Floor
Gatineau, QC, K1A 0M5
Karen.Keenleyside@pc.gc.ca
Tel:(819)934-4797

DRAFT

Principles and Guidelines for Ecological Restoration in Canada's Protected Natural Areas

Compiled by:

Ecological Integrity Branch
Parks Canada Agency
Gatineau Quebec

On Behalf of the Canadian Parks Council

June, 2007

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1.0 Introduction

1.1 Purpose

This document has been developed to guide policy-makers and practitioners in their efforts towards the improvement of ecological integrity in Canada's protected natural areas, including the meaningful engagement of partners, stakeholders, communities, the general public, and visitors in this process. It sets out national principles and guidelines for ecological restoration and provides a practical framework for making consistent, credible, and informed decisions regarding ecological restoration in protected natural areas. A companion document will be developed that demonstrates ecological restoration best practices through case studies that illustrate the application of these principles, guidelines, and implementation framework in protected natural areas in Canada.

These principles and guidelines focus on the restoration of natural heritage, including native biodiversity and ecosystem functions. The restoration of historic sites and built heritage in Canada is explained in *Standards and Guidelines for the Conservation of Historic Places in Canada* (Parks Canada Agency 2003).

1.2 Definitions and Context

The Society for Ecological Restoration International defines ecological restoration as *the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed* (Society for Ecological Restoration International Science & Policy Working Group, 2004). That definition has been adopted for these principles and guidelines. Broadly, ecological restoration as used here also encompasses activities that may be referred to ecosystem rehabilitation or remediation.

The concept of ecological integrity anchors the policies and practices of Canada's protected areas[1] organizations and is central to the development of an ecological restoration program. Ecological integrity may be defined, with respect to a protected natural area as: "*a condition that is determined to be characteristic of its natural region and is 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). That definition has been adopted for these principles and guidelines.

[1] Exceptions include National Marine Conservation Areas, which are managed for ecologically sustainable use.

The Canadian Parks Council provides a Canada-wide forum for intergovernmental information sharing and action on parks and protected areas[2]. Its priorities reflect those of member jurisdictions and include: protection; heritage appreciation; outdoor recreation; and tourism and the economy. The development of principles and guidelines for ecological restoration is an initiative of the Canadian Parks Council under its 2006 Strategic Framework/Direction to advance the protection efforts of member agencies. These principles and guidelines will provide a consistent pan-Canadian approach that can be used in managing issues of common concern and in so-doing facilitate inter-jurisdictional cooperation in setting and achieving regional management goals. These principles and guidelines, and the restoration actions they support, will also contribute to other shared priorities by creating opportunities for meaningful engagement of citizens and fostering deeper connections between people and nature.

These principles and guidelines were developed on behalf of the Canadian Parks Council by a multi-jurisdictional, multi-functional working group composed of a diverse range of Canadian and international experts and managers, including representatives of federal, provincial, territorial and international protected areas agencies, Aboriginal groups, and academic institutions. The working group corresponded throughout 2006 and 2007 and met on several occasions during that period to share their knowledge and experience and contribute to the draft document. The principles and guidelines presented here represent the consensus of this working group. They are a distillation of 'best practices' for the planning and implementation of ecological restoration projects in Canada's protected natural areas.

These principles and guidelines are intended to be applicable to the full range of Canada's network of protected natural areas, including national parks (http://www.pc.gc.ca), marine conservation areas, national wildlife areas, migratory bird sanctuaries, Ramsar sites (i.e., wetlands designated under the international Ramsar convention; http://www.ramsar.org), wildlife and forest reserves, wilderness areas, provincial and territorial parks, and other conservation areas designated through federal, provincial and territorial legislation (Environment Canada 2006). However, the decision to endorse, adopt and use them is one that each jurisdiction or competent authority must make.

The principles and guidelines for ecological restoration presented here should be interpreted and applied within the context of the legislation and policy of relevant jurisdictions (Appendix I). The vast majority of Canadian protected areas jurisdictions recognize the importance of maintaining the ecological integrity of their terrestrial protected areas network (in whole or in part) by including specific reference in appropriate legislation and policy (Environment Canada 2006). Restoration of ecological integrity is thus the over-arching goal of ecological restoration in terrestrial protected natural areas in Canada. As the marine protected areas network develops, and

[2] Throughout this document, the term "protected natural areas" is used to refer to parks and other protected natural areas. In the context of the Canadian Parks Council, the term "parks and protected areas" is used because, when a jurisdiction has separate parks and protected areas agencies, only the parks agency is represented on the Canadian Parks Council.

intergovernmental cooperation on planning and management continues, a variety of designations and zonations will allow for the protection of multiple values, including, wildlife habitat, fishery resources, ecological representation, cultural heritage (Environment Canada 2006) and the concept of ecologically sustainable use.

The development of priorities for ecological restoration action by individual jurisdictions will generally be accomplished through their management planning processes. These principles and guidelines are intended to complement rather than replace the role of these processes in establishing restoration priorities. For example, through its management planning process, Parks Canada integrates information from research and monitoring to gain a better understanding of the state of natural and cultural heritage to make informed decisions for prioritizing actions. Its management planning also considers ways for the Agency to facilitate opportunities for visitors to enjoy unique, engaging, and safe, high quality experiences that incorporate education and learning information and contribute to the maintenance or restoration of ecological integrity or sustainable use. This approach is intended to foster a shared sense of responsibility for heritage places, thereby supporting future efforts for their conservation. Similar approaches are used in other protected areas jurisdictions.

These principles and guidelines address the requirements for restoring ecological integrity, as established with reference to an appropriate range of historical variability. They do not address in detail the requirements of environmental assessment, asset management or cultural resource management. However, as is outlined in Chapter 4, restoration practitioners should make themselves aware of these and other, related requirements by consulting the appropriate authorities at the beginning of restoration planning and addressing these requirements on an ongoing basis. For example, ecological restoration projects may have a significant cultural dimension. Practitioners should seek the advice of cultural resource managers and practitioners as restoration projects are developed (and throughout the projects). They should also consult reference documents such as Parks Canada's *Cultural Resource Management Policy* and the *Standards and Guidelines for the Conservation of Historic Places in Canada*.

Canadian protected areas agencies recognize that ecosystems are dynamic. Ecological restoration efforts should thus be focused on developing and maintaining resilient, self-sustaining ecosystems that are characteristic of the protected area’s natural region. In addition, the principles and guidelines elaborated here reinforce the concept that the practice of ecological restoration is multi-dimensional; it requires that the system of interest be placed in its context; the species of which it is composed, the community of which it is a part, and the environment in which it is nested. This approach must not be limited to only the ecological dimension of the system, but should be extended to and integrated with the social, cultural, and spiritual dimensions with which the ecological dimension has a dynamic relationship.

The approach described in this document recognizes the importance of adopting an inclusive process that integrates philosophical, socio-cultural, educational and economic dimensions necessary for ecological restoration to achieve positive and long lasting outcomes. In conjunction with the implementation framework, these principles and guidelines provide a consistent basis for making decisions. However, they are neither intended to replace the advice of ecological restoration specialists nor to provide detailed technical instructions. Furthermore, it should be recognized that the field of ecological restoration is a rapidly changing one. The guidelines presented here are expected to be updated periodically to reflect new information, knowledge and understanding.

1.3 Why Do We Restore?

As was emphasized in the recently released Millennium Ecosystem Assessment (MEA 2005), the earth's natural capital produces all of those ecosystem goods and services upon which human society and well being are completely dependent. At the same time, degradation of ecosystems is widespread. Protected natural areas ecosystems in Canada (National Round Table on the Environment and the Economy 2003) and globally play a critical role in the conservation of biodiversity and natural capital, and the ecological goods and services that accrue from them. While ecosystem management outside protected areas may be directed towards modifying or controlling nature, producing crops, or extracting natural resources, management efforts within protected areas are directed at maintaining ecosystems in as natural a state as possible.

In Canada, protected natural areas are established to protect natural heritage for all Canadians to experience, discover, learn and appreciate into the future. Despite this goal, protected areas rarely contain complete, unaltered ecosystems, particularly in densely populated southern regions. The ecological integrity of protected areas, and thus their ability to conserve biodiversity and natural capital faces a number of threats. In Canada, incompatible land uses adjacent to protected areas, habitat fragmentation, and invasive alien species are the most commonly reported threats to protected areas (Environment Canada 2006). Other stresses such as downstream effects of air and water pollution and global climate change contribute further to the degradation of protected areas ecosystems and the loss of ecological integrity. Ecological restoration offers a way of halting and reversing ecosystem degradation.

Effective ecosystem-based management usually requires that ecosystems be managed with minimal intervention and that efforts to maintain ecological integrity and reduce or eliminate threats to it should precede restoration efforts. However ecological values of a protected area should be restored where they are threatened or degraded. Ecological restoration is supported by legislation such as the Canada National Parks Act (which places a priority on the maintenance or restoration of ecological integrity, as discussed in section 1.2) and the Species at Risk Act (2002), which mandates the development of recovery plans for endangered, threatened or extirpated species, and the management of species of special concern. Similar requirements are included in the policies and regulations of provincial protected areas agencies, including, for example, Ontario Parks and BC Parks (http://www.e-laws.gov.on.ca/DBLaws/Statutes/English/06p12_e.htm;

http://www.ene.gov.on.ca/envregistry/028855ep.htm;
http://www.env.gov.bc.ca/bcparks/conserve/consprog.html).

More broadly, ecological restoration contributes to the conservation objectives of protected areas management by ensuring these areas continue to safeguard biodiversity and natural capital and provide ecosystem services into the future. It strives to improve the biological diversity of degraded landscapes, increase the populations and distribution of rare and threatened species, enhance landscape connectivity, increase the availability of environmental goods and services, and contribute to the improvement of human well-being (Society for Ecological Restoration International and IUCN Commission on Ecosystem Management 2004).

On a deeper level, ecological restoration in Canada's protected areas aims to restore the non-material values and benefits of protected areas ecosystems that may relate to spiritual or religious ethics, education, recreation and tourism, aesthetics, social relations, and sense of place for all Canadians. It provides inspiration and strengthens our connection with the natural world.

Ecological restoration provides an opportunity for protected areas agencies to facilitate meaningful engagement and experiences that connect the public, communities and visitors to these special places. As Higgs (1997) states "in order for it [ecological restoration] to avoid becoming a passing fad, it must … depend on the development of authentic engagements between people and ecosystem; in other words, the development of a heightened place awareness". Direct public engagement in restoration activities and additional, related education efforts facilitate the development of deeper understanding and appreciation of natural systems and the threats they face, and contribute to long-term societal commitment to restoration goals (Schneider 2005). Participation in restoration efforts can itself result in quality, memorable visitor experiences. Ecological restoration thus provides an additional opportunity for protected areas agencies to demonstrate how they can enhance ecological integrity while enhancing the quality of recreational and other visitor experiences. Meaningful engagement and experiences help ensure the relevance of protected natural areas to Canadians. They can lead to the development of a constituency of informed, involved and committed partners, stakeholders, community members, public and visitors who will serve as effective stewards of these special places.

2.0 Principles

2.1 General Concepts

This section provides a brief overview of concepts that form the foundation of *principles of ecological restoration in Canada's protected natural areas*.

Ecological restoration is an intentional activity that initiates or accelerates recovery of an ecosystem with respect to its function (processes), integrity (species composition and community structure), and sustainability (resistance to disturbance and resilience). It enables abiotic support from the physical environment, suitable flows and exchanges of organisms and materials with the surrounding landscape, and the reestablishment of cultural interactions upon which the integrity of some ecosystems depends (Society for Ecological Restoration International Science and Policy Working Group 2004).

Through intervention, the process of ecological restoration attempts to return an ecosystem to its historic trajectory – that is, to a state that resembles a known prior state or to another state that could be expected to develop naturally within the bounds of the historic trajectory (Society for Ecological Restoration International Science & Policy Working Group, 2004). However, although ecological restoration should be anchored in an understanding of the past (e.g., historical ranges of variability in ecosystem attributes), the goal is not to reproduce a static historic ecosystem state. Restored ecosystems may not necessarily recover their former states, since contemporary constraints and conditions can cause them to develop along altered trajectories. Thus, the goal of ecological restoration is to initiate, re-initiate, or accelerate processes that will lead to the evolution of an ecosystem that is characteristic of a protected area's natural region.

Effective ecological restoration depends on recovering and maintaining ecological integrity. However, restoring ecosystems is typically an expensive process that requires substantially more effort than prevention of ecological damage. Over the last several decades the practice of restoration has evolved so that best practices are developed to ensure that restoration projects are not only *effective* (i.e., achieving ecological integrity) but also *efficient* in doing so with practical and economic methods to achieve functional success (Higgs 1997).

Ecological restoration is as much a process as it is a product. The actions of restoring an ecosystem bring people together, often in significant ways that lead to a renewed engagement between people and ecological processes. There is pride in accomplishment, but more significantly the process of restoration creates stronger understanding, appreciation, social support, and engagement for restoration initiatives as well as the need of preservation and conservation. In the most general sense, ecological restoration is, according to the Mission Statement of the Society for Ecological Restoration, "a means of sustaining the diversity of life on Earth and re-establishing an ecologically healthy relationship between nature and culture." Thinking of ecological restoration as a process leads to *engaging* restoration, a more encompassing view than either effective or efficient restoration allow.

Protected area agencies in Canada envision a model that integrates concepts related to ecological integrity and cultural values. It recognizes that cultural heritage is important not only as a way of supporting the process of restoration but also in building engaging relationships between culture and nature. This model also recognizes that both ecosystems and our values towards them shift over time and that long-term cultural and ecological processes are intertwined (e.g., Higgs 2003). The challenge of ecological restoration is to reach into the past to understand historical patterns and processes and then to take these forward to an uncertain future with ever-changing contemporary knowledge and with increasingly diversified and complex societal relationships to nature.

Some value systems, especially those advocated by Aboriginal peoples, do not recognize a separation of culture and nature. Aboriginal peoples do not separate themselves from the environment; they believe they are part of the environment and see ecologically healthy communities as communities of interdependent parts (Parks Canada 1999; Martinez 2006a). Their land ethic includes specific obligations on the part of all ecosystem participants to maintain the spiritual order of things natural, and includes Aboriginal humans as playing an important natural role in that order. Effective restoration, from an Aboriginal perspective, should recognize that nature is always changing and that a spiritual obligation exists to participate in the "re-creation of the world" through restoration that is an ongoing process of engagement with other humans and the natural world. In this context, "effective" and "engaging" restoration are inseparable.

Increasingly, Aboriginal cultural practices and world views are being incorporated into protected areas planning and management (e.g., Parks Canada 1999) and are contributing to the international development of the field of ecological restoration. Ecologically appropriate cultural practices of longstanding duration may be seen as a middle ground in a continuum of human influence – between inappropriate historic or contemporary influences at one end and self-organizing, autogenic nature at the other. Some ecosystems have evolved for millennia in concert with ecologically appropriate cultural practices (e.g., fire management) that contribute to the ecological integrity of the system. The restoration of such ecosystems may include the concomitant recovery of Aboriginal ecological management practices and support for the cultural survival of Aboriginal peoples and their languages as living libraries of Aboriginal Traditional Knowledge (ATK). Through their relationship with nature, Aboriginal people have developed unique and extensive knowledge about these systems. To be both effective and engaging, ecological restoration should respect and be informed by western ecological and social science and traditional ways of knowing and relating to the land.

Ecological restoration encourages and may indeed be dependent upon long-term participation of people. Canadian protected areas agencies are responsible for maintaining and restoring ecological values of protected natural areas. Likewise, they recognize (e.g. Parks Canada 1994) that ecological integrity should be assessed and restored with an understanding of the regional evolutionary and historic context that has shaped the system, including past occupation of the land by Aboriginal people. They are striving to ensure that ecosystem management practices respect and conserve cultural values and associated practices upon which the integrity of some ecosystems depends. Where legislation and policy of relevant jurisdictions permit, these values may include Aboriginal cultural landscapes (e.g., Parks Canada 1999) or other identified and protected cultural heritage values.

2.2 Principles of Ecological Restoration in Canada's Protected Natural Areas

Protected areas agencies are charged with ensuring that Canada's natural protected areas remain unimpaired for future generations to experience, discover, learn and appreciate. They also recognize that people and their environment cannot be separated and that the protection and presentation of natural areas should recognize the ways in which people have lived, and still live, within particular environments (Parks Canada 1994). Increasingly, they are also striving to foster a sense of inclusiveness and shared responsibility among all Canadians for the protection and presentation of Canada's natural heritage through meaningful engagement and connections (Parks Canada Agency 2006a). The process of ecological restoration in Canada's protected natural areas should be consistent with this approach by adhering to the following three guiding principles. It should be:

- *Effective* in restoring and maintaining ecological integrity
- *Efficient* in using practical and economic methods to achieve functional success
- *Engaging* through implementing inclusive processes and by recognizing and embracing linkages between culture and nature

Ecological restoration activities in Canada's protected natural areas should be ecologically effective, methodologically and economically efficient, and socio-culturally engaging. To be truly successful, the process of ecological restoration will help provide for the significant improvement of the state of the ecological integrity, the opportunities for people to appreciate and experience the protected area, and the engagement of public in the processes. These concepts are elaborated below.

Ecological restoration is effective

when it:

- Restores the natural ecosystem's structure, function, composition and dynamics (e.g., perturbations, retrogressive or progressive succession) within the constraints imposed by medium to long-term changes.
- Strives to ensure ecosystem resilience over time.
- Endeavours to increase natural capital.

because it:

- Respects the present and changing biophysical environment of the natural region.
- Is attentive to historical ranges of spatial and temporal variability, allowing for evolutionary change.
- Depends on a judicious blend of the best available scientific knowledge, Aboriginal traditional knowledge, and local knowledge.
- Avoids adverse effects on ecosystem components, cultural resources and socio-economic conditions.
- Is conducted according to these principles and guidelines as well as the implementation framework (e.g., Chapter 4), which encompasses key aspects of planning (e.g., consultation), execution, and follow-up.

recognizing that it:

- Typically requires continued commitment.
- Requires humility in the face of complex ecological and cultural uncertainties.

Ecological restoration is efficient:

when it:

- Strives for consistent and timely results.
- Is mindful of limited resources and creative in seeking novel means for accomplishing objectives and partnerships.
- Fosters creativity, innovation and knowledge sharing to ensure best future science and practice.
- Is responsible to the individuals, communities and institutions upon which the project(s) depends for success.

because it:

- Takes advantage of synergistic partnerships
- Encourages a minimum level of intervention

recognizing that it:

- Ensures long-term capacity for ecosystem maintenance through monitoring, intervention, and reporting
- Reports and communicates on actions and activities undertaken.

Ecological Restoration is engaging:

when it:

- Integrates the heritage value of cultural resources, especially where these are highlighted in the protected area's designation.
- Provides opportunities for people to more deeply connect with nature and enhances their understanding and appreciation of the relationships between cultural and ecological patterns and processes.
- Offers Canadians opportunities to discover and experience Canada's nature in ways that help to broaden their sense of attachment to the protected areas.
- Provides opportunities for community members, individuals, and groups to work together towards a common vision.
- Assists in promoting community wellness
- Creates opportunities for culture-nature reintegration that results in spiritual order and balance and enhances human well-being.

because it:

- Is inclusive and creates opportunities for meaningful engagement in restoration activities that support the development of a culture of conservation.
- Recognizes cultural[3] practices as ecological values to be restored or maintained.

[3] The term "cultural practices" in this context refers to ecologically sustainable traditional practices of long-standing application (i.e., usually, one thousand years or more; e.g., traditional use of fire by Aboriginal people).

recognizing that it:

- Ensures that proper consultation with Aboriginal peoples is conducted if there is a possibility that the restoration project or activity might have adverse effects on Aboriginal rights or title, even those that are claimed but unproven.

These principles of ecological effectiveness, practical and economical efficiency and socio-cultural engagement should be interwoven in the application of the guidelines and the framework for the planning and implementation for ecological restoration described in the following sections.

3.0 Guidelines for Ecological Restoration in Canada's Protected Natural Areas

3.1 How to Use the Guidelines

Guidelines *for ecological restoration in Canada's protected natural areas are specific recommendations that provide practical guidance for particular aspects of ecological restoration projects* in a manner consistent with the principles described above.

Figure 1 (below) identifies how the guidelines are to be used in the context of the principles set out above and the planning and implementation framework outlined in Chapter 4. As is illustrated in Figure 1, an important first step is to identify the overall natural and cultural heritage values of the protected area and/or the ecosystem to be restored. While all protected areas are established to conserve biodiversity and associated cultural resources, each protected area conserves its own unique series of natural and cultural heritage values. These values are reflected in the broadest sense by its IUCN protected area management category. The different management categories reflect the variety of specific objectives for which protected areas are established and managed – wilderness preservation, targeted wildlife population protection, recreation, sustainable use of natural resources, etc. In the approach described here, existing information (e.g., from monitoring and inventories) is used to evaluate ecosystem condition relative to these values, including consideration of the management objectives.

The principles in section 2.2 should be referred to in establishing goals for specific ecological restoration programs and projects. The *guidelines for ecological restoration in Canada's protected natural areas* described below are selected according to the degree of intervention required to meet restoration goals and objectives. During more detailed planning phases, they provide guidance for the development of restoration prescriptions for specific projects. Throughout this process, the specific guidelines referred to and the manner in which they are implemented must be balanced with other considerations, including social and cultural dimensions, related to the ecosystem of concern and the surrounding region, as is detailed in Chapter 4.

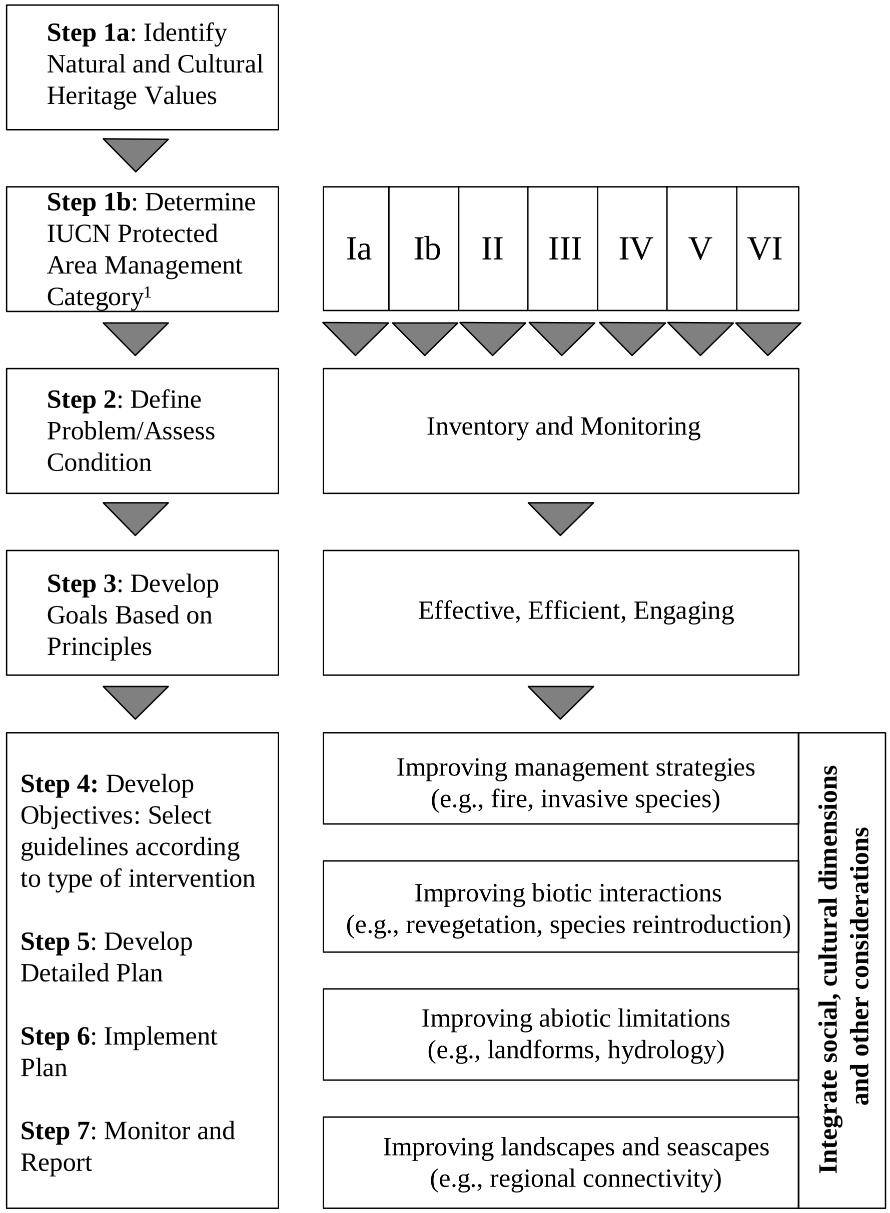

Figure 1: How to use the Principles and Guidelines for Ecological Restoration

[1]IUCN Management Categories are:
Ia Managed mainly for science and wilderness protection
Ib Managed mainly for wilderness protection
II Managed mainly for ecosystem protection and recreation
III Managed mainly for conservation of specific natural features
IV Managed mainly for conservation through management intervention
V Managed mainly for landscape / seascape conservation or recreation
VI Managed mainly for sustainable use of natural resources

3.2 Guidelines for Ecological Restoration in Canada's Protected Natural Areas

Current ecological thinking acknowledges that ecosystems are complex and dynamic, and thus change in composition and structure over time, in response to long-term climate and evolutionary changes. Furthermore, they are thermodynamically open, heterogeneous systems that are not only internally variable across time and space, but also interact with other ecosystems at the landscape level (Wallington et al. 2005). These characteristics of ecosystems represent a challenge for restoration practitioners faced with deciding which interventions are required to restore the characteristic composition, structure, and function of protected area ecosystems.

Figure 2 is a conceptual model for understanding ecosystem states and transitions amongst them. It also helps to identify the types of interventions that may be required to restore the functions of ecosystems that are degraded to varying degrees, as is outlined below. In this figure, the numbered "cups" represent alternative ecosystem states that may exist as a result of the influence of natural or anthropogenic disturbance and stress. Disturbance and stress cause transitions towards increasingly degraded states (6 being the most degraded) while interventions (restoration activities) attempt to force transitions towards an intact state (e.g., state 1 or above).

In Figure 2, the ecological resilience of the ecosystem in any given state is indicated by the width and depth of the "cup" (Holling 1973). Its depth represents the degree of disturbance (moving to the left) or intervention (moving to the right) required to cause transition between states. Several authors (e.g., Hobbs and Norton 1996; Whisenhant 1999, 2002; Hobbs and Harris 2001; Bestelmeyer 2006) have suggested that restoration thresholds, or barriers, may exist between some ecosystem states that prevent the system from returning to a less degraded state without the input of management effort. There may be multiple barriers for each ecosystem attribute. The effort (or energy and information) required to "push" a system up to a higher-functioning, less degraded state is greatest when a threshold must be crossed. Thus, preventing systems from crossing degradation thresholds in the first place, by removing degrading factors (i.e. stressors), is highly desirable. Furthermore, Whisenant (1999) has suggested that restoration thresholds, or barriers, may be primarily caused by 1) biotic interactions (e.g., grazing pressure) or 2) abiotic limitations (e.g., soil erosion or contamination). Interventions may thus be understood as focusing on preventing or reversing transition in ecosystem states across these barriers.

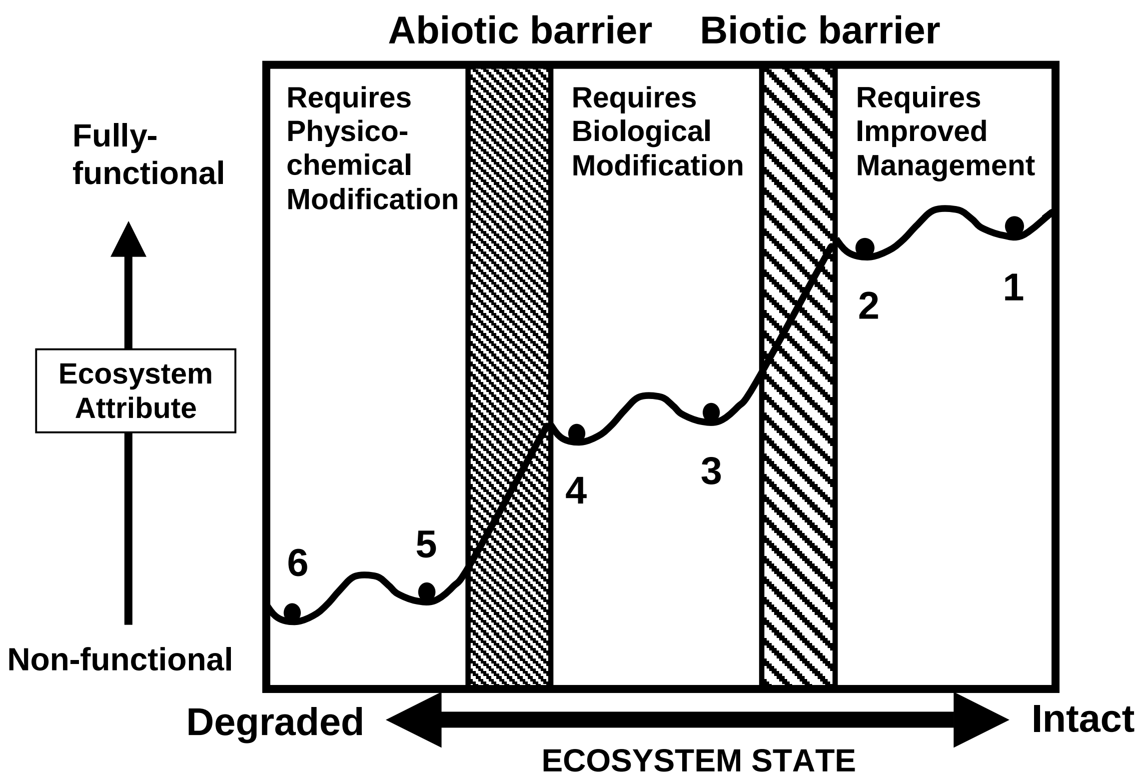

Figure 2: Conceptual model for ecosystem degradation and restoration (Adapated form Whisenant 1999, and Hobbs and Harris 2001)

The *Guidelines for Ecological Restoration in Canada's Protected Natural Areas* presented below are organized according to the above model. That is:

1. Before the biotic barrier is crossed, improvements in ecosystem management practices (e.g., restoration of natural disturbance regimes, managing resource extraction, removing harmful invasive species) may be sufficient to restore intact fully functioning ecosystems. Guidelines for interventions that are relevant to preventing transition across the biotic barrier are included in section 3.2.1.

2. If degradation is allowed to continue and the biotic barrier is crossed (e.g., as measured by reduced biological diversity and productivity), manipulation of ecosystem components may be required. Interventions may be more complex and costly and might include, for example, recreation of native communities or habitats, or species re-introductions. Guidelines for interventions that are relevant to forcing a transition back across the biotic barrier (i.e., improvements in biotic interactions) are included in section 3.2.2.

3. Crossing the abiotic barrier implies that the physical or chemical environment has become so impaired that the ecosystem no longer functions as an intact system (e.g., as measured by changes in soil stability, hydrology, or water or soil chemistry).

In this circumstance restoration efforts aimed at restoring landforms, hydrologic regimes, and water and soil quality would be necessary. In such severely degraded systems, these improvements in abiotic limitations would occur before biotic manipulations would be worthwhile. Guidelines for interventions that are relevant to forcing a transition back across the abiotic barrier (i.e., improvements in abiotic limitations) are included in section 3.2.3.

4. Finally, as is emphasized by Hobbs and Norton (1996) and Hobbs and Harris (2001), restoration should not only focus on individual sites but on the landscape as a whole, with the watershed (catchment) being the primary level of organisation. This expanded focus is particularly important in the protected natural areas context, as protected areas agencies strive to maintain and restore conservation values in increasingly fragmented and modified landscapes. Guidelines for interventions that are relevant to restoring linkages between ecosystems and the surrounding landscape are included in section 3.2.4.

Guidelines are presented according to the above model to facilitate selection of appropriate recommendations regarding interventions relevant to the degree of ecosystem degradation. However, as is pointed out by King and Hobbs (2006), it may be difficult to determine whether a given ecosystem has crossed a particular barrier. A good general strategy under any circumstances would thus be to focus on manipulations that will positively affect both abiotic and biotic functions.

Several attributes of ecosystems can be measured and subsequently manipulated to alter ecosystem structure and function and cause state transitions. Many measures of ecosystem attributes associated with ecosystem structure, function, and stressors that are currently used in ecological integrity monitoring programs developed by protected areas agencies (see section 4.2 and Appendix II of this document) may be useful in identifying ecosystem states and relevant interventions. Additional guidance is provided by the Society for Ecological Restoration International, which has developed a list of nine attributes of restored ecosystems (Society for Ecological Restoration International Science and Policy Working Group 2004). These attributes are listed in Appendix II.

Fundamentally, these guidelines and the conceptual model within which they are placed reinforce the *principles of ecological restoration in Canada's protected natural areas* that they support. They help ensure that ecological restoration will be ecologically effective, methodologically and economically efficient, and socio-culturally engaging. To be successful, ecological restoration should be conducted within the context of the ecosystem and landscape of which the protected area is a part. It should take a holistic approach to the restoration of ecosystem structure, function, and dynamics by integrating social, cultural, and spiritual processes in decision-making. Finally, as Bradshaw and Chadwick (1980) have stated, putting ecosystems back in working order will be the acid test of our understanding of them. The usefulness of these guidelines will only be measured by the degree to which they help us pass that test.

3.2.1 Improvements in Natural Areas Management Strategies

3.2.1.1 Restoration of natural disturbances and perturbations

Recommended	Not Recommended
Restoring, in a controlled manner, the frequency of natural disturbances such as fires, floods, saltwater inundations, and insect outbreaks such that they approximate natural cycles, and taking advantage of events such as storms.	Artificially controlling a natural cyclical insect outbreak; removing fallen wood after storms.
Allowing natural regenerative processes to occur when restoration of ecological integrity is measurable within a reasonable time-frame.	Initiating major restoration activities in ecosystems that are undergoing natural regeneration.
Promoting re-establishment of natural nutrient cycling (e.g., through re-introduction of nitrogen-fixing species or organic debris accumulation).	
Maintaining, restoring, or modifying cultural practices that contribute to ecological integrity, such as grazing of ecologically appropriate (e.g., bison) wild or domestic animals to restore grasslands.	Eliminating human activities that contribute to the maintenance or restoration of ecological integrity.
Promoting responsible exploration and learning activities that facilitate natural regeneration of disturbed areas or facilitate regeneration of recently-restored areas.	Failing to consider alternative ways to explore and discover Failing to facilitate public understanding about the ecological rationale for decisions
Collaboratively planning traditional resource uses to ensure that such activities contribute to ecological integrity of protected area ecosystems.	Failing to collaborate with Aboriginal groups in collecting and evaluating monitoring data to build consensus.
Seeking the advice of cultural resource specialists to assess the impact of changes in management strategies upon cultural resources in the area where interventions are planned.	Failing to seek the advice of cultural resource management specialists when cultural resources may be impacted by proposed management changes.
Undertaking changes in a way that respects the cultural resources in the area.	Failing to consult the *Standards and Guidelines for the Conservation of Historic Places in Canada* when cultural resources have been identified in the protected area where restoration interventions are planned.
Seeking advice of affected communities to assess the impact of changes in management strategies upon their cultural values and practices in areas where interventions are planned.	

Recommended	Not Recommended
Seeking advice of visitor specialists to assess opportunities and the impacts of changes on the visitor's experience	Failing to assess impacts on visitor experience
Providing opportunities to facilitate public understanding and appreciation of the role of natural disturbances and perturbations in ecological processes	

3.2.1.2 Control of harmful invasive species (alien or native)

Recommended	Not Recommended
Ensuring restoration activities are consistent with recommended strategies of *An Invasive Alien Species Strategy for Canada*, and related action plans.	
Avoiding the introduction of invasive species and varieties in restoration.	Assuming an alien species will not become invasive.
Placing priority on removal of invasive plant and animal species that threaten ecological integrity at landscape and regional levels.	Removing alien species that have become naturalized and fulfill an important ecological function.
	Removing species that have migrated into the ecosystem as a result of natural disturbances.
Developing plans for targeted species that include replacement with non-invasive native species to limit opportunities for re-invasion.	Introducing species that are known or suspected to be invasive.
Planning for ongoing active management of invasive species.	
Providing opportunities to facilitate public understanding and appreciation of the impact of invasive species on ecosystem composition, structure and function	
Providing opportunities for public engagement in the removal of invasive species where appropriate	

3.2.1.3 Management of hyperabundant populations

Recommended	Not Recommended
Identifying and treating the cause of population hyperabundance such as altered food-web interactions or habitat limitations.	Focusing on achieving a fixed population density or steady state condition rather than on maintaining or restoring key ecological processes
Using management methods for hyperabundant populations that duplicate the role of natural processes as closely as possible.	Culling of hyperabundant organisms without prior consideration of other options.
Evaluating the impact of reduced populations on protected area ecosystems.	
Engaging the public and other stakeholders prior to, during, and following active removal (culling) of hyperabundant organisms.	Failing to adequately inform and engage the public and other stakeholders.

3.2.2 Improvements in Biotic Interactions

3.2.2.1 Re-creation of native communities or habitat

Recommended	Not Recommended
Allowing the area to recover naturally where degradation is recent, relatively small, and in an area not likely to be invaded by alien species.	Assuming natural recovery will occur without evaluating natural recovery potential (e.g. previous examples in similar ecosystems).
Restoring stable soil surfaces, stream banks and shorelines to reduce erosion through the re-initiation of natural processes, and/or using natural materials.	Seeding or planting in locations that have not been stabilized or adequately prepared.
Planting short-lived, non-invasive “nurse” species, if they are non-invasive, to hold soil temporarily, if necessary (e.g., corn to create shade).	
Choosing a mix of species and genotypes that will facilitate the establishment of other native protected area species and provide habitat for species that are 1) already present in the protected area, 2) are expected to migrate into the protected area, or 3) will be re-introduced as part of the restoration plan.	
Using genetic material that is native to the protected area or its adjacent communities, provided evidence suggests that genetic diversity of such material is sufficient to sustain viable, resilient populations into the future. Alternative sources of genetic material	

Recommended	Not Recommended
include, in decreasing order of preference: native to the ecoregion, native to the ecozone, native ecovar, native cultivar (certified seed only).	
Creating a natural vegetation pattern at an appropriate spatial scale.	
Providing opportunities for public engagement in the re-creation of communities or habitats	

3.2.2.2 Species re-introductions for functional purposes

Recommended	Not Recommended
Focusing on restoring components of food webs that will likely result in them being resilient, flexible and self-sustaining.	Re-introducing species because of species-centred motivations (e.g., visibility, public interest) without prior consideration of food-web and habitat relationships.
Using native species or, if not available, considering other alternatives as a last resort (e.g., using cattle to graze in parts of Grasslands).	
In the case of species at risk, considering individual species recovery plans while working towards the ultimate goal of the restoration of protected area ecological integrity.	
Considering habitat requirements of target species as well as co-occurring and potentially essential symbiotic species (including microbial, floral and faunal organisms) that make up the ecosystem.	Failing to restore appropriate habitat prior to species re-introduction.
Evaluating possible negative interactions with other species in the restored ecosystem (i.e., as it will exist following restoration as opposed to when the target species was last present).	
Aiming at sufficient genetic diversity (and/or sufficiently large founding populations) to sustain viable, resilient populations into the future.	
Considering all functional groups (e.g., micro-organisms such as bacteria and fungi; plant pollinators), carbon age classes (including deadwood), and processes (e.g., decomposition of vegetation and wildlife) in restoration plans.	Removing deadwood, routinely or after storms, thus eliminating important food sources for insects and other species, and impairing nutrient cycling.

Recommended	Not Recommended
Working with stakeholders outside the protected area to facilitate biotic interactions between the protected area and its regional ecosystem (e.g. through maintenance or restoration of a mix of habitat types).	
Engaging the public and other stakeholders prior to during, and following re-introduction or manipulation of large carnivores (e.g., wolves), venomous organisms (e.g., snakes), or other species of high public interest (exceptions include species of high commercial value such as Ginseng).	Failing to adequately inform and engage the public and other stakeholders.
Providing opportunities to facilitate public understanding and appreciation of the role of large carnivores, venomous organisms and other species of high public interest	

3.2.3 Improvements in Abiotic Limitations

3.2.3.1 Landforms

Recommended	Not Recommended
Removing constructed features such as non-essential or abandoned buildings, or roads.	Removing or modifying any structure of cultural or historic significance.
Consulting visitor and engineering specialists to assess impact of removals	Failing to assess impacts on visitor experience
Assessing the cultural values and significance of cultural resources within a protected area.	
Consulting the *Standards and Guidelines for the Conservation of Historic Places in Canada* when planning interventions.	
Restoring natural topographic gradients (e.g., removing abandoned borrow pits) and drainage patterns with minimal disturbance to the protected area ecosystem.	Developing new borrow pits within the protected area.
Retaining sod, soil and other materials excavated during required developments for restoration projects with similar soil/geological types.	
Bringing only weed-free, contaminant-free, and invasive species-free soils into the protected area.	

Recommended	Not Recommended
Amending soil with natural organic material from within the protected area or sterile organic material from outside the protected area.	
	Failing to meet provincial or territorial health standards for biosolids, particularly through application on coarse-grained soils (e.g., sand and gravel pits).

3.2.3.2 Hydrology

Recommended	Not Recommended
Restoring natural hydrologic flow regimes in protected area ecosystems. Working on the scale of drainage basins where possible. Taking into consideration the significance of cultural resources where interventions are planned.	Not consulting cultural resource management specialists and *the Standards and Guidelines for the Conservation of Historic Places* when cultural resources may be affected by proposed interventions.
Taking into consideration implications and opportunities for visitor experience	Failing to assess impacts on visitor experience
Using progressive water level and flow regime restoration techniques	Causing sudden changes in water levels and flow regimes
Restoring habitat features such as floodplains, riparian systems, woody debris accumulations, terraces, gravel bars, riffles, and pools, using natural materials wherever possible.	
Removing structures such as dams and weirs, and artificial channels, to restore natural processes including flooding, stream migration (i.e., natural change in channel location), and associated erosion and deposition	Installing permanent artificial structures to control flooding and erosion
Restoring stream connectivity through the use of appropriate materials (e.g., corrugated metal versus plastic culverts) and procedures (e.g., revegetation of riparian areas; removal or modification of stream crossings; introduction of large woody material) and considering passage requirements for fish and other aquatic organisms.	

Recommended	Not Recommended
Reducing sedimentation through improvements to protected area hydrological regime rather than through dredging, wherever possible	
Protecting quantity of surface water and groundwater resources during restoration activities	
Re-establishing a positive water balance where groundwater use or drainage affect ecosystem processes	
Providing opportunities to facilitate public understanding and appreciation of the significance of the concept of watershed	
Providing opportunities for public engagement in the various restoration activities	

3.2.3.3 Water and Soil Quality

Recommended	Not Recommended
	Investing in costly contaminated site remediation without carefully evaluating other priorities for restoring ecological integrity in the protected area.
Referring to national (CCME) standards and guidelines for petroleum hydrocarbons and other substances in soil, water, aquatic sediments, and tissues of aquatic organisms. Evaluating site conditions, and either adopting generic (i.e., guideline or standard) levels or modifying them for site-specific conditions to develop site-specific objectives.	Remediating to generic levels without consideration of site-specific conditions.
Promoting nutrient cycles by ensuring all ages of carbon (from living through to dead and decomposing plant and animal materials) are present.	Removing carbon in the form of deadwood.
Using in-situ techniques such as phytoremediation, soil inoculation, or natural attenuation, where practical, to achieve levels that meet or exceed national standards or site-specific objectives.	Using ex-situ techniques (e.g., removal and disposal of contaminated materials) without first considering the feasibility of in-situ techniques.
Protecting quality (i.e., do not introduce chemical or biological contaminants) of surface waters, groundwater, aquatic sediment, and soil.	

Recommended	Not Recommended
Working with adjacent communities, other agencies, government bodies, and stakeholders, to ensure water quality inside the protected area is not compromised due to activities in parts of the watershed that are outside protected area boundaries.	Undertaking remediation efforts inside the protected area without reducing or eliminating contaminant inputs from outside the protected area.

3.2.4 Improvements in Landscapes and Seascapes

Recommended	Not Recommended
Identifying the relevant ecosystem boundaries (e.g. watersheds, key home ranges key/small/special biomes/ecozones) during project design.	Using political boundaries as the basis for defining area of interest. Proceeding unilaterally with a restoration project when the park is smaller than the relevant ecosystem boundary.
Identifying elements that favour ecosystem connectivity/permeability/matrix such as: increase protected area size; establish buffers and easements; reduce habitat fragmentation; provide migration corridors; conserve sources of propagules and colonists; conserve refugia for sedentary species; reduce edge effects; and increase opportunities for adaptation of protected area ecosystems to large-scale disturbances such as climate change.	Focusing on increasing the size of a protected area without demonstrating the conservation and economic benefits for the region.
Working with adjacent communities, landowners, government and non-government agencies, other stakeholders, and the general public to effectively achieve restoration on an ecosystem scale while respecting the significance of cultural resources and visitor experience opportunities identified in the region. Continuing to engage all stakeholders in planning, execution, maintenance and monitoring of ecological restoration projects.	Failing to engage stakeholders.
Identifying existing and potential threats to ecosystem integrity, such as sources of contamination, epidemic disease, or harmful invasive species in the broader ecosystem and mechanisms for limiting their impact.	Dealing with the symptoms without addressing underlying and long-term root causes.

Recommended	Not Recommended
Recognizing that some threats are global in nature (e.g. climate change, development) and addressing them in mitigation and adaptation strategies.	Maintaining the status quo or archetype in a changing environment.
Building in ecological resilience (e.g. maintaining drought/flood/winter thaw tolerant species in the system).	
Increasing public understanding, appreciation, support, and engagement towards ecological restoration in a variety of scales (local to global).	Negating the contribution of communication and education to ecological restoration. Restricting communication and educational efforts to only one or a few groups.
Monitoring, evaluating, adapting at a scale that is appropriate (e.g. controls, reference or broader ecosystem) to capture ecosystem-level characteristics.	Monitoring only within the restoration project boundary.
Considering the use of proven ecosystem-scale technologies.	Assuming existing data sets are sufficient at the ecosystem scale now being considered.
Ensuring redundancy at all trophic levels (e.g., multiple predator species) to secure redundancy and therefore stability in response to environmental perturbations.	

4.0 Framework for Planning and Implementation of Ecological Restoration in Canada's Protected Natural Areas

The ecological restoration planning and implementation process described below (and illustrated in Figure 3) is intended to promote national consistency in the manner in which the *Guidelines for Ecological Restoration* developed in Chapter 3 are applied across sites. It is based in large part on the Society for Ecological Restoration International's "Guidelines for Developing and Managing Ecological Restoration Projects" (Clewell et al. 2005). It is also consistent with guidance that has been developed by British Columbia (British Columbia Ministry of the Environment 2001) as well as with Principles and Guidelines for Wetland Restoration developed by the Ramsar Convention on Wetlands (2002), to which Canada is a party. This framework builds upon the principles outlined in Chapter 2, describes how the Canadian Guidelines for specific components (Chapter 3) should be implemented, and considers issues specific to the Canadian Protected Natural Areas context (e.g., legislation, jurisdiction). Management plans and other legislated requirements should be key documents for identifying where and when ecological restoration planning and implementation processes are required.

It is important to recognize that the resources committed to each step described in this framework will vary substantially according to the relative complexity of individual projects. The level of detail provided in this framework should be sufficient to apply to the most complex projects. Although all steps described below should be followed regardless of complexity, details of specific elements may not always be applicable. For example, all projects should have clearly articulated goals, measurable objectives, and specified timelines and they should ensure that visitor experience and enjoyment and public understanding and appreciation interests are fully considered and appropriate stakeholders are involved. However, restoration plans for some projects may have simple designs with hypotheses that are effectively tested during routine monitoring and may include minimal involvement of stakeholders and partners. The relative complexity of proposed projects should thus be considered during the implementation of this guidance framework.

This framework for planning and implementation of ecological restoration in Canada's protected natural areas focuses on planning and implementing specific restoration projects. It does not directly address issues related to the prioritization of restoration actions within particular protected areas or across protected areas systems. While protected areas agencies are mandated to ensure the ecological integrity of all protected natural areas for present and future generation, limited resources must also be spent judiciously. Some organizations (e.g., US EPA Superfund Hazardous Waste Program; The Alliance for Zero Extinction) have proposed prioritization schemes. A brief discussion of these schemes is provided in Appendix III. Individual jurisdictions may wish to consider these schemes in developing prioritization procedures.

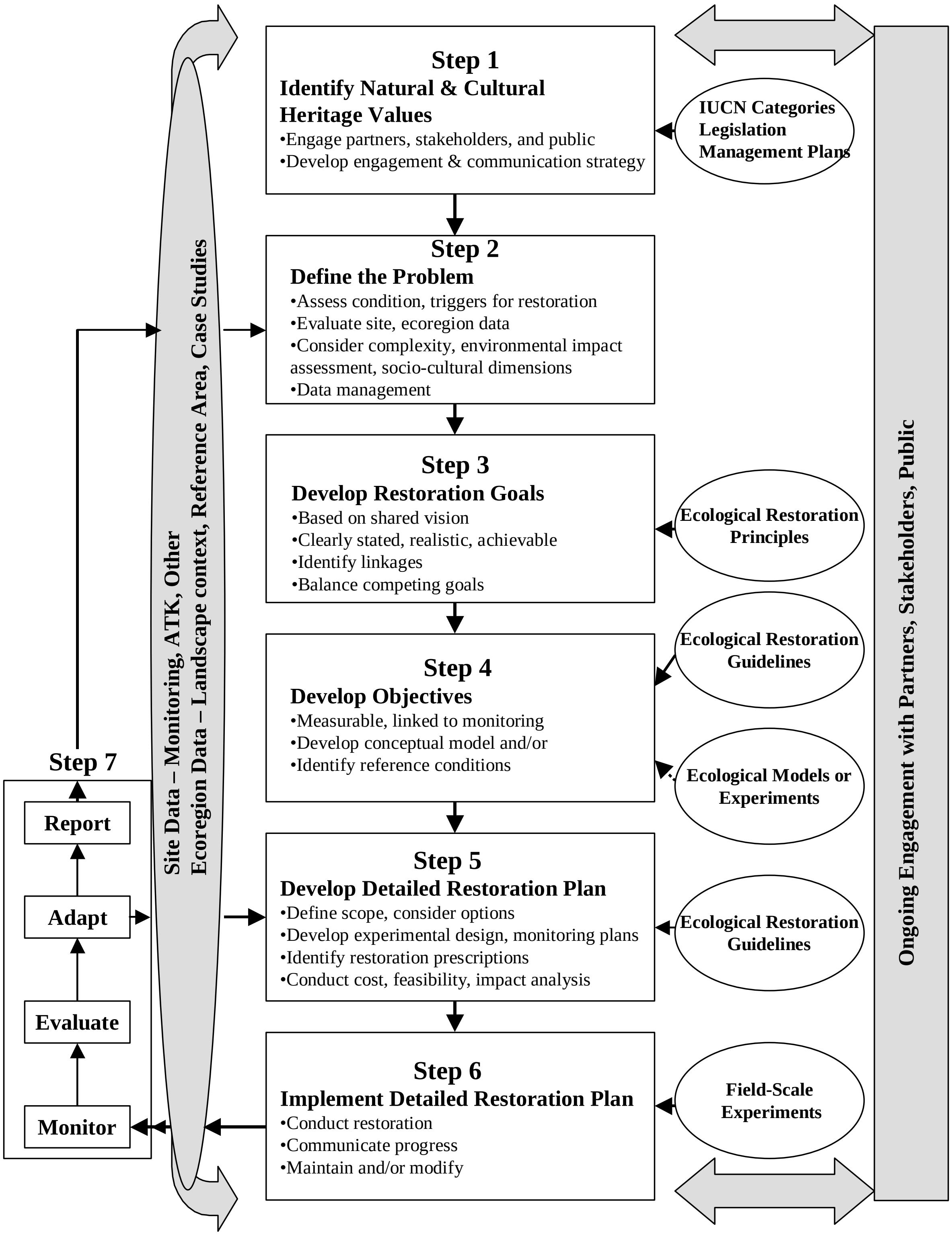

Figure 3: Ecological Restoration Planning and Implementation Framework

This framework encompasses seven major steps, which lead the user through conceptual planning to implementation and follow-up. While these steps follow a logical sequence, they may not always be completed in this order. For example, Steps 1 and 2 may often be completed simultaneously. Similarly, data for the ecosystem (site) and the ecoregion, as well as other supporting information such as case study results, are used throughout the process. Engagement of partners and stakeholders is integral to this process and is a component of each of the seven steps. The ecological restoration principles described in Chapter 2 are the basis for planning and implementation and should be considered in each step.

While the framework presented here is specific to ecological restoration, it should also be noted that it is broadly consistent with other environmental management frameworks that take into consideration the impact of decisions on all aspects of the management of parks and protected areas. In particular, it integrates many principles and procedures of ecological risk assessment (e.g., Gaudet et al. 1994). Like ecological risk assessment, it is fundamentally a values and goal-driven process that identifies, organizes and analyzes diverse scientific and socio-cultural information to make informed decisions about appropriate management actions.

4.1 Step 1: Identify Natural and Cultural Heritage Values

4.1.1 Identifying Values

The first step in the ecological restoration planning process should be the identification of an initial set of ecological and cultural values to be considered in the proposed project. Natural heritage values of the protected area that are to be maintained and/or restored are generally captured in planning documents. Management plans are important as strategic guides to managing protected natural areas, including ecological restoration activities. They describe each protected area and its regional setting, and identify conservation, visitor experience, and education goals as well as issues and challenges associated with the attainment of those goals. These documents should be consulted to identify an initial set of values for consideration in the proposed restoration project. In some cases, existing Ecological Integrity Statements, or other similar statements of natural significance may need to be reviewed and updated. In other cases (e.g., a newly-established protected area), planning documents may not exist and the process for identifying values may be more complex. As was discussed in section 3.1, natural and cultural values of a protected natural area are usually reflected by its IUCN management category. This classification should provide guidance regarding a protected area’s national or regional ecological, socio-cultural visitation, economic and public education context and purpose.

Protected natural areas also have cultural significance, because they are important to people for various reasons. Cultural heritage values should be identified and respected in the restoration plan. Statements of value for cultural resources may be identified by consulting the Canadian Register of Historic Places, which includes statements of significance for all federal, provincial or territorial places included in the Canadian Register. Individual jurisdictions may have other planning documents that can provide guidance to practitioners. For example Parks Canada prepares Commemorative Integrity Statements, Statements of Commemorative Intent and Management Plans.

Respect for all cultural and natural heritage values and the individuals who hold those values should be maintained throughout any related consultations. Any conflicts amongst heritage values must be resolved before the planning process proceeds. Engagement of stakeholders, partners, local communities and the general public in understanding and expressing natural and cultural heritage values for the ecosystem should minimize conflicts and focus the planning process. This engagement may often take place through parallel processes such as management planning or environmental assessment, or visitor experience assessment for other projects.

4.1.2 Legislative Requirements

Federal, provincial, regional, and municipal legislation, regulations, and policies applicable to the project should be identified and consulted. These requirements may help in the resolution of conflicts between management objectives (i.e., where those objectives are based in law). Extensive legal frameworks guide the management of the protected areas in which ecological restoration activities are proposed. For Parks Canada, several acts of Parliament direct the actions of the Agency on its lands. A checklist can be found in Appendix I. For areas within other federal, provincial or territorial jurisdictions, some of these acts, or other similar legislation, such as provincial environmental assessment acts, may apply. Specific requirements may relate to conservation of ecosystems and cultural resources, health and safety, labour code, etc. Any relevant case law should also be identified, as should formal plans or policies specific to the region. Standardized protocols set out in legislation or policy (e.g., for the Species at Risk Act) should also be identified. Similarly, broad strategies (e.g., An Invasive Alien Species Strategy for Canada; Environment Canada 2004) and proposed actions for managing threats such as invasive alien species should be consulted.

In addition, Aboriginal claim settlements (i.e. modern treaties) have the status of constitutionally protected documents and so have a standing above that of acts of Parliament. Most have chapters dealing with harvesting or wildlife management issues. Settlements apply to select regions of the country, including most of the North. A list is provided at the end of this document (Appendix I); the appropriate claim should be reviewed when planning a project.

4.1.3 Engagement and Communication

The identification and engagement of partners and stakeholders (e.g., Aboriginal groups, other government agencies, universities landowners, local communities, conservation groups, tourism bodies, visitor experience specialists, local experts, and the general public) in the proposed restoration project is critical to a successful outcome over both the short and long terms. In the short term (Step 1), stakeholders and partners should be engaged in affirming the natural and cultural heritage values of the ecosystem within the context of the protected area and its natural region. In later stages, they should be engaged in sharing information about the ecosystem (Step 2) setting project goals (Step 3), defining objectives (step 4), gaining permission for the proposed work, and contributing skills, knowledge, financial, and human resources to the development, implementation, maintenance, and monitoring of the project (Steps 4 through 6). This process is critical to ensuring effective long-term success of the restoration project. Effective engagement should also ensure information and knowledge transfer from the ecosystem and protected area to surrounding regions and jurisdictions. More broadly, as was discussed in Chapter 2, engaging restoration contributes to re-establishment of an ecologically healthy relationship between nature and culture. Engagement in ecological restoration activities provides an opportunity for learning, visitor experience and connection to place and can inspire Canadians through individual involvement.

Protected areas agencies are moving beyond stakeholder consultation to more fully involve stakeholders and partners in meaningful ways that bring their unique perspectives into multi-lateral processes that will broadly influence planning and management (e.g., Parks Canada Agency 2006a,b). Recent Supreme Court of Canada decisions (Haida-Taku, Mikisew Cree) have also confirmed that the Crown (Federal and Provincial) has a duty to consult with Aboriginal peoples, and must seek a balanced approach to accommodation, when it has knowledge of the potential or perceived existence of an Aboriginal right or title and contemplates conduct that might adversely affect it. Cooperative management agreements (such as those developed between Parks Canada and its Aboriginal partners) that stipulate when and how Aboriginal groups must be consulted and accommodated further reflect the modern reality that protected areas organizations have genuine partnerships with Aboriginal groups that must be respected (Parks Canada Agency 2006b).

4.1.3.1 Engagement and Communication Strategy

In Step 1, restoration project managers should develop an engagement and communication strategy. In doing so, they should consider the appropriate level of detail and recognize that much depends upon the sensibilities of local groups. This strategy could involve analyzing the communications environment and developing strategies for stakeholder and partner engagement, or it could be a simple set of bullets describing the work to be done and its purpose. For a more complex project, this process should include framing of the issues, identifying and considering the community of interest, setting preliminary objectives, and developing a budget for working together. Complexity rating tools used in specific applications (e.g., prescribed burning or closure of facilities) may also have more general applicability in helping to define what types of engagement and communication are appropriate for different types of projects.

In framing the issues, background information and events should be described, and preliminary goals, objectives (including substantive, relationship, and process objectives), and related measures should be established. Potential and real public perceptions, concerns and issues associated with the project should be identified, as should the level of risk that the project or phases of the project will elicit public concern, anger, or resentment.

In identifying the community of interest project managers should identify target stakeholder groups and their social values and demographics. They should also understand how these social values and demographics affect stakeholder perceptions of the restoration project. Gaps in stakeholder knowledge of the project should be identified and the degree of urgency should be established. Information about the site (Step 2) as well as an understanding of off-site influences and effects (Step 4) should be used to re-evaluate who should be involved throughout the project duration. Anyone with a legal interest in the project must be engaged at the earliest possible time. Other individuals and organizations with particular interests or expertise can be brought in at different stages. Finally, substantive, relationship, and process goals and objectives should be considered in developing project budgets.

Meaningful engagement of stakeholders and partners may include a range of types of communication and mechanisms for working together, from informing, through involving/consulting, to collaborating. Information dissemination to stakeholders and partners is critical to developing an understanding of the project and of restoration principles and processes. Project managers, stakeholders and partners may all influence project development through information exchange that fosters collective knowledge and understanding. Information exchange should be initiated during early planning stages of the project (e.g., Steps 1 and 2) and should continue throughout the project.

4.1.3.2 Consultation

Involving partners and stakeholders through consultation that includes dialogue and an exchange of ideas (e.g., through an advisory committee that provides advice and input to the project managers) builds support and commitment for the project. During the initial conceptual planning phase of an ecological restoration project it is important to hear all perspectives relevant to the project. For example, different cultural or visitor groups may have different or even conflicting values with respect to nature. These values should be expressed and respected. Early consultation is fundamental to the success of ecological restoration projects, not only in conducting effective project planning but in building a greater understanding and appreciation of the role of ecological restoration in attaining broader conservation goals. Consultation should thus be conducted as early as possible in the process and should continue throughout all phases of planning, implementation and monitoring. Parks Canada has published a guidebook to Aboriginal consultations (Parks Canada Agency 2006b), which should serve as a useful reference manual.

It should also be recognized that effective consultation can stretch limited resources. In addition, the same stakeholders and partners may be consulted on related issues and become fatigued with the consultation process. If a relevant local or regional management planning process exists, it may have already met some of the consultation needs. Rather than establishing a new process, restoration planning should make use of consultation opportunities associated with any other processes, such as management planning, environmental assessment, or assessment of impacts on visitor experience.

4.1.3.3 Collaboration

Through collaboration, project managers, stakeholders, partners, local communities and the general public seek shared understanding, common purpose and vision, and collective action. Stakeholders and partners become fully engaged in a multi-lateral process that influences the entire scope of project planning and implementation. Depending on the scope and complexity of the restoration project, individuals (e.g., Aboriginal groups, landowners) and agencies (e.g., other jurisdictions) outside the protected area may be involved to varying degrees in the planning and implementation of the proposed project. Resources should be coordinated amongst partners wherever possible. Effective coordination of resources should create efficiencies and improve the chances of success. Examples of areas of coordination include, but are not necessarily limited to: coordination of volunteer programs; joint funding; contract mechanisms; program level coordination of projects; coordination of communications; and project management systems (benchmarks, training, effective oversight/tracking, accountability).

A broad range of tools should be considered in engaging stakeholders and partners. Such tools may include workshops, open houses, special events, community planning weekends, modeling games, the establishment of a temporary program office or "shop front", or ideas competitions. The choice of tool(s) will depend on the experience of the community of interest and the complexity of the issues being considered.

Participation in ecological restoration projects can generate personal responsibility and accountability and help ensure that all interests are considered. This is intimately connected with Aboriginal peoples' lineage, and spiritual connection. These links should be respected and the project team should work within the context they dictate when Aboriginal representatives are unavailable to participate in the design of the restoration plan. This will ensure that Aboriginal values and perspectives are embedded.

4.2 Step 2: Define the Problem

4.2.1 Assessing Condition

Before detailed planning can proceed, preliminary information about the ecosystem should be collected to assess its condition and define the restoration problem. Ultimately, sufficient information should be gathered and evaluated to: establish an understanding of linkages amongst stressors, and other ecosystem attributes (Parks Canada Agency 2007; Appendix II), to determine the degree to which ecological integrity indicators for the ecosystem deviate from reference conditions (e.g., Stoddard et al. 2006) and to formulate preliminary restoration options. These options should be evaluated using a risk-based approach, as is discussed in Step 5.

In many cases, existing monitoring and assessment frameworks may provide sufficient data to identify cases in which the ecological values of a protected area are threatened and should be restored. When such a monitoring and assessment system is in place, particularly over a reasonable time frame, impairment in ecological integrity should be detectable when it occurs. In some cases (e.g., large remote ecosystems), there may not be sufficient background information available to identify changes relative to a reference condition. In such cases, additional information about the protected area ecosystem and its regional and landscape context may be required. In any case, problem identification should be an ongoing process that uses information from a variety of sources in addition to routine monitoring. These sources may include new information from similar ecosystems (e.g., identification of whitebark pine as threatened in tree line ecosystems in the United States eventually led to restoration efforts in Canada), case studies, research results, expert opinion, local knowledge, and Aboriginal traditional knowledge.

Once the existence of a problem is identified, the problem should be more rigorously defined in order to develop project goals and objectives and to select the tactics and technologies required to achieve them (Steps 3 through 5). In addition to the information sources described above (and in Appendix II), other information sources about the ecosystem, the protected area, and the surrounding landscape should also be consulted. These information sources may include but are not limited to: historical and current inventories, maps, photographs, databases, notebooks, and anecdotal information. Stakeholders and partners should be informed about existing information and should be engaged as appropriate in providing additional relevant information. Data gaps should be identified and mechanisms should be put in place to fill them.

Existing information should be used to identify the need for ecological restoration and the causes of degradation. Specifically, ecological values that are threatened or impaired should be identified. Section 3.2 and Appendix II of this document addresses in general the ecosystem attributes that should be considered in ecological restoration. Nonetheless, identification of ecological values that are critical to the health or integrity of specific ecosystems or ecoregions may require additional evaluation and assessment. For example, Fisheries and Oceans Canada has developed a process for identifying ecologically and biologically significant areas (Fisheries and Oceans Canada 2005b) and is developing detailed guidance regarding the criteria to be used in determining ecologically significant species and community properties (Fisheries and Oceans Canada 2006). Similar criteria may be useful for other protected areas agencies.

Ecological values of a protected area should be restored where they are degraded and where effective, efficient and engaging interventions exist. The need to restore will generally be triggered by poor (e.g., relative to threshold of concern) or declining (negative trend) ecological integrity. Specific restoration triggers may relate to the conservation goal(s) of the protected area, as identified in Step 1. For example, loss of ecological integrity may trigger the need to restore for Wilderness Areas or National and Provincial Parks (IUCN categories I and II) whereas threats to a natural feature or to a specific species or community may be triggers for restoration in National Monuments or

Wildlife Sanctuaries (IUCN category III and IV). Threats to interactions between culture and nature (e.g., enjoyment by humans) or to sustainable uses (e.g., fisheries) would trigger the need to restore in protected natural areas that are managed for values related to natural landscapes or seascapes or to the sustainable flow of products and services (IUCN category V and VI).

Existing information is also critical to establishing pre-treatment baseline conditions against which changes in ecosystem attributes following restoration can be evaluated. Changes in the characteristics of the ecosystem that have occurred (i.e., relative to a historical condition) should be described. Similarly characteristics of the restored ecosystem should be briefly described. These descriptions should be in language appropriate to facilitating communication with stakeholders and partners and ensure collective understanding of the problem.

Data and information collection and evaluation should not be limited to the ecosystem of concern or the project site. Additional information should be evaluated for the protected area as whole as well as the surrounding landscape. This information should assist in identifying off-site influences and impacts, which, in some cases (i.e., when they contribute to ecosystem impairment or degradation or have cultural or socioeconomic impacts), may need to be reduced or eliminated before restoration can proceed. It may also clarify priorities for the establishment of partnerships and/or outreach programs. Finally, it should also contribute to an understanding of pre-disturbance or reference conditions that can assist in the description of a "reference ecosystem" as is discussed in Step 4.

Problem definition is an important component of the "feedback loop" of adaptive management, as discussed in Step 5. Once restoration projects are implemented, ongoing monitoring results should be evaluated and used to adapt (or adjust) design specifications. As data are collected through this process, assessment of site and ecoregion conditions should be ongoing. In some cases, such assessments may lead to redefinition of the restoration problem.

Assessment of existing information and clear definition of the problem should contribute to an understanding of the complexity of the restoration project. In some cases (e.g., prescribed burning) it may be useful to use a formal complexity rating process. Although each step of this implementation framework should be accomplished for all projects, project managers should consider the relative complexity of the project in deciding on the amount of resources committed to each step.

4.2.2 Environmental Assessment

The planning of an ecological restoration project must also include consideration of the potential for adverse environmental effects. This is an element of good planning, regardless of whether or not it is required by legislation or policy applicable to the jurisdiction within which the restoration project is to take place. The alteration of some elements of ecosystem structure or function, the introduction of infrastructure, or mere human presence during the restoration, may result in adverse consequences, even while achieving the project's intended objectives. Environmental impact assessment will aim to identify all the consequences of the project, unintended as well as intended, in order to maximize the benefits and minimize any adverse effects. This will include possible adverse effects on both ecological and cultural (e.g., archaeological) resources.

It will be necessary to determine whether or not there is a legislated or other environmental assessment requirement that is applicable to the project in order to be sure the assessment is done in a way that serves the needs of that process. In general, a good environmental impact assessment is one that supplies useful information to planners and decision-makers, and the elements tend to be consistent regardless of the applicable legislation or policy. It need not be lengthy. Advice should be sought from an environmental impact assessment specialist early in concept development on how and when to conduct an efficient and useful impact assessment and who should be involved.

If the restoration proposal is multi-faceted and encompasses multiple projects likely to take place over several years and in different locations, it is wise to consider beginning with a strategic environmental assessment of the entire proposal. This would provide confidence early in the planning process that major concerns have been identified and resolved. A strategic environmental assessment can contribute to good planning by providing an effective process for informing and consulting with potential partners, neighbours, and other interested parties. It can also be an effective means of simplifying and guiding subsequent project-level assessments which will be undertaken when more detailed plans are available.

4.2.3 Visitor Experience Assessment

Many protected areas provide opportunities for visitors. Ecological restoration activities should create opportunities for meaningful public engagement and visitor experiences that connect people more deeply to their protected areas. Visitor experience may be enhanced, for example, through direct participation of visitors in restoration actions or through their continued future enjoyment of a restored ecosystem. Potential adverse impacts of restoration projects on visitor experience should also be considered during project planning. Where possible, advice should be sought from a visitor experience specialist early in the concept development regarding how to conduct an efficient and useful evaluation of impacts on visitor experience.

4.2.4 Data Management

Plans for managing data should be included during early data-gathering stages. Data and metadata collected and used in ecological restoration projects should be managed according to requirements of relevant protected areas agencies (e.g., Parks Canada Research and Collection Permit System - Researcher's Guide www.pc.gc.ca/apps/rps/ReGuide_e.asp). Important factors to consider in managing data in the context of ecological restoration projects, which in many cases may span years or decades, include: using meta-data standards; using a universal archival system to identify where data can be found and understood and where it should be housed; maintaining data security and intellectual property rights, especially where Aboriginal Traditional Knowledge (ATK) is shared and employed or Species at Risk Act (SARA) listed taxa are involved. (In these cases, formal data sharing agreements are needed); using clearly defined and rationalized data analyses that are specific about biases in collection and analysis and limitations; using and recording reference collections where digital photographs are taken, vouchers are collected (if possible) and identifications of taxa are peer reviewed in some form. Data management plans should also include plans for efficient data and information sharing within and among protected areas agencies.

4.3 Step 3: Develop Restoration Goals

In Step 3 project goals that define the desired future state of the ecosystem should be established. Stakeholders, partners, local communities and the general public should be engaged in building a shared vision for the project upon which these goals are based. Project restoration goals must be based on consultation with, and support from partners with a legal interest in the process and the outcomes. They should ideally also be based on consultation with and support from other interested parties identified in Step 1, above. Principles of ecological restoration (Chapter 2) as well as the heritage values and condition of the ecosystem to be restored (Steps 1 and 2 above) should guide the goal-setting process.

Project goals should be clearly stated. While overall the goal of ecological restoration in Canada's protected natural areas (as was articulated in the principles outlined in Chapter 2) is restoration that is effective (restores ecological integrity), efficient (cost-effective), and engaging (respects socio-cultural linkages with nature), goals for individual projects may vary. Because goals are values-based, the ecological and cultural values identified in Step 1 may influence project goals. For example, ecological values such as the presence of species at risk may lead to the development of goals related to the restoration of critical habitat. Similarly, cultural values associated with Aboriginal uses, learning, or visitor experience may generate goals associated with spiritual, educational, or recreational qualities of the ecosystem.

It is important that project goals be realistic and achievable in the context of off-site influences and global change. For example, because of the often-significant mobility of many marine, large mammal, and avian species, management and restoration of such species may be beyond the authority of protected areas managers alone, and require collaboration and coordination with other resource managers. Similar concerns exist regarding projects aimed at assisting the recovery of migratory species or in restoring freshwater ecosystems that are affected by what happens elsewhere in the watershed. Goals for such projects may only be achievable if off-site collaboration is effective. Similarly, although history should be taken into account as a guide to setting restoration objectives, it is not necessarily the only guide to effective restoration. For example, it is important to recognize that historic ecosystem characteristics may not be achievable under present or future climatic conditions. A balance is needed between history and ecosystem resilience to global change, as was discussed in section 3.2. Ecosystems that we restore are complex and have attributes that are difficult to understand. Restoration projects and programs will need to build in flexibility to adapt as they progress. Project goals should reflect such realities.

Goals for individual restoration projects should be linked to, and consistent with, all applicable national, regional and local policy and management planning goals. While one agency may initiate the project, it may serve the needs of multiple agencies. Linkages are particularly important where there are complexes of natural areas and other types of green or open space, held under different ownerships, that all contribute to the ecological integrity of a larger landscape (e.g., biosphere reserves, natural heritage systems). Establishing these linkages early will create efficiencies and ensure the project is compatible with large-scale plans and processes.

In some cases, multiple competing goals for the restoration of protected areas ecosystems may exist. For example, goals for the recovery of sea otter populations in British Columbia (listed as threatened under the Species at Risk Act) may conflict with goals for the sustainable harvest of shellfish in marine protected areas. Potential conflicts should be considered and resolved as goals are established.

4.4 Step 4: Establish Objectives

In Step 4, measurable project objectives are developed based on the goals established in Step 3, and, depending on the complexity of the project, a conceptual model for the restoration project is developed.

A list of objectives should be prepared that describe the actions that will be completed as part of the project to attain the goals outlined in Step 3. These objectives should be measurable through monitoring, achievable within an acceptable range of variation, and consistent with higher-level goals and plans described above. If it proves impossible to develop objectives that meet these criteria, it may be necessary to re-evaluate the problem definition (Step 2) and project goals (Step 3).

Guidelines for ecological restoration of Canada’s protected natural areas, as outlined in Chapter 3, provide guidance regarding the range of objectives that might be considered for specific types of interventions. For example, where the degree of intervention is limited to improvements in existing management strategies (section 3.2.1), an objective might be related to restoration of fire regime. Alternatively, where interventions include improvements in biotic interactions (section 3.2.2), objectives might refer to re-introduction and re-establishment of specific species, communities, or habitats. Objectives should be stated in terms of specific measurable targets (e.g., primary productivity meets a specified level, specific % removal of an invasive species is accomplished; species population size is within 95% confidence limits of reference conditions). Varying levels of intervention may be required for different areas or zones of the ecosystem. Goals of the project should lead to the setting of objectives that consider both ecological (e.g., physical environment, food web structure, disturbance regime) and cultural (e.g., visitor experience, participation, education, spirituality) outcomes. Further background can be found in the Park Level Monitoring Guide developed by the Parks Canada Agency (2007).

The complexity of a project will drive the number and type of objectives required. For example, a complex project is more likely to include goals and resulting objectives for social engagement, community participation, and mitigating unwanted off-site effects, as well as specific objectives for ecosystem attributes such as biodiversity, function, or stressors. Relatively simple projects may have only a single goal and a few objectives.

Objectives should be measurable using appropriate performance measures, as is discussed in Step 5. If there are multiple linked objectives, their relationship should be described and the order in which they must be pursued, or whether they can be pursued concurrently, should be established. The time required to meet objectives should be estimated.

For relatively complex projects, the development of a conceptual model for the proposed restoration may help organize and focus the planning process and assist in the development of specific objectives and testable hypotheses. Such models are developed using information collected in Step 2. They should synthesize the socio-cultural and ecological characteristics of the system (including linkages across ecosystems), including interconnections amongst cultural practices, environmental stressors, ecosystem attributes, and restoration activities. As syntheses of the state of understanding of the system, conceptual models can provide a basis for examining the potential risks and consequences of various restoration options and related management actions, as is discussed further in Step 5. Modelled attributes of the restored ecosystem can also be used as benchmarks for evaluating the success of various stages of the project and determining the need to change restoration actions or policies through an adaptive approach, as is discussed in Step 5.

Descriptions of the abiotic and biotic attributes of one or more sets of reference conditions (reference ecosystems) are important contributors to conceptual models for ecological restoration projects. Reference ecosystems may be identifiable pre-disturbance conditions, actual undisturbed sites that represent the same type of ecosystem, descriptions of such sites, or other documentation that describes the target state of the restored ecosystem. Since attributes vary across ecosystems regardless of the degree of disturbance, project managers should consider identifying and describing multiple reference ecosystems. In such cases, objectives and associated targets would be described with a range of possible outcomes in mind. Specifying a range of outcomes recognizes the inherent variability of natural systems. It also recognizes that unforeseen or uncontrollable disturbance (e.g., climate change) may have an impact on the outcome.

The use of multiple reference ecosystems incorporates natural ranges of variability and thus also increases the statistical power of experimental designs.

Specific actions (i.e., restoration prescriptions) that will be taken to attain individual objectives are developed in Step 5 and implemented in Step 6.

4.5 Step 5: Develop Detailed Restoration Plan

The development of a detailed restoration plan entails definition of the scope of the project, consideration of the scientific design of the restoration, and selection of specific restoration prescriptions that include practical considerations such as the choice of specific treatments, cost, and personnel. These processes are discussed briefly below.

4.5.1 Scope

The scope of the project should be defined spatially and temporally, in consultation with stakeholders and partners. Goals and objectives established in Steps 3 and 4 should be used to define broadly the degree of intervention. In defining the project scope, available options for achieving objectives should be considered. For example, a project could be designed to achieve the maximum degree of restoration that is technically possible on implementation or it could be designed to set processes in motion to achieve the desired level of restoration over time, with or without assistance. In some cases, a short-term option, such as stabilization of a rapidly eroding site, may be chosen while longer-term plans are developed. The likelihood of success of various restoration options should be considered. This process may take a risk assessment approach. Potential risks (i.e. risk of failure, risk of a permanent loss of a resource, risk of cascading effects, risk of off-site impacts, risk of impact on visitor experience and educational opportunities, risk of losing support of partners) should be evaluated amongst options, including the option of doing nothing. The relative cost of different restoration options should be considered in this process.

Consideration of the temporal scope of the project is critical in that some objectives (e.g., species reintroduction) may be attainable in a short timeframe (e.g., within a few years) whereas others (e.g., reforestation) may not be realized for decades. Objectives to be included in the project scope must be attainable with the resources available. Where it is determined that specific objectives cannot be met, goals related to those objectives should be re-evaluated.

Strategies for ongoing engagement and communication with stakeholders and partners and for opportunities for experience and learning should be included in the project scope. Any unknowns that may lead to adjustment of the spatial extent or duration of the project should be identified.

4.5.2 Project Design and Adaptive Management

Designs for ecological restoration projects should follow a hypothesis-testing model that is consistent with the “learning by doing” approach of adaptive management. Ecological restoration is a form of active management in which protected areas agencies make changes in policies and operational procedures to achieve their stated goals. However, the responses of ecosystems to these changes cannot be predicted with certainty. Ecological restoration practice embraces the concept of adaptive management in which restoration projects are implemented as deliberately conceived experiments and results are monitored, documented, and used to guide future policies and actions. In this approach, elements of experimental design, monitoring and reporting are important to successful ecological restoration, as is discussed below.

In implementing an adaptive management approach, restoration strategies are tested using a scientifically and statistically rigorous process that allows for an evaluation of their effectiveness through monitoring. The hypothesis or hypotheses to be tested (i.e., the predicted condition(s)) should be specified and a detailed experimental design, which includes power analysis wherever possible, should be developed. Ecological models may be used to predict specific outcomes of proposed restoration treatments. Supplementary smaller scale bench and/or field-scale experiments may also be conducted to reduce model uncertainties and help refine the design. In some cases (e.g., when the ecosystem is extensive enough and science capacity is great enough) multiple hypotheses may be tested in parallel as controls and replicates. Where actual reference ecosystems can be identified and monitored, comparisons amongst control (untreated but impaired) sites, reference (unimpaired) sites, and the treated (restored) sites before, during and after treatment increases the certainty of statistical analysis as well as the level of generalization of results (Lake 2001).

In other cases (e.g., smaller sites, limited degree of intervention), it may only be possible to test a single hypothesis. However, comparisons between treated and untreated conditions should still be made before and after treatment wherever possible. In such cases, cause and effect may not be established and the generality of inferences that can be made from results will be more limited. In either case, however, effective adaptive management requires the setting of time-bound targets for interim and final outcomes (objectives, as discussed in Step 4), monitoring of performance measures to track progress, and the setting of intermediate thresholds for consideration of success or the need to change actions or policies. Decisions regarding appropriate management strategies, or changes to such strategies, should be made on the basis of experimental results. Conceptual models or reference ecosystems, as discussed in Step 4 above, may be useful in establishing these targets, measures, and thresholds.

4.5.3 Monitoring

Monitoring in the context of ecological restoration projects is linked to other monitoring activities in protected natural areas. Selection of performance measures and monitoring strategies should thus consider other ongoing work in the protected area or the surrounding region (e.g., ecological integrity condition monitoring) in order to identify possible overlaps, optimize program design and resource expenditures, and contribute to larger-scale reporting. Ongoing awareness of, and linkages with other monitoring activities should also ensure project managers are aware of, and can respond to, off-site conditions that may have an impact on design, implementation, and success of the restoration project. However, the focus should be on measures and strategies that are specific to the restoration project and its desired outcome.

Monitoring should be directly integrated into the design of restoration projects in testing restoration hypotheses, in assessing the ongoing condition of the restored ecosystem, and in enhancing engagement, learning and visitor experience. The restoration design should also consider how and when detailed monitoring of the project to follow the success of the intervention will be phased out. Ultimately, it should be replaced with monitoring of adjacent sites or infrequent returns to the site as part of other related monitoring activities (e.g., ecological integrity condition monitoring).

Performance measures to monitor should be: related to objectives defined in Step 4; accurately and precisely measurable to enable hypothesis testing; appropriate to the temporal and spatial scale of the ecosystem attributes they represent; and cost-effective. Existing monitoring protocols and manuals (e.g., Parks Canada Agency 2005, 2007) should be consulted in selecting performance measures, determining monitoring frequency, level of detail and duration, and evaluating relative costs.

While the focus of many ecological restoration projects may be their ultimate success, in an adaptive management context, an evaluation of progress being made towards interim targets is also important. Performance measures should be measurable at appropriate temporal scales and with sufficient precision to determine when an interim target or threshold is reached, or conversely, when it is not reached. This approach enables decisions to be made regarding how to proceed (i.e., whether to continue with the current approach or to change it and to formulate additional research questions). Interim reports may also be important as a means of demonstrating results to obtain ongoing community, political, or financial support.

As was noted in Step 4, ecological restoration projects may have socio-cultural as well as ecological goals and objectives. The strategies described above for experimental design and monitoring apply equally to ecological and socio-cultural objectives. Similarly, predicted expenditures should be monitored and budgets should be re-evaluated during the project duration to ensure adequate funds are available to see it to completion.

Plans for communicating results through formal and informal reporting mechanisms should be developed as part of the detailed project plan. For example, as discussed above, monitoring results may be reported as part of other ongoing processes such as ecological integrity condition monitoring or an environmental assessment follow-up program. They should also be rapidly communicated to all relevant stakeholders and partners, local communities, and the general public so that any necessary changes to the restoration plan can be made efficiently. Communication with partners and stakeholders through strategies developed in Step 1 should continue throughout the project duration. In addition, mechanisms for broader communication such as the media, interpretive signs, community-based special events, government web sites and publications, refereed literature, and presentation at relevant conferences (when appropriate) and meetings should be considered during the development of the detailed plan. Communication strategies should identify the purpose of each communication mechanism (e.g., engaging public and neighbours, information sharing, routine reporting) as well as the target audience and frequency. Both successes and failures should be reported to encourage ongoing learning and refinement of restoration techniques and processes. The need to communicate results further underscores the value of using an adaptive management approach in which progress towards meeting objectives is evaluated at intermediate stages. Communicating the achievement of short-term objectives and goals rather than waiting until longer-term objectives are met, is important to maintaining enthusiasm and ensuring ongoing engagement of partners and stakeholders.

4.5.4 Restoration Prescriptions

In addition to the elements of experimental design described above, detailed restoration plans should include specific prescriptions regarding how the restoration should be carried out. These prescriptions should include selection of the specific restoration treatments that will be used to meet project objectives as well as the tactics and technologies used to implement them. *Guidelines for Ecological Restoration of Canada's Natural Protected Areas* (Chapter 3) should be referred to in order to ensure proposed treatments are consistent with recommended approaches.

This element of planning should include details of the work such as roles and responsibilities, decision-making authority, onsite supervision and workforce, logistics, permits, and safety concerns. Locations of the work should be specified as should the timing and costs of each activity. Plans and budgets should consider contingencies (e.g., weather, availability of nursery plants or other biotic resources) wherever possible. Plans for implementation monitoring (i.e., monitoring whether the restoration was carried out according to plan) should also be included. As was discussed in Step 1, planning for the involvement of stakeholders and partners in implementing the restoration project should contribute to its success.

Many ecological restoration projects will require ongoing maintenance in the future (e.g., periodic removal of invasive alien species). Details of planned maintenance activities should be provided. Monitoring of the success of ongoing maintenance activities should be included in the overall monitoring design.

Before implementation, the detailed restoration plan should be evaluated for feasibility and cost. Any environmental impact assessment requirements identified in Step 2 should be fulfilled, including potential impacts to cultural resources. Modifications to the plan should be made as necessary.

4.6 Step 6: Implementation

Effective planning of an ecological restoration project following the process outlined in Step 1 through Step 5 should facilitate effective, efficient, engaging implementation, with genuine engagement of partners and stakeholders, local communities, and the general public.

In Step 6, the restoration plan developed through the processes described above is implemented. Monitoring of measures identified in Step 5 is conducted to assess restoration success using an adaptive management approach and modifications to the restoration plan are made as necessary.

Communication of results and lessons learned to stakeholders, colleagues, the public, and policy-makers, as discussed above, is an important component of project implementation. Successes should be celebrated and broadly publicized. Communication to the public contributes to a broader understanding of the concept of ecological restoration and builds public support. Communication amongst restoration practitioners contributes to the larger body of knowledge that leads to advances in this field and the development of evidence-based conservation in general (Sutherland et al. 2004). Communicating results to policy-makers and decision-makers helps ensure ongoing support and funding and is particularly important in ensuring the long-term funding needs of complex projects that may require ongoing maintenance and intervention are met.

4.7 Step 7: Monitoring and Reporting

As was discussed in Steps 5 and 6, above, restoration planning and implementation should specify monitoring requirements that include mechanisms for determining how results will inform subsequent management decisions through an adaptive management approach. The effort required to design and execute monitoring programs, to collect, evaluate, analyze, interpret, and synthesize data, and to report results should not be under-estimated (Parks Canada 2007).

Wherever possible, monitoring activities specific to the project should also be linked with other monitoring activities in the protected area. Projects aimed at monitoring the effectiveness of restoration or other management actions (i.e., management effectiveness monitoring) may encompass limited periods (e.g., < 5 to 20 years), depending on project objectives. They use focussed experimental designs, address specific questions for specific management actions, and often include treatments and controls. Other monitoring programs (e.g., protected-area-wide ecological integrity condition monitoring) may be ongoing, with less frequent sampling (e.g., once in five years). In some cases (e.g., where the scale of the management intervention approaches the scale of the whole park), monitoring established for ecological integrity condition assessments may inform specific management actions and vice versa (Parks Canada 2007).

Monitoring of ecological restoration projects thus contributes to our understanding of how these management actions contribute to the ecological integrity of the protected area. Where programs exist, monitoring for visitor experience and education outcomes will provide further understanding of the impact of restoration actions.

Communication of results of the restoration project is often critical to its success, as was discussed under Step 6, above. Effective reporting of ongoing monitoring results is also important. In some cases (e.g., Parks Canada State of the Park Report and State of the Parks and Heritage Areas Report; Parks Canada Agency 2007) it may be necessary to report project results in terms of agreed-to measures of ecological integrity, visitor experience and education to demonstrate the improvements brought about by investment in the ecological restoration undertaking. Regardless of the specific reporting mechanism, reporting on results should be an integral component of the protected area's management cycle.

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6.0 Glossary

Aboriginal peoples: First Nations, Inuit, and Métis, as defined n section 35 of the Constitution Act, 1982.

Aboriginal Cultural Landscape: A place valued by an Aboriginal group (or groups) because of their long and complex relationship with that land. It expresses their unity with the natural and spiritual environment. It embodies their traditional knowledge of spirits, places, land uses, and ecology. Material remains of the association may be prominent, but will often be minimal or absent.

Alien Species: Species of plants, animals, and micro-organisms introduced by human actions outside their natural past or present distribution.

Amendment: Any substance added to the soil or other substrate for the purpose of altering its properties to make it more suitable for plants or other organisms.

Community Structure: The characteristic features or appearance of a community with respect to the density, horizontal stratification, and frequency distribution of species-populations, and the sizes and life forms of the organisms that comprise those communities.

Cover crop: A native or non-native species seeded primarily for the purpose of protecting and improving soil and microsite conditions to enhance the establishment of the desired plant community.

Cultivar: A plant variety that has undergone genetic selection by plant breeders for agronomic traits, has been registered by a certifying agency, and is propagated under specific guidelines to maintain its genetic diversity.

Cultural Resource: A human work, or a place that gives evidence of human activity or has spiritual or cultural meaning, and that has been determined to be of historic value. Cultural resources may include but are not limited cultural landscapes and landscape features, archaeological sites, structures, engineering works, artifacts and associated records.

Cultural Landscape: Any geographical area that has been modified, influenced or given special cultural meaning by people.
Heritage value: The aesthetic, historic, scientific, cultural, social, or spiritual importance or significance for past, present, or future generations.

Goal: A specified state of a specific element of the reference ecosystem or outcome

Guideline: A specific recommendation that provides practical guidance for a particular aspect of an ecological restoration project.

Ecological Integrity: A condition that is determined to be characteristic of (a park's) natural region and likely to persist, including abiotic components and the composition and abundance of native species and biological components, rates of change and supporting processes.

Ecological Restoration: The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed

Ecoregion: An area characterized by a distinctive regional ecological factors, including climate, physiography, vegetation, soil, water, and fauna (Environment Canada and Agriculture and Agri-Food Canada1999).

Ecosystem Function/Ecosystem Process: The dynamic attributes of ecosystems, including interactions among organisms and interactions between organisms and their environment.

Ecovar: A name registered by Ducks Unlimited for plant varieties of native species developed with particular attention to characteristics that allow them to establish and reproduce in specific ecological regions as opposed to agronomic characteristics; ecovars are characterized by greater genetic diversity.

Hyperabundant populations: Populations whose numbers clearly exceed the upper range of natural variability that is characteristic of the ecosystem, and where there is a demonstrated impact on ecological integrity.

Invasive Species: Those harmful species whose introduction or spread threatens the environment, the economy, or society, including human health. Invasive species may be native or alien in origin.

Landscape: A mosaic of two or more ecosystems that exchange organisms, energy, water and nutrients.

Native Species: Organisms that occur naturally in a particular area instead of being introduced, directly or indirectly, by human activity.

Objective: An expression of a goal that is in the realm of sensible experience, independent of individual thought, and perceptible by all observers. A goal may have one or more objectives associated with it.

Outcome: A description of a time-bound end-point of an ecological restoration project that allows for the setting of performance measures and targets for evaluating progress toward that end-point. In this context, an outcome is the desired end-point for direct restoration actions, after which natural systems should be able to independently achieve the desired reference conditions.

Principle: A statement of a value that leads to the setting of performance measures and targets, thereby guiding the choice among alternative courses of action.

Performance measure: A quality of an objective to be measured and reported.

Reclamation: The process of returning land to its former or other productive uses.

Reference Ecosystem/Condition: A real-world analogous ecosystem or hypothetical ecosystem that defines the ideal future state of an area of land or water after an ecological restoration project has taken place. It serves as a model for planning restoration work and later for evaluation.

Regional Ecosystem: A geographic depiction of an ecosystem of a scale appropriate to understanding and management of ecosystem components. Regional ecosystems frequently cross jurisdictional boundaries. Also called greater ecosystem or greater park ecosystem.

Remediation: The process of removal, reduction or neutralization of contaminants from a site to prevent or minimize any adverse effects on the environment now or in the future.

Resilience: The ability of an ecosystem to regain structural and functional attributes that have suffered harm from stress or disturbance.

Restoration: The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed.

Target: The desired value of a performance measure.

Threshold: A value of a performance measure that invokes a pre-described management response. A threshold may therefore be either a target, in which case the management response would be to declare a successful conclusion to at least that aspect of the restoration project, or it could be an intermediate value invoking a change of prescription or justifying a continuation of a prescription.

Appendix I. Legislation Checklist

The following lists refer to protected-areas legislation that should be consulted prior to initiating restoration projects in specific jurisdictions. It is believed to be current at the time of writing (December 2006). It does not include all legislation related to specific requirements (e.g., environmental assessment). The first list (section AI.1) refers to protected natural areas outside Parks Canada's jurisdiction. Legislation specific to Parks Canada's mandate is included in the second list (section AI.2).

AI.1 Provincial, Territorial, and Federal Legislation Relevant to the Management of Protected Natural Areas

British Columbia
Protected Areas of British Columbia Act
Ecological Reserves Act
Environment and Land Use Act
Wildlife Act
Land Act
Ministry of Environment Act
Ministry of Lands, Parks and Housing Act

Alberta
Provincial Parks Act
Wilderness Areas, Ecological Reserves, Natural Areas and Heritage Rangelands Act
Willmore Wilderness Park Act

Saskatchewan
The Ecological Reserves Act
The Parks Act
The Wildlife Act

Manitoba
The Provincial Parks Act
The Ecological Reserves Act
The Wildlife Act
The Forest Act

Ontario
Endangered Species Act
Environmental Assessment Act
Provincial Parks Act
Public Lands Act
Wilderness Areas Act
Provincial Parks and Conservation Reserves Act

Quebec
La loi sur la conservation du patrimoine naturel
La loi sur les parcs

New Brunswick
Parks Act
Protected Natural Areas Act

Nova Scotia
Wilderness Areas Protection Act
Provincial Parks Act
Special Places Protection Act
Conservation Easements Act

Prince Edward Island
Natural Areas Protection Act
Recreation Development Act
Wildlife Conservation Act

Newfoundland and Labrador
Provincial Parks Act
The Wilderness and Ecological Reserves Act
National Park Lands Act
The Wild Life Act
The Lands Act

Yukon
Parks and Land Certainty Act
Yukon Wildlife Act

Northwest Territories
Northwest Territories Act
Territorial Parks Act

Nunavut
The Territorial Parks Act

Fisheries and Oceans Canada
Oceans Act

Environment Canada
Canada Wildlife Act
Marine Wildlife Act
Migratory Birds Convention Act

A1.2 Legislation Relevant to the Management of National Parks, National Historic Sites, and National Marine Conservation Areas

All or Most Parks Canada Lands

- Canadian Environmental Assessment Act (this does not apply to the Mackenzie Valley, i.e., Nahanni, and applies in limited fashion to other northern areas)
- Fisheries Act
- Navigable Waters Protection Act
- Federal Real Property and Federal Immovables Act and Regulations
- Species at Risk Act and Orders
- Federal Wetlands Policy
- Treasury Board Policy on Real Property

All Parks Canada Lands in Specified Areas

- Yukon Environmental and Socio-economic Assessment Act
- Inuvialuit Final Agreement (see below)
- Nunavut Land Claims Agreement(see below)

National Parks

- Canada National Parks Act
- Yukon Environmental and Social Assessment Act
- Inuvialuit Final Agreement (see below)
- Nunavut Land Claims Agreement(see below)
- Parks Canada Guiding Principles and Operational Policies: National Park Policy

National Historic Sites

- Canada National Parks Act (section 42 is specific to NHS's)
- Parks Canada Agency Act
- Historic Sties and Monuments Act
- National Historic Sites Policy
- Cultural Resource Management Policy
- Guide to the Preparation of a Commemorative Integrity Statement

National Marine Conservation Areas

- Canada National Marine Conservation Areas Act
- National Marine Conservation Area Policy

Aboriginal Claim Settlement Checklist

Check to see if your region falls within the area covered by one of these agreements. The proposed project may affect Aboriginal rights as set out in the agreements, for example in the areas of harvesting or wildlife management.

British Columbia

Nisga'a Final Agreement (1999)
- There are no PCA lands that are impacted by this Agreement, nonetheless chapters 5, 8, and 9 concern Forest Resources, Fisheries, and Wildlife and Migratory Birds.

Newfoundland and Labrador

Labrador Inuit Land Claims Agreement (2005)
- Chapters 9 and 12 to 14 concern National Parks and Protected Areas, Wildlife and Plants, Fisheries, and Harvesting Compensation.

Northwest Territories

The Western Arctic Claim The Inuvialuit Final Agreement (1984)
- Chapters 11, 12, 13, and 14 concern Environmental Impact Screening and Review Peocess, Yukon North Slope (parks and harvesting in this chapter), Wildlife Compensation and Wildlife Harvesting and Management.

Gwich'in Comprehensive Land Claim Agreement, Volume 1 (1992)
- Chapters 12 to17 concern Wildlife Harvesting and Management, Forestry, Plants, National Parks, Protected Ares, and Harvesting Compensation.

Sahtu Dene and Metis Comprehensive Land Claim Agreement, Volume I (1993, effective date 1994)
- Chapters 13 to18 concern Wildlife Harvesting and Management, Forestry, Plants, National Parks, Protected Ares, and Harvesting Compensation.

Tlicho Agreement (signed 2003)
- Chapters 10 to 16 concern Wildlife Harvesting Rights, Wildlife Harvesting Compensation, Wildlife Harvesting Management, Trees and Forest Management, Plants, National Parks, and Protected Areas.

Nunavut

Nunavut Land Claims Agreement (1993)
- Articles 5, 6, 8, 9, 11,12, and 15 concern Wildlife**,** Wildlife Compensation, Parks, Conservation Areas, Land Use Planning, Development Impact, and Marine Areas.

- Note that legislation related to Chapter 12 (Impact Assessment) is now being drafted.

Quebec

The James Bay and Northern Quebec Agreement and Complimentary Agreements (1975 effective date 1977)

- There are no PCA lands that are impacted by this Agreement, nonetheless sections 22, 23, and 24 concern Environment and Future Development below the 55^{th} Parallel, Environment and Future Development North of the 55^{th} Parallel, and Hunting, Fishing and Trapping.

The Northeastern Quebec Agreement (1978)

- There are no PCA lands that are impacted by this Agreement, nonetheless sections 14 and 15 concern Environment and Future Development, and Hunting, Fishing and Trapping.

Yukon

Umbrella Final Agreement Between The Government Of Canada, The Council For Yukon Indians And The Government Of The Yukon (1993)

- Chapters 10, 11, 12, 16, and 17 concerns Special Management Areas, Land Use Planning, Development Assessment, Fish and Wildlife, and Forest Resources. The Yukon Environment and Socio-economic Assessment Act supercedes this agreement.
- 10 of the 14 Yukon First Nations, which were signatories to the UFA have Final Agreements. Generally speaking the provisions reflect those outlined in the UFA. Not all of these individual Agreements impact PCA administered lands.

Note:
This list contains agreements in force as of December 2006. More are in preparation. In British Columbia, the Maa-nulth Final Agreement, the Tsawwassen First Nation Final Agreement, and the Lheidli T'enneh Final Agreement may be signed and ratified this coming year. The Maa-nulth and Tsawwasswn Final Agreements will impact PCA administered lands; the Lheidli T'enneh Final Agreement will not impact PCA administered lands. There will be chapters with respect to the environment, fisheries and forestry in each of these Agreements.

In Labrador, the Labrador Innu Final Agreement may be nearing completion.

In Quebec, the Nunavik Inuit Marine Region Final Agreement may be nearing completion.

Appendix II. Ecosystem Attributes for Measurement and Manipulation

Several attributes may be identified from monitoring, research, and practical experience that are key to maintaining the characteristic composition, structure and function of an ecosystem (i.e., ecological integrity). For example, ecological integrity monitoring programs in National Parks generally include biodiversity (e.g., native and invasive alien species, population parameters of focal species, and trophic structure), ecosystem process/function (e.g., succession/retrogression, representation of park ecosystems, phenological observations, local and landscape level productivity, and decomposition rates), and stressor (e.g., greater regional ecosystem stressors, and in-park ecological footprints and human effects) elements (Table AII.1; Parks Canada 2005).

Examining resource management agencies within and outside Canada, one finds that this list hardly varies. Approaches are similar among, for example, Ontario Parks (http://www.prfo.ca/MONITORING-proceedings-TofC.pdf), British Columbia (http://www.env.gov.bc.ca/esd/), United States National Parks Service (http://www.nps.gov/cue/i_and_m.htm), European Union (http://www-tem.jrc.it//introduction.htm), IUCN (http://www.iucn.org/themes/wcpa/), and UNEP (http://www.unep-wcmc.org/). Similarly, as part of its Framework for Assessing and Reporting on Ecological Condition, the US EPA Science Advisory Board (2002) provides a list of ecological attributes that may be measured or manipulated in environmental management and assessment programs (Table AII.2).

These attributes of ecosystems are the basis for identifying performance measures and the ranges of acceptable or desirable targets for those measures. Conceptual models that describe components, development stages, relationships among components and controlling factors and processes should also be developed (e.g., Parks Canada Agency 2007). Such models are valuable in connecting assessments of key attributes (i.e., the current condition) with restoration needs and desired future conditions. An understanding of these connections will assist in the planning of restoration activities and the selection of appropriate guidelines.

Additional guidance for understanding linkages between ecosystem attributes, desired future conditions and restoration activities is provided by the Society for Ecological Restoration International. The Society has developed the following nine attributes of restored ecosystems, as part of the SERI Primer (Society for Ecological Restoration International Science and Policy Working Group 2004):

- The restored ecosystem contains a characteristic assemblage of the species that occur in the reference ecosystem and that provide appropriate community structure.
- The restored ecosystem consists of indigenous species to the greatest practicable extent. In restored cultural ecosystems, allowances can be made for exotic domesticated species and for non-invasive ruderal and segetal species that

presumably co-evolved with them. Ruderals are plants that colonize disturbed sites, whereas segetals typically grow intermixed with crop species.

- All functional groups necessary for the continued development and/or stability of the restored ecosystem are represented or, if they are not, the missing groups have the potential to colonize by natural means.
- The physical environment of the restored ecosystem is capable of sustaining reproducing populations of the species necessary for its continued stability or development along the desired trajectory.
- The restored ecosystem apparently functions normally for its ecological stage of development, and signs of dysfunction are absent.
- The restored ecosystem is suitably integrated into a larger ecological matrix or landscape, with which it interacts through abiotic and biotic flows and exchanges.
- Potential threats to the health and integrity of the restored ecosystem from the surrounding landscape have been eliminated or reduced as much as possible.
- The restored ecosystem is sufficiently resilient to endure the normal periodic stress events in the local environment that serve to maintain the integrity of the ecosystem.
- The restored ecosystem is self-sustaining to the same degree as its reference ecosystem, and has the potential to persist indefinitely under existing environmental conditions. Nevertheless, aspects of its biodiversity, structure and functioning may change as part of normal ecosystem development, and may fluctuate in response to normal periodic stress and occasional disturbance events of greater consequence. As in any intact ecosystem, the species composition and other attributes of a restored ecosystem may evolve as environmental conditions change.

Table AII.1: Indicators for assessing ecological integrity in National Parks (Parks Canada 2005)

Assessing Ecological Integrity		
Biodiversity	**Ecosystem Functions**	**Stressors**
Species richness - change in species richness - numbers and extent of exotics **Population dynamics** - mortality/natality rates of indicator species - Immigration/ emigration of indicator species - population viability of indicator species **Trophic structure** - faunal size class distribution - predation levels	**Succession/ retrogression** - disturbance frequencies and size (fire. insects, flooding) - vegetation age class distributions **Productivity** - Remote or by site **Decomposition** -by site **Nutrient retention** - Ca, N par site	**Human land-use patterns** - land use maps, roads densities, population densities. **Habitat fragmentation** - patch size, inter-patch distance, forest interior **Pollutants** - sewage, petrochemicals etc. - long-range transport of toxics **Climate** - weather data - frequency of extreme events **Other** - park specific issues

Table AII.2: Essential Ecological Attributes and Reporting Categories provided as a check list by the US EPA Science Advisory Board (US EPA Science Advisory Board 2002).

Landscape Condition
- Extent of Ecological System/Habitat Types
- Landscape Composition
- Landscape Pattern and Structure

Biotic Condition
- Ecosystems and Communities
  - Community Extent
  - Community Composition
  - Trophic Structure
  - Community Dynamics
  - Physical Structure
- Species and Populations
  - Population Size
  - Genetic Diversity
  - Population Structure
  - Population Dynamics
  - Habitat Suitability
- Organism Condition
  - Physiological Status
  - Symptoms of Disease or Trauma
  - Signs of Disease

Chemical and Physical Characteristics (Water, Air, Soil, and Sediment)
- Nutrient Concentrations
  - Nitrogen
  - Phosphorus
  - Other Nutrients
- Trace Inorganic and Organic Chemicals
  - Metals
  - Other Trace Elements
  - Organic Compounds
- Other Chemical Parameters
  - pH
  - Dissolved Oxygen
  - Salinity
  - Organic Matter
  - Other
- Physical Parameters

Ecological Processes
- Energy Flow
  - Primary Production
  - Net Ecosystem Production
  - Growth Efficiency
- Material Flow
  - Organic Carbon Cycling
  - Nitrogen and Phosphorus Cycling
  - Other Nutrient Cycling

Hydrology and Geomorphology
- Surface and Groundwater Flows
  - Pattern of Surface Flows
  - Hydrodynamics
  - Pattern of Groundwater Flows
  - Salinity Patterns
  - Water Storage
- Dynamic Structural Characteristics
  - Channel/Shoreline Morphology, Complexity
  - Distribution/Extent of Connected Floodplain
  - Aquatic Physical Habitat Complexity
- Sediment and Material Transport
  - Sediment Supply/Movement
  - Particle Size Distribution Patterns
  - Other Material Flux

Natural Disturbance Regimes
- Frequency
- Intensity
- Extent
- Duration

Appendix III. Prioritization of Restoration Actions

Selection of which degraded site or resources to address with limited resources poses a challenge. Schemes for prioritizing restoration activities may assist with management planning. Decisions to prioritize should be placed in the context of a park-wide or broader strategy for how individual restoration projects contribute to overall protected area management goals.

Some programs have developed numeric ranking schemes that assign values to various factors that influence priority for action. For example, the US EPA's Superfund Hazardous Waste site program developed a National Hazard Ranking System to evaluate which sites should be addressed first http://www.epa.gov/superfund/programs/npl_hrs/hrsint.htm). Various categories of threat factors were assigned scores and a formula was developed to produce a score for each site. This ranking system exists for larger, long-term projects. The Superfund program "prioritizes" sites that pose the greatest imminent threat through an Emergency Response program, thus applying a tiered prioritization.

Restoration priorities can, and often are, integrated into conservation priorities. For example, the Alliance for Zero Extinction (AZE)[4] uses three higher level criteria, all of which must be met, for a site to qualify as a priority (http://www.zeroextinction.org/selection.htm).

1. Endangerment: A site must contain at least one endangered or critically endangered species, as listed on the IUCN Red List.

2. Irreplaceability: A site is the sole area where an endangered or critically endangered species occurs, or contains the overwhelmingly significant resident population, or contains the overwhelmingly significant known population for one life history segment (e.g., breeding or wintering) of the endangered or critically endangered species.

3. Discreteness: The area must have a definable boundary within which the character of habitats, biological communities, and/or management issues have more in common with each other than they do with those on adjacent areas.

AZE recognizes the value of identifying the context of its priorities within broader Biodiversity Priorities:

a) Areas that contain the entire global populations of endangered species;
b) The regions of the Earth that contain highest levels of species endemism;

[4] The Alliance for Zero Extinction (AZE), a global initiative of biodiversity conservation organizations, aims to prevent extinctions by identifying and safeguarding key sites where species are in imminent danger of disappearing. The goal of the Alliance is to create a front line of defence against extinction by eliminating threats and restoring habitat to allow species populations to rebound.

c) The most biologically distinct and intact ecoregions of the planet representing all biogeographical realms;
d) The conservation of globally outstanding ecological and evolutionary phenomena and processes (migrations, breeding aggregations, contact zones of high speciation)

Hierarchical prioritization schemes may be considered in making decisions at the protected area level. For example, it may not make sense to restore a rare plant to a spring if regional groundwater extraction polices restrict water availability to that spring (decreasing odds of a successful plant population establishment). The approach to prioritizing restoration efforts described below is being considered by the US National Park Service. The information below was provided by Greg Eckert, Restoration Ecologist, U.S. National Park Service, Fort Collins, Colorado.

Proposed US National Park Service Approach

Hierarchies exist for different management and resource attributes (see Table AIII.1). At a minimum, considering impacts of restoration work one level up and one level down will help avoid unintentional consequences of actions conducted at a single hierarchical level. The development and use of conceptual ecosystem models to identify key attributes of a functioning system and strengths of ecological interactions cannot be overstated here.

Table AIII.1. Hierarchies of scale, ecological organization, and restoration actions

Spatial Scale	Ecological Organization	Restoration Actions
		Landscape Processes
	Region	Geomorphic / Hydrologic Patterns
National	Landscape	Soil Quality
Region	Ecosystems	Plant Community
Unit and immediately surrounding areas	Communities	Plant-soil relationship
Watersheds within unit	Population/Species	Species Functional groups/ Key interactions
Sites/stands	Organisms/ Genes	Biodiversity

Another important consideration in prioritizing work is the need to determine which actions conducted promptly will save significant effort in the future. That is, emergency stabilization projects should be prioritized independently of prioritization of large and/or complex projects.

Given these considerations a suggested approach to prioritizing work in US National Parks is:

- Abate current threats including causal agents of degradation, incompatible management practices and sources of invasive species and disease dispersal;

- Stabilize sites that pose an imminent threat to public health or the environment, such as a contaminant release or open mine shaft or unstable site where visitor control is difficult

- Restore irreplaceable resources, including rare, threatened and endangered species and biological communities

- Apply Triage Restoration Strategies
    - Sites that are not imminent threats, but are actively degrading and at risk of shifting across thresholds to undesirable states; or where biological and chemical contaminants are moving or are likely to move off-site into unaffected areas.
    - Considering sites as patches within a broader resource matrix, sites where landscape processes, such as fire regime, are intact, or patches that function independently of higher order processes (for example, rocky outcrop ecosystems function independent of surrounding forest type fire regime).
    - Sites that are integrated with landscape process restoration

Managers can also look at prioritization via site classification, and related initial response. A suggested *Site Classification Key* (see below) identifies different responses, and a protected area manager can identify and prioritize work this way, since resources for certain activities may not be available in a timely way. For example, a manager may elect to restore two abandoned, denuded oil and gas exploration sites because these sites only require some limited soil ripping and local pine and grass seedlings are available, whereas the same manager may delay action on restoring a sedge to a rare wetland community while genetics tests of the sedge seed source are pending. Another example is a heavily disturbed site that is still degrading, and presents a problem as a weed source area in the park, weed specialists should work with resource managers to prescribe a native species cover that "stabilizes" the site from subsequent weed establishment. This preferably reflects an early seral stage of pre-disturbance communities that can also be easily manipulated to achieve full site restoration. Roadside areas that require frequent weed control can be a priority for adaptive maintenance regime work. If a “biological contaminant” (i.e., alien and/or invasive species) source cannot be contained off-site, and other restoration work commences on-site, continued weed control must be incorporated into all subsequent site management.

Other park values can also be addressed at the discretion of the Park manager. This approach to prioritization is presented to put greater emphasis on reducing the potential for cumulative effects and greater expense once resources or sites are addressed.

Costs are not considered in this analysis. To evaluate the role of costs in prioritization would require a valuation of specific resources and a thorough understanding of connectivity of the resource in question with other resources. All program managers must seek to be cost-effective in their work, but it is better to focus on the role of costs when conducting threshold analysis or alternative analysis in restoration planning. This would be based on the establishment of clear objectives for the condition of the park resource. Part of this consideration is that efforts to fund less expensive, but piecemeal projects often fail, and end up costing more than a well-planned larger project would have. Protected Areas should aim to make all degraded resources whole.

Proposed US National Parks Service Categorization and Response Using a Site Classification Key

This classification key is a proposed tool for prioritization of restoration activities for invaded habitats in US National Parks. It could serve as a useful tool for other agencies.

As inventory and assessments are conducted and certainly once it is concluded, identifying site types will assist the direction of various programs for initial and long-term actions.

1a. Site has no apparent anthropogenic disturbance to soils, landforms or vegetation Native plants are present and community patterns are within natural range of variation (NRV). Disturbance to vegetation is from natural pest outbreak, drought, wind, etc.
Site Class: Natural Range of Variation
Action: Monitoring

1b. Site has apparent disturbance to soils, landforms of vegetation **(Go to 2)**

2a. Vegetation (structure &/or composition) is altered; soil, landforms, hydrologic conditions not altered **(Go to 3)**

2b. Site landforms, hydrologic conditions &/or soil altered **(Go to 5)**

3a. Site vegetation altered through uncharacteristic succession &/or uncharacteristic invasions by species within their native range
Site Class: Uncharacteristic Seral stage
Action: Address excluded ecosystem processes (eg., fire or grazing) or excessive application of processes (eg., herbivory)

3b. Site vegetation altered through invasion of alien species **(Go to 4)**

4a. Alien species not known to alter ecosystem properties, or control techniques are documented and native regeneration likely with control.
Site Class: Alien Invasion
Action: Set thresholds for weed control; monitoring; routine weed control

4b. Alien species known to, or suspected to alter ecosystem (particularly soil chemistry) properties
Site Class: Alien species alteration of soil
Action: Set thresholds for action; weed control; stabilization native revegetation; restoration planning to address the legacy of invasive species.

5a. Newly opened areas as a result of natural disturbance – landslides, avalanches, floods, fire, hurricanes, windstorms, ice storms, etc.
Site Class: Natural Disturbance
Action: Set thresholds for weed control; monitoring; routine weed control; conservation of rare elements

5b. Site is disturbed through current or past management **(Go to 6)**

6a. Site is frequently and routinely disturbed. Examples are roadside maintenance, areas of foot and vehicular traffic, parking areas, cultural plantings, WUI fuel reduction or right-of-way zones.
Site Class: Active Management
Action: Adjust maintenance regime to promote native species; Set thresholds for weed control; monitoring; routine weed control; reclamation planting where useful.

6b. Site is disturbed be a discrete event that may re-occur, but is not intentionally routine. Examples are fires outside of the NRV, mines, hazardous and other waste releases, channel diversions, fill, excavations, building sites, ditches, headcuts, burned area rehab treatments, historic plantings not maintained as a cultural resource, hazard fuel treatments. **(Go to 7)**

7a. Site is actively degrading (primarily via erosion)
Site Class: Active Disturbed
Action: Stabilize for erosion control and for weed invasion **(Go to 7b)**

7b. Site is not actively degrading

Site Class: Stable Disturbed
***Action: Restoration planning* (Go to 8)**

8a. Site conditions and processes are independent of landscape processes or landscape processes intact
Site Class: Landscape Independent
Action: Proceed with previously described site actions or planning

8b. Site conditions and processes are related to landscape processes and landscape processes are absent or significantly altered in terms of frequency and severity.
Site Class: Excluded process
Action: Model role of landscape process in restoration and persistence of site resources; establish partnerships to address landscape needs and integrate into site actions and planning.

NOTES –

1a. Historic grazing or logging, etc may have taken place, but native communities have recovered. Landscape processes are assumed to be present. If not, an altered desired condition of native vegetation may need to be determined until landscape processes can be restored. Assumes park has a vegetation management plan.

1b. **"**apparent disturbance" can be determined for most sites by lack of native vegetation, distinctly different soil color or texture**,** presence of gravel, paving, greater amounts of bare soil, pedestals, etc compared to reference sites. Disturbance indicators are listed and more thoroughly addressed in the Disturbed Lands Inventory and Assessment SOPs. While site assessments are helpful, first steps should include discussions with facilities and other staff on management history of the park.

3a. Are there native species that need to be replaced? Do they represent a functional group, or significant area of community density? This would raise likelihood that this would be an appropriate measure to undertake.

4a. Will addition of more native plants to the site make a difference in natives outcompeting weeds? Overseeding is a strategy that is used successfully in difficult environments, and could be considered on a trial basis.

4b. How are weeds successful? Are they more efficient at resource (including space) use? Do they alter biogeochemical and other ecosystem properties to establish positive feedback loops to support their spread into an "intact" ecosystem? An understanding of the basic biology of the alien species is key to understanding the ability to control it through restoration.

5a. Care should be taken to determine that the source of the symptoms is not actually driven by some other anthropogenic activity (landslides could be natural or caused by historic mining). Also, some of these natural processes are frequent, and provide equally frequent opportunity to be invaded by alien species. In this case, weed control will need to be prioritized based on conservation objectives such as protection of rare species, access, likelihood of spread, etc. Weed control programs may choose to not do control in isolated, frequently disturbed areas such as avalanche zones, but given the frequent nature of disturbance in these areas, they may have high conservation value reflected by rare species/communities. These resources must be considered a priority for conservation.

8b. Presently, NPS is experiencing decline in species due to alien pests such as Chestnut blight, Hemlock wooly adelgid, and Sudden Oak Death. While site mitigation strategies can be developed for environmental protection and replacement species, NPS should adopt range-wide strategies for an appropriate NPS role in prevention, mitigation, and restoration of such species. Park-by-park responses absent a broader strategy with partner organizations will be ineffective and inefficient.