

Invasive Species Strategy for British Columbia

MAY 2012



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American Bullfrog (*Rana catesbeiana*),

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Wetland, Cowichan Valley. Photo: J. Leekie



Prince George Invasive Species Strategy workshop. Photo: E. Armagost

Executive Summary

British Columbia's diverse topography and climate produce a wide range of ecosystems, creating a multitude of environments for introduced species. The establishment and spread of invasive species has become a growing concern in British Columbia, as they have significant impacts on BC's environment, society, and economy. Invasive species significantly alter the integrity of natural ecosystems, adversely affect societal values, and result in increased management costs and lost resource productivity. The *Invasive Species Strategy for British Columbia* is a strategic framework for improved invasive species management in BC for the next five years or longer.

The strategy addresses invasive species, which are defined in Canada's national invasive species strategy as "alien species regarded as harmful and whose introduction or spread threatens the environment, the economy, or society, including human health" (Government of Canada 2004). Effective and efficient management of invasive species is critical to the health and well-being of British Columbians, the environment, and the economy. By taking responsible actions now, British Columbia can maintain and improve its terrestrial and aquatic ecosystems and biodiversity for current and future generations.

The strategy is inclusive and was designed for flexibility towards British Columbia's wide variety of regions and ecosystems. The strategy's **vision** is "British Columbia's citizens, ecosystems, and resources are protected from invasive species impacts." Its **scope** includes terrestrial and aquatic (freshwater and marine) ecosystems; and invasive plants, animals, microbes (including bacteria), and fungi that have the potential to pose undesirable or detrimental impacts on humans, animals, ecosystems, or the economy. The strategy excludes diseases directly related to human or domestic animal health, aggressive native species that can become invasive, and the effects of climate change on native species distribution.

The strategy addresses three key challenges for invasive species management in British Columbia:

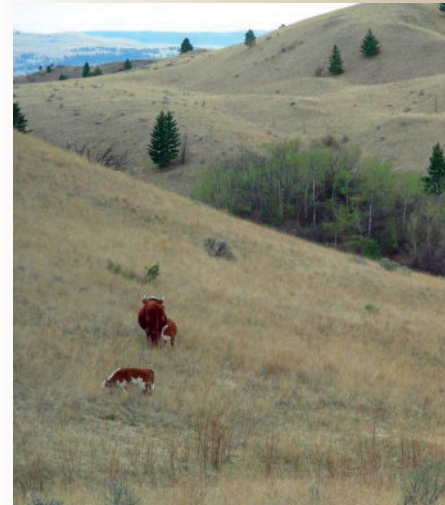
1. **Numerous invasion pathways and vectors of spread:** Ample opportunities exist for invasive species to enter and move within British Columbia through a variety of natural and human-caused pathways of introduction and vectors of spread.
2. **Increasing impacts:** There is a general lack of awareness among British Columbians about invasive species and their impacts to valued resources. Effective management of invasive species requires all British Columbian citizens to work together, take responsibility for their actions, and change their behaviors.
3. **Insufficient funding, collaboration, and capacity:** Invasive species management can be more effective across the province with:
 - adequate long-term funding to support management needs;
 - collaboration to address management inefficiencies; and
 - the necessary institutions, skills, infrastructure, technical support, information management, linkages, networks, and exchanges.

The strategy presents integrated **solutions** to address the three key challenges. Implementation of all the solutions will provide the most effective results:

1. **Establish and Enforce Effective Regulatory Tools:** Complete an analysis of existing legislation, regulations, and policies, and identify gaps and opportunities for integrating and updating invasive species legislation to ensure it is current, effective, and enforceable.
2. **Build Strong Collaboration:** Bring together all organizations, agencies, groups, and individuals involved in invasive species management in British Columbia and beyond, and work together towards shared goals. This includes supporting current partnerships and fostering new ones, and building cross-jurisdiction collaboration.
3. **Prevent Introduction and Spread:** Reduce the number of invasive species entering, establishing, and spreading across British Columbia by managing key pathways of introduction and vectors of spread, and promoting positive behavior change in British Columbian residents and visitors.
4. **Implement Effective Control, Restoration, and Monitoring Programs:** Eliminate new invasive species introductions by implementing Early Detection and Rapid Response principles and methods, restore ecosystems impacted by invasive species to a functional state, successfully treat invasive species populations to acceptable levels, and monitor invasive species management efforts.
5. **Conduct Relevant and Applicable Research:** Carry out research on invasive species and promote knowledge transfer on prioritized topics and issues among academia, resource managers, and policy makers. This will help identify research needs, promote sound policy development, and assist in delivering effective management practices.
6. **Provide Stable, Long-Term Funding:** Ensure there is adequate, stable, long-term funding for effective and successful invasive species prevention and control in British Columbia.

Finally, the *Invasive Species Strategy for British Columbia* recommends five key initial actions to improve invasive species management in British Columbia:

1. Build **recognition** of, and broad **support** for, the Invasive Species Strategy for British Columbia.
2. Produce an **implementation plan**, with clear priorities, for the strategy.
3. Develop a long-term **funding strategy** for invasive species management in BC.
4. Develop **performance indicators** that are applicable to all existing and potential invasive species in British Columbia.
5. Implement the *Invasive Species Strategy for British Columbia*, with the necessary support from the **Invasive Species Council of BC** serving as the strategy's **steward**.



Healthy rangelands are vital for BC's agriculture industry. Photo: Ministry of Forests, Lands and Natural Resource Operations

Introduction

An *Invasive Alien Species Strategy for Canada* is the key national document that provides a comprehensive framework for a national approach to invasive species management. It provides the foundation for the *Invasive Species Strategy for British Columbia*.

The *Invasive Species Strategy for British Columbia* addresses the management of **invasive species**, which are defined as **harmful alien invasive species whose introduction or spread threatens the environment, economy, or society, including human health**.

Now is the time for British Columbia to aggressively address invasive species to benefit the province's ecosystems, economy, and society. The *Invasive Species Strategy for British Columbia* provides the framework to protect our resources from invasive species.

Note: Glossary terms are initially shown in bolded burgundy text.

British Columbia's diverse topography and climate create a wide range of ecosystems, from grasslands in the southern Interior, to temperate rainforests on the west coast, to rugged mountainous areas in the east and boreal forests in the north. The province subsequently hosts Canada's largest variety of bio-regions, ecosystems, and native species. Over time, the use and management of ecosystems for their services has altered their natural state, creating a multitude of environments for a wide range of **invasive species**. The establishment and spread of invasive species has become a growing concern provincially, nationally, and globally.

Alien species are species of plants, animals (including fish), fungi, and micro-organisms introduced to areas outside their natural distribution, a definition derived from *An Invasive Alien Species Strategy for Canada* (Government of Canada 2004). Alien species are also referred to as exotic, foreign, or non-native. **Invasive alien species** are alien species regarded as harmful and whose introduction or spread threatens the environment, the economy, or society, including human health (Government of Canada 2004). The *Invasive Species Strategy for British Columbia* addresses invasive alien species, referred to as **invasive species** in this document.

Invasive species are typically introduced by human action; however, they may be spread by other means. Some invasive species arrive from their native habitats through intentional introductions, such as the importation of products for cultural or commercial reasons, or unintentionally through animals, tourists, and residents. Without their natural predators, pests, or pathogens, invasive species can establish and flourish in new habitats and displace native species (including rare and endangered plants and animals), impact ecosystems and biodiversity, and reduce the economic and social values of many important natural resources that people enjoy, value, and rely on.

The *Invasive Species Strategy for British Columbia* is a framework for successful invasive species management in the province of BC. Implementation of this strategy will provide a valuable opportunity for British Columbians to work collaboratively towards preventing further impacts of invasive species to environmental, economic, and social values.

The strategy is expected to remain relevant for five or more years, after which time it should be reviewed, and updated if necessary. The strategy development process is outlined in Appendix 1.

Why Care?

British Columbia's healthy landscapes and ecosystems are not only important to native flora and fauna, but to the health and well-being of British Columbians and the economy. By taking responsible actions now, British Columbia can maintain and improve its **terrestrial** and **aquatic** ecosystems and biodiversity for current and future generations.



Healthy field. Photo: M. Harder

Environment

Healthy ecosystems provide the foundation for British Columbia's natural diversity, and promote the health and well-being of residents and visitors. Invasive species can threaten ecosystems, as they often displace native species and disrupt natural ecological processes. Invasive species can out-compete native species and form monocultures that reduce ecosystem complexity and stability, as well as degrade habitats. Invasive species can also alter ecosystem functions by changing nutrient cycles, wildfire regimes, and other natural processes. This can radically reduce the invaluable and essential **ecosystem services** that form the basis of life.

Invasive species are often considered as “a slow-moving wildfire” and “biological pollution” because of the way they can significantly alter the integrity of terrestrial, freshwater, and marine ecosystems. For example, at least 140 invasive species—including round goby, sea lamprey, zebra mussels, and spiny water flea—have entered the Great Lakes since the 1800s and compete for resources with native fish and mollusks; zebra mussels alone have almost eliminated the native clam population (US Environmental Protection Agency 2011). The invasive leafy spurge is threatening Spalding's campion, a federally listed species at risk that is found on the Tobacco Plains Indian Band land in British Columbia. Less than five percent of Garry oak ecosystems in British Columbia are in a near-natural condition, and these ecosystems are threatened by over 173 invasive species, in the form of trees, shrubs, herbs, reptiles, birds, and mammals (Garry Oak Ecosystems Recovery Team 2011).

These examples of the impacts of invasive species on a range of ecosystems and habitats demonstrate the importance of preventing establishment and undertaking prompt control when required. Prevention and control of new invasive species clearly has widespread benefits to the environment.

Economy

Invasive species create significant economic impacts wherever they become established. The economic impacts of invasive species are a combination of increased management costs to control the particular species as well as the subsequent loss of resource productivity, such as grazing lands or fish habitat.

Sixteen invasive species in Canada were conservatively estimated to annually produce cumulative costs of \$13.3 to \$34.5 billion to Canadian fisheries, agriculture, and forestry (Colautti et al. 2003). More specifically, six species of invasive plants were estimated to produce combined impacts in British Columbia of \$65 million in 2008, increasing to \$129 million by 2020 with further spread (Frid et al. 2009). Another example is that in 2004, the loss of cattle forage to knapweed species was \$400,000/year; if knapweed expands to its range limits, the economic impacts to the cattle industry could exceed \$13 million per year (Rankin and Associates et al. 2004).

Zebra and quagga mussels (Dreissenidae family) are rapidly invading North American fresh waters and causing major economic and ecological impacts. American congressional researchers have estimated that Dreissenid mussel infestations in the Great Lakes area have cost the power industry \$3.1 billion between 1993 and 1999, with an economic impact to industries, businesses, and communities of more than \$5 billion. In Idaho, the conservative estimate

The *Invasive Alien Species Framework for BC* (Rankin and Associates et al. 2004) provides a thorough review of threats to biodiversity by invasive species in British Columbia. The framework also discusses the protection of vulnerable ecosystems and species, prevention of introductions, early detection and rapid response, effective control and management, and restoration of at-risk ecosystems and native species.

White-nose syndrome is a fungal disease believed to be responsible for the mass die-off of hibernating bats throughout eastern North America. There is possibility for this disease to reach British Columbia and adversely affect three or more native bat species (BC Bat Action Team 2009).



Little brown bats with White-Nose Syndrome. Photo: N. Heaslip, New York Dept. of Environmental Conservation; BC Bat Action Team, Bat Conservation Fact Sheet, Spring 2010.



Diffuse Knapweed. Photo: R. Mueller

Every dollar spent on biocontrol of diffuse knapweed returns approximately \$17 in benefits, and hawkweed biocontrol has an even higher projected return of \$185 (Frid et al. 2009).



Eurasian watermilfoil. Photo: A. Fox



Zebra and quagga mussels. Photo: J. Leekie

The strategy's purpose is to enhance the coordination of invasive species prevention and control, and to develop a common vision for invasive species management in British Columbia.

of statewide direct and indirect costs from establishment of Dreissenid mussels, excluding mussel impacts on irrigation systems, is \$94,474,000 (Western Regional Panel on Aquatic Nuisance Species 2010).

In the United States, invasive species cost the national economy over \$100 billion annually, and the situation is likely to intensify as climate change further facilitates the spread of invasive species (Associated Press 2011). For example, in American forests, non-native wood- and phloem-boring forest insects produced estimated costs of \$1.7 billion in local government expenditures and \$830 million to homeowners through diminished residential property values (Aukema et al. 2011).

Increased prevention and detection, and improved management, of invasive species can provide significant economic benefits to the province, businesses, industry, and citizens. British Columbia ultimately benefits when invasive species are prevented from becoming established.

Society

Invasive species management in British Columbia has significant benefits for citizens and visitors. For example, removal of existing invasive plants along road rights-of-way improves sight lines and increases driver safety. Proper management of cheatgrass can reduce fire risks by 100 percent (Link et al. 2006), ultimately minimizing fire threats to public safety and property. Health hazards posed by particular species, such as skin burns from giant hogweed, could be reduced if the plant was properly controlled. Preventing new invasions and effectively managing established invasive species can also help maintain property values. For example, Eurasian watermilfoil has decreased lakefront property values in Wisconsin by 13 percent (Horsch and Lewis 2008).

Recreation, whether on land or water, is affected by harmful and unpleasant plants and animals that reduce or ruin recreational quality. Fish diversity in lakes can be significantly reduced if an invasive fish species, such as Asian carp, is introduced. Viewscapes are degraded by a vast expanse of a single invasive plant species, such as orange hawkweed. Parks can become unusable when an invasive plant—carpet burweed, for example—invades and displaces the natural ground cover. Bicycle tires and dog paws are vulnerable to puncturevine on trails, and Eurasian watermilfoil ruins lakeshores for swimming. Infrastructure can also be significantly impacted by invasive species. For example, Japanese knotweed has been known to damage buildings, houses, roadways, and railways. The underground stems of this plant are able to push through asphalt, building foundations, concrete retaining walls, and even drains (Japanese Knotweed Alliance 2012).

Economic costs to society can be reduced significantly when these potential risks and impacts are reduced. Invasive species prevention and control programs will also help create job opportunities for British Columbians. Employment would include inventory, control treatments, **monitoring** activities, and ecosystem restoration; capital projects, such as equipping boat launches and trailheads with outreach material and washing stations; and professional and technical positions in regulation, control, **collaboration**, and other solutions outlined in this strategy.

Degradation or loss of many “invisible” ecosystem services poses one of the most

serious threats to society by invasive species. When a native species is displaced by an aggressive invasive species, ecosystems functions are disrupted and ecosystem services are threatened. Predicting these impacts is impossible, but they are clearly best avoided through improved prevention and control of invasive species.

Key Elements

The following key elements provided the foundation for the development of the *Invasive Species Strategy for British Columbia* and should be used as a basis for the strategy's implementation:

- Focus on the benefits of healthy ecosystems.
- Prevent invasive species establishment and spread.
- Encourage incentive programs, in contrast to enforcement and penalties for non-compliance.
- Build on the strengths of successful existing programs and models.
- Engage researchers, land managers, industry, and universities to determine needs-driven research and share projects.
- Proactively identify and address emerging trends in which introduced species (e.g., for biofuels) could prove to be invasive.
- Continue, and expand, international support and collaboration.
- Ensure adequate, stable, long-term funding for successful invasive species prevention and control.

Vision

The vision for the *Invasive Species Strategy for British Columbia* is: "British Columbia's citizens, ecosystems, and resources are protected from invasive species impacts."

Scope

This strategy provides guidance for the management of invasive species in British Columbia. However, existing organizations may have more intensive and detailed plans to address specific invasive species, such as plants and forest pests. The *Invasive Species Strategy for British Columbia* is designed for flexibility towards British Columbia's wide variety of regions and ecosystems. It builds on lessons learned from work completed on invasive plants in the province, and on a broader range of global invasive species.

The strategy's scope includes:

- Terrestrial and aquatic (freshwater and marine) ecosystems, including, but not limited to, estuaries, lakes and rivers; and
- Invasive plants, animals, microbes (including bacteria), and fungi that have the potential to impose undesirable or detrimental impacts on society, species, ecosystems, or the economy.



Yellow Perch. Photo: Wikipedia



Nelson Invasive Species Strategy workshop.
Photo: Invasive Species Council of BC

The strategy does not specifically address:

- Diseases directly related to human or domestic animal health,
- Aggressive native species that can become invasive, or
- The effects of climate change on native species distribution.

Challenges

The *Invasive Species Strategy for British Columbia* addresses three key challenges that must be overcome in order to reach successful invasive species management in British Columbia:

1. Numerous Invasion Pathways and Vectors of Spread

Invasive species currently have numerous **pathways** to enter British Columbia, and **vectors** of spread to move within the province. Human pathways are most commonly based on travel and the importation of goods; invasive species can arrive intentionally as a planned import from another province or country. They may, however, also accidentally arrive on vehicles or in shipping containers. Natural vectors of spread include wildlife travel and migration. Humans also serve as a major vector through their own travel (for example: vehicles, pets, clothing, and footwear).

British Columbia supports a wide range of hosts, sites, and ecosystems for the establishment of invasive species from all over the world. Complicating this is climate change, which is causing warming trends and increased variation in weather patterns. These changes are resulting in altered ecosystems that are often favourable for invasive species, enabling some species to expand or shift their ranges. This often leads to adverse effects on native, rare, and endangered species. Therefore, an important challenge is to identify and manage both natural and human-caused invasion pathways and vectors, and to recognize patterns that enable invasion.

2. Increasing Impacts

Many British Columbians are unaware of invasive species and the impacts they pose to valued resources. Recognizing the impacts and acting to reduce the introduction and spread of invasive species is critical for British Columbia, based on the maxim that “an ounce of prevention is worth a pound of cure.” It is significantly more cost-effective to address new invaders in small numbers than to manage widespread established infestations. This opportunity, however, requires significant behaviour change based on increased awareness of invasive species and their impacts. Raising public awareness is also important to ensure that British Columbia can meet national and international obligations and agreements for the management of invasive species.

Effective management of invasive species requires all British Columbia citizens to work together, take responsibility for their actions, and change their behaviors. Educating the public about how invasive species can impact their own lives—for example, a degraded recreational area or tax dollars spent on control efforts—can help foster understanding, participation, and cooperation.

Pathways are the geographic routing by which invasive species enter and move within British Columbia. They can be natural (e.g., water currents or air) or human-caused (e.g., roads and railway corridors).

Vectors are the means by which invasive species from a source population follow a pathway to a new destination (McNeely et al. 2001). Examples of vectors include boats, vehicles, and animals.

Addressing pathways and vectors of spread will significantly reduce impacts from invasive species.

As the impacts increase from a wide range of invasive species, British Columbians must recognize how their actions will aid, or stop, invasive species introduction and spread.

3. Insufficient Funding, Collaboration, and Capacity

British Columbia currently has insufficient funding, collaboration, and capacity to effectively manage invasive species, except for the most prominent few. Increased resources for short-term activities, however, would clearly decrease the long-term costs of the harmful impacts of invasive species. An improved ability to manage invasive species, primarily through increased funding, would help reverse the current trend of increasing establishment and spread of new invasive species.

People working together to expand knowledge and apply new practices is part of the foundation for reducing the impacts of invasive species. Collaboration demonstrates the value of synergy and coordination to increase efficiency and effectiveness in meeting a common goal. One example of collaborative management is the West Coast Governors' Agreement on Ocean Health that was created in 2006. The collaborative is a regional partnership established to protect and manage coastal and ocean resources and the economies they support along the entire west coast of the United States (West Coast Governors' Agreement on Ocean Health 2011).

Building capacity requires developing the institutions, skills, infrastructure, technical support, information management, linkages, networks, and exchanges required to effectively prevent and manage invasive species.

Solutions

This invasive species strategy presents six solutions to address its three key challenges. The solutions presented are inter-connected, address more than one challenge, and provided in no particular order of importance or priority. Integration and implementation of all the solutions will provide the most effective results. Each solution includes one or more goals, each with its own set of objectives.

1. Establish and Enforce Effective Regulatory Tools

Legislation, regulations, and policy are tools to regulate and manage invasive species. Jurisdiction over invasive species in British Columbia involves four levels of authority: federal, provincial, local, and First Nation governments. As of early 2012, there were 15 known federal laws and five provincial laws that address invasive species (Appendix 2).

Consequently, two related challenges to effective regulation of invasive species are the multitude of legislation and regulations that require and enable different results, and the lack of a comprehensive, overarching regulatory framework for invasive species. For example, the *Weed Control Act* only addresses invasive plants, the *Forest and Range Practices Act* is limited to forest and range practices on Crown land, and the *Wildlife Act* has a regulation for invasive species but currently only prohibits those dangerous to humans. Possession and transport of any aquatic species—such as fish, mollusks, and crustaceans—are regulated by the provincial *Wildlife Act*, but tropical ornamental species are excluded. The introduction of fish, mollusks, or crustaceans into fish habitat is illegal without a permit under the federal *Fisheries Act*.

The *Invasive Species Strategy for British Columbia* calls for increased funding and collaboration to more successfully address invasive species and subsequently reduce their widespread economic, environmental, and social impacts.



Spartina removal. Photo: Invasive Plant Council of Metro Vancouver

The early focus on weeds, and then invasive plants, has progressed into a comprehensive management approach for all invasive species. Legislation must progress in this direction as well.



Aspen forest and field. Photo: D. Page



Virile Crayfish. Photo: J. Olden

Goal: Establish Effective Regulatory Tools

Establishing effective regulatory tools requires integrating and updating existing invasive species legislation so that all legislation is current, effective, and enforceable. Updated legislation should address and resolve any current conflicts that exist between regulations, and promote cross-government agreements with neighboring provinces, territories, and countries. Regulations must enable and support responsive actions to new outbreaks of invasive species.

The key objectives and preliminary actions required to achieve this goal are:

- Complete an extensive review of existing invasive species regulatory approaches and tools in British Columbia and beyond, and determine successes and opportunities for improvement.
- Update existing legislation and resolve conflicts between current Acts and regulations within the next five years.
- Analyze the strengths and weaknesses of existing legislation and **develop a business case** that will support the development and enactment of a single legislative Act for invasive species.
- Create a **single piece of legislation for all** invasive species in **British Columbia**, such as an Invasive Species Act, within the next 10 years.
- Develop **assessment processes** to justify legislating individual invasive species, which will require developing **risk assessment** protocols and tools.
- Expand **all local charters to include** invasive species, beyond invasive plants. Produce model bylaws for municipalities, regional districts, and other local government to use for their own purposes. This requires the necessary support and resources for bylaw development and enforcement and other anticipated costs.

Goal: Enforce Regulatory Tools

Effective enforcement requires that all invasive species legislation, regulations, and policies in British Columbia are enforced fairly and equally across all jurisdictions. Enforcement should be applicable across all aspects of invasive species management, including, but not limited to, pathways of introduction, vectors of spread, and early detection and rapid response activities.

The key objectives and preliminary actions required to achieve this goal are:

- Develop **assessment processes** that will provide the basis for banning or immediate control of a particular invasive species, and ensure that the necessary resources, such as personnel and training, are provided. Assessment processes should favour voluntary compliance over legal action, where possible.
- Identify the **agency or agencies responsible for enforcement** and ensure that they are actively enforcing legislation. This will include developing a business case that provides a framework for training and certifying dedicated enforcement staff.
- Define the **roles and responsibilities of the enforcer**.
- Develop **reasonable, broadly supported penalties** for non-compliance.



Regional invasive species committees meet for an invasive plant field tour in Penticton. Photo: L. Scott

2. Build Strong Collaboration

Successful invasive species management requires collaboration, cooperation, and coordination among different levels of government, land management agencies, land users, industry organizations, community groups, and the public. A province-wide process or system to enable and support broad collaboration is therefore very important. It should build on existing structures and processes that form a valuable foundation for expanded collaboration. Appendix 3 lists potential participants to collaboratively implement this strategy.

A practical example of effective collaboration and coordination is the eradication of the Norway rat in Alberta. Alberta Agriculture has supervised and coordinated a rural-based control program for the Norway rat for over 60 years. Rats are eliminated within a control zone that is 600 km long and 30 km wide along the southeastern border of the province; systematic detection and eradication are applied throughout the zone to minimize rat infestations. Strong public support and citizen participation were developed through public education to increase awareness, and rat response plans deal with large or difficult cases. Government preparedness, legislation, effective control measures, and close cooperation between provincial and municipal governments have all contributed to keeping Alberta rat-free (Government of Alberta 2011).

Collaboration and cooperation in British Columbia are threatened by insufficient personnel capacity, varying mandates and management approaches, limited availability of technical expertise, and a lack of awareness by British Columbian residents and visitors. There is also a need to ensure that current structures can adequately meet future needs in the most efficient manner.

Goal: Build Strong Collaboration and Coordination

Strong collaboration and coordination requires bringing together all organizations, agencies, groups, and individuals involved in invasive species management in British Columbia and beyond, and working together towards shared goals. This includes supporting current partnerships and fostering new ones, and building cross-jurisdiction collaboration.

The key objectives and preliminary actions required to achieve this goal are:

- Continue to build and expand **partnerships** with bordering provincial, territorial, state, and national jurisdictions to encourage management efficiencies, and promote mutual understanding and support.
- Establish **effective coordination and communication** within and between all organizations, groups, and agencies to ensure that invasive species management fits into multi-party decisions for the land base. Some of the actions that will facilitate this include:
 - Creating a **provincial** invasive species **network** that includes and coordinates all organizations, groups, agencies, and individuals involved in invasive species management in British Columbia and beyond; and
 - Establishing a **provincial communication network** that is responsible for coordinating invasive species information and messaging across the province.

An example of collaboration is the Pacific Coast Collaborative. The collaborative provides a formal basis for cooperative action, a forum for leadership and information sharing, and a common voice on shared issues facing Alaska, British Columbia, Washington, Oregon, and California.

The Collaborative's *Action Plan on Ocean Conservation and Coastal Climate Change Adaptation* includes addressing the spread of invasive species such as: cordgrasses (*Spartina* spp.), tunicates, and green crab (Action Plan on Ocean Conservation and Coastal Climate Change Adaptation 2011).



Norway Rat. Photo: U.S. National Park Service

- Define the **roles and responsibilities** for all organizations, groups, agencies, and individuals involved in invasive species management in British Columbia.
- Create **consistent and timely messaging** about invasive species through standardized best management practices for land and resource managers in British Columbia.
- Provide **incentives** to increase stakeholder participation and partnerships, and stewardship by land managers and occupiers.
- Host an invasive species **workshop** for all British Columbia municipalities that focuses on collaboration, partnerships, and outreach. This should be coordinated by a central provincial coordinating body for invasive species, such as the Invasive Species Council of BC.

3. Prevent Introduction and Spread

Invasive species are often introduced to British Columbia by specific patterns or key pathways. **Pathways** are the geographic routes by which invasive species enter British Columbia or a new part of the province. Pathways may be natural—such as wind or water currents, and may also include intentional human activity, such as importing invasive species for cultural or commercial reasons. Pathways may also be human-made, such as roadways and recreational trails on which vehicles transport invasive species in their undercarriages or on wheels. Managing these pathways, with the goal of stopping new species from entering British Columbia and becoming established, is a cornerstone to effective invasive species management.

Vectors of spread require equal attention. Vectors of spread are the mechanisms by which invasive species move from a source population to a new destination (Government of Canada 2004). Examples include fishing gear, animals, vehicles, and boats. Addressing introduction pathways and vectors of spread requires organizational changes, as well as changes in individual actions by all British Columbians.

Behavioural change is also critical to improved invasive species management. Traditional approaches to education and awareness have demonstrated that, while people’s understanding of an issue may increase, this does not always translate into changes in their behavior or actions. Specifically, increasing the level of awareness across the public and governments in British Columbia and beyond may not necessarily produce changes in practices that will reduce the introduction and spread of invasive species. This strategy is intended to mobilize citizens through education and outreach to act responsibly at home, work, and play. This also means that they take pride in protecting public and private resources and assets. Achieving sustainable behavioural changes will result from a coordinated effort from all associated organizations, groups, agencies, and individuals.

Goal: Close Entry Pathways and Manage Vectors of Spread

Reducing the number of invasive species entering British Columbia requires eliminating the means by which invasive species can enter the province, and actively managing the key mechanisms responsible for the transfer of established invasive species.



Cleaning an ATV at a wash station in Prince George. Photo: J. Mohr



Outdoor display and live samples of invasive plants. Photo: Northwest Invasive Plant Council

The key objectives and preliminary actions required to achieve this goal are:

- Identify and **close key pathways** of invasive species introduction and vectors **of spread**.
- Pursue **cross-border options** to address invasive species movement vectors. This will involve working with national border agencies and neighbouring jurisdictions to ensure that mandatory inspections for vectors such as boats, all-terrain vehicles, and other modes of transportation are implemented.
- Improve and expand on risk assessment **processes** to help determine which invasive species are most likely to enter British Columbia and become established. Risk assessments should consider pathways of introduction and vectors of spread as one criterion. This process will help identify which invasive species should be legislated against importation.

Goal: Encourage British Columbians to Undertake Responsible Actions

Promoting positive behavior change will reduce the introduction and spread of invasive species in British Columbia, enabling best management practices for land base users and resource managers.

The key objectives and preliminary actions required to achieve this goal are:

- Develop a **Behaviour Change Strategy** for British Columbia that identifies key pathways, audiences, and practical solutions that will lead to positive actions in British Columbian residents and visitors. The strategy should be developed and supported by the wide breadth of agencies that are committed to working together on common messaging and approaches. It should focus on changing behaviors that contribute to spread and encouraging use of best management practices. The strategy should be incentive-based, in which demonstrated positive actions and behaviors are formally recognized.
- Build the necessary **partnerships** within British Columbia and across borders to foster positive behaviour change. This will ensure consistent and timely messaging that will promote behaviours to reduce invasive species impacts across all jurisdictions.
- Obtain the necessary **resources and tools** to promote positive behaviour changes in British Columbian residents and visitors. This could include education and outreach materials, such as information on how to identify and report invasive species, and on-the-ground tools, such as cleaning stations at boat launches and boot cleaners at trail heads.
- Formally **recognize positive actions** and behaviours to set good examples, demonstrate leadership, and improve stewardship.
- Enhance **education and awareness** of invasive species in British Columbia. Such programs will be used to address organizations, agencies, groups, and citizens linked to key pathways of invasion and vectors of spread. Some additional outreach and education action items include:
 - Mandatory inclusion of an invasive species curriculum in relevant academic and training programs;
 - Developing invasive species programs for land management, extension, and certification;
 - Websites and smart phone apps;
 - “Watch lists” to alert the public about invasive species of particular importance to British Columbia that have high potential to enter; and



Yellow Flag Iris in a roadside ditch.
Photo: R. Mueller

Social marketing is an approach used to develop activities aimed at changing or maintaining people’s behaviour for their benefit (National Social Marketing Centre 2006).



Eurasian Watermilfoil attached to boat trailer. Photo: Ontario Federation of Anglers and Hunters

- A requirement that retailers provide relevant invasive species information to consumers at the point of purchase (examples include boats, horticultural materials and services, all-terrain vehicles, and mountain bikes).



Reseeding to prevent invasive plant introduction and spread. Photo: Ministry of Environment



Removal of Scotch Broom at the Kokanee Creek Provincial Park. Photo: Central Kootenay Invasive Plant Committee

“...conserving ecosystem functions and integrity is vital because viable ecosystems are the basic life support system for human communities” (Leech et al. 2009).

4. Implement Effective Control, Restoration, and Monitoring Programs

Taking action and addressing invasive species is a key part of this strategy. Controlling invasive species is a complex issue, as it involves everything from knowing where populations exist, to treating them, to monitoring results. **Control** encompasses four main aspects:

1. Responding quickly and effectively to newly arrived species of concern, both at the regional and provincial levels, using Early Detection and Rapid Response principles and methods.
2. Conducting inventories, using established methods for the target species and entering data into a central database, for the purpose of undertaking control treatments where necessary.
3. Treating known occurrences based on current best management practices and scientific understanding.
4. Monitoring target invasive species to evaluate management efforts and identify trends in populations.

Control, however, must consider naturalized invasive species that provide ecosystem services. One example is bees and other pollinators that rely on some invasive plant species; if these plants dominate an area and are treated, the pollinator populations may be adversely affected. Care must therefore be taken to provide native or suitable replacement species that provide similar ecosystem services.

Restoration and pre- and post- control monitoring are essential components of controlling invasive species. **Restoration** is an intentional activity that initiates or accelerates ecosystem recovery with respect to its health (functional processes), integrity (species composition and community structure), and sustainability (resistance to disturbance and resilience) (Society for Ecological Restoration International 2004). Where invasive species have altered the fundamental structure and processes of ecosystems, rehabilitation is necessary to restore those ecosystems to a functional state.

Monitoring is defined as gathering information on physical, chemical, and/or biological variables before after proposed activities take place (Mazzotti et al. 2009). By monitoring, land managers can gather baseline data that will help determine short- and long-term trends, as well as make comparisons against standards, or targets. Monitoring is a way to evaluate and improve management decisions, and ultimately, the health of British Columbia’s natural resources.

Some of the barriers to overcome in achieving effective management include lack of training, insufficient resources for land managers (including managing invasive species on Aboriginal lands), lack of accurate and current data, regional differences and local buy-in, lack of monitoring efforts, and the lack of a flexible plan for use by all.

Goal: Eradicate New Invasive Species Occurrences

Eliminating new invasive species introductions requires implementing Early Detection and Rapid Response (EDRR) principles and methods. Early detection and rapid response efforts increase the likelihood that invasions will be addressed successfully while populations are still localized and relatively small.

The key objectives and preliminary actions required to achieve this goal are:

- Support existing invasive species **EDRR protocols** for British Columbia and establish new EDRR protocols where required. EDRR protocols will be based on the development of an action plan that clearly identifies key organizations, groups, and agencies that should be involved; roles and responsibilities; communication networks; species identification and reporting systems; risk assessments; treatment options; and monitoring plans. The EDRR plan should enable and support action across all jurisdictions.
- Enable **EDRR actions** by acquiring a stable pool of funds and readily available resources and tools, and establishing the authority to act immediately.

Goal: Effectively Treat Invasive Species Populations to Minimize Impacts

Successfully treating established populations of invasive species to reach acceptable levels minimizes their impacts to the environment, economy, and society. This can be achieved by encouraging and supporting land managers to participate in management efforts, making the necessary resources and tools available, and providing recognition and incentives.

The key objectives and preliminary actions required to achieve this goal are:

- Ensure **efficient and effective operational programs** by establishing collaborative management priorities, plans, and goals across all administrative boundaries, both within and beyond British Columbia. This requires the development of:
 - A provincial action plan that outlines the roles and responsibilities of all agencies involved;
 - A centralized database to record and track invasive species occurrences and management efforts; and
 - A centralized data-sharing system that identifies funding sources across fiscal years.

It will also be necessary to:

- Deliver management programs that combine operations, education, and outreach; and
- Promote integrated management (e.g., including invasive species in silviculture surveys).
- Secure adequate, stable, long-term **funding for treatment activities**, including, but not limited to, inventory, mechanical, chemical and biological treatments, monitoring, and education and outreach.
- Implement **effective treatment methods** for all species using protocols and tools developed from current research and operational experiences.
- Develop an **incentive program** to reward land managers for good practices.



American Bullfrogs. Photo: S. Price



TOP: Before biocontrol of Diffuse Knapweed in the Rock Creek area, July 1997. BOTTOM: After biocontrol, using the seedhead-attacking weevil, *Larinus minutus*, July 2001. Photos: Ministry of Forests, Lands and Natural Resource Operations



Small-mouth Bass. Photo: BC Ministry of Environment

Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed (Society for Ecological Restoration International 2004).

- Restrict the movement of materials that are contaminated with invasive species, including gravel, forage, and soil.

Goal: Restore Ecosystems Impacted by Invasive Species

Restoration is designed to reinstate ecosystem functions and services, and to prevent the opportunity for future invasive species establishment. **Ecosystem management** may be required to avoid repeated degradation of restored ecosystems. Restoration techniques should be employed in a collaborative manner to rehabilitate ecosystems impacted by invasive species.

The key objectives and preliminary actions required to achieve this goal are:

- Include restoration as an integral **component** of all **management plans and activities**.
- Identify and share **available resources** to support restoration efforts.
- Develop **standardized restoration guidelines** that are applicable across all jurisdictions and to all stakeholders. The components of the guideline should include an explanation of the problem, and the goals and objectives, planned activities, and post-restoration monitoring and evaluation.
- Streamline permitting and evaluation processes to ensure timely implementation of ecosystem restoration actions.
- Improve and **expand tools** used for ecosystem restoration, including biological control.

Goal: Monitor Management Efforts to Enhance Effectiveness and Efficiencies

Monitoring invasive species management efforts will reveal short- and long-term trends that can lead to new knowledge and understanding, and subsequently improve management effectiveness and efficiencies.

The key objectives and preliminary actions required to achieve this goal are:

- Develop a **provincial monitoring strategy** for invasive species management in British Columbia. The development of this strategy should build upon existing invasive species monitoring tools and work towards answering key invasive species management questions. This strategy would be a living document that would be evaluated and updated for improvement.
- Improve **existing monitoring standards and protocols** so that data collected are useful for determining the effectiveness of invasive species control methods.

5. Conduct Relevant and Applicable Research

Invasive species management is heavily based on scientific knowledge of species biology, habitats, control methods, and other aspects of their natural history. Research requires adequate funding, recognition and support of government's role, and the will within both government and industry to conduct research on invasive species prevention and control.

Future research efforts should expand on existing knowledge and incorporate the needs of resource managers. Investigations into invasive species should be non-biased and all-

encompassing; managers need to consider all ecosystem values, including those that are created or enhanced by invasive species. For example, honey bees rely on Canada thistle in some areas, and beekeepers are reluctant to see all Canada thistle eliminated without immediate replacement by equally valuable native species in areas that bees are known to use for honey production.

Some of the barriers identified for successful invasive species research include a lack of awareness and education (i.e., invasive species not perceived as a big enough issue), addressing data ownership and access, knowledge transfer, limited understanding of the impacts of invasive species, and the transition from research to application.

Goal: Conduct Relevant Research on Invasive Species

Applicable research on invasive species is required, supplemented with knowledge transfer on prioritized topics and issues among academia, resource managers, and policy makers. This will help identify research needs, promote sound policy development, and assist in delivering effective management practices. The key objectives and preliminary actions required to achieve this goal are:

- Develop a **guiding document** for invasive species research in British Columbia to provide a shared vision on the collective needs and priorities for invasive species research in British Columbia.
- Establish a **Centre of Excellence** to provide a venue for sharing of research findings in British Columbia. This could be accomplished by leveraging existing positions and creating a virtual institute of existing researchers. This central coordinating body should include a variety of practitioners and researchers specializing in different species groups, e.g., plants, vertebrates, and invertebrates. At least one academic researcher and one practitioner should be appointed to facilitate communication between disciplines.
- Enhance the **transfer of knowledge** from researchers to invasive species managers and the public in suitable, easily understood formats. This could be achieved through developing an **adaptive management framework** and **promoting partnerships** among educational institutions, industries, federal and provincial government, and international agencies and organizations.
- Identify and address invasive species **knowledge gaps** to promote optimal management options and practices. This may include using research techniques, such as predictive modeling to forecast potential invasive species behaviors and trends. Some preliminary areas identified that require better understanding and additional research include:
 - Effects of climate change on invasive species introductions and distribution;
 - Effects of invasive species on species at risk;
 - Restoration techniques; and
 - Invasive species and ecosystem services.
- Carry out research to better understand invasive species **impacts** on human health, the environment and ecosystems, and local and provincial economies, and use this information to facilitate setting management priorities among species or geographic locations.
- Continue to investigate and report on the risk and long-term cost of leaving invasive species occurrences unmanaged. A **“no-treatment” analysis** would provide a realistic comparison with treatment costs. This analysis should consider the values associated with the loss of ecosystem services and the risk of discontinuing the development of new control methods.



European Cottontail Rabbit.
Photo: Wikipedia.

Invasive species research needs to include the consequences of lost ecosystem services compared with prevention and control costs.



Invasive plant managers look at a research plot of Spotted Knapweed in Kamloops.
Photo: J. Leekie



Participants of a community weed pull on Vancouver Island. Photo: Coastal Invasive Plant Committee

Effective invasive species management requires adequate, stable, long-term funding to address all areas of invasive species management, including but not limited to regulations, education, outreach, research, prevention, control activities, and monitoring.

6. Provide Stable, Long-Term Funding

Obtaining adequate, stable, long-term funding for invasive species management is a serious challenge, particularly when the potential economic impacts are not fully understood by the public or by all decision-makers. However, governments have legal responsibilities for managing the land base. Historic government funding levels have not been sufficient or consistent to effectively respond to invasive species and protect British Columbia's landscapes. Adequate, stable, long-term investments in prevention and responding to invasive species will reduce negative impacts and ongoing management costs.

As described earlier in this strategy, the benefit-cost ratio of preventing infestations or addressing them as soon as possible is significant when compared with allowing an infestation to establish and spread. In short: **prevention and early control pay back far more than they cost.** Funding is a critical aspect of this invasive species strategy, and adequate, stable funding levels must cross fiscal years, and be flexible and accessible.

Goal: Establish Adequate, Stable, Long-Term Funding for Invasive Species Management

Adequate, stable, long-term funding is essential for effective and successful invasive species prevention and control in British Columbia.

The key objectives and preliminary actions required to achieve this goal are:

- Develop and distribute a **guiding document** for invasive species funding in British Columbia to provide a shared vision on the collective funding needs for provincial invasive species management. This document should:
 - Summarize **current baseline investments** for invasive species management in British Columbia, including dollar investment, staff and volunteer time, and in-kind contributions;
 - Provide widely supported **funding targets** for both critical-level (minimum) programs that prevent invasive species impacts from becoming worse, and full-level (desired) programs that, in addition, reduce the impacts of existing invasive species populations; and
 - Propose reasonable **new mechanisms for obtaining additional funds** that consider the amount of funding generated, the process and ease of implementation, and the level of support for the mechanism.
- Augment traditional funding levels by implementing a **suite of new mechanisms** that will provide stable funding across fiscal years. New **funding mechanisms** should include approaches that are both universal (applicable to all British Columbians) and targeted (linked to special interests, such as key pathways of introduction and vectors of spread). The development of funding sources would be carried out in full collaboration with appropriate groups.
- Investigate and establish a **funding distribution mechanism** to determine where and how additional funds could be managed and distributed to stakeholders.
- **Leverage funds** to address similar management objectives, including, but not limited to, species at risk, habitat restoration, education, and research. Funds generated for management can often be applied more effectively across the land

- base if all resource concerns are being addressed in an integrated fashion.
- Ensure that all government agencies can responsibly manage invasive species on **Crown lands** by ensuring they have base budgets to meet their land occupier requirements.
 - Establish an **emergency response funding model** to ensure funds are readily available for immediate response to new invaders (Early Detection and Rapid Response) on all land jurisdictions. A review of existing funding models, such as that used for wildfire control, should provide the basis for this funding model.

Next Steps

The *Invasive Species Strategy for British Columbia* provides five key steps to ensure implementation of improved invasive species management in British Columbia.

1. Build **recognition** of and broad **support** for the *Invasive Species Strategy for British Columbia*. This will include:
 - Promoting and supporting existing invasive species organizations, groups, and agencies in implementing the *Invasive Species Strategy for British Columbia*; and
 - Providing the necessary tools to promote and gain support for the strategy.
2. Develop an **implementation plan**, with clear priorities, for the strategy. This will include identifying prominent British Columbian leaders as key champions for invasive species management. Champions would serve as public figures for the implementation of this strategy.
3. Develop a long-term **funding strategy** for invasive species management in BC that includes baseline funding targets and possible funding mechanisms.
4. Develop **performance indicators**, such as a monitoring-for-success plan, that are applicable to all existing and potential invasive species in British Columbia.
5. Implement the *Invasive Species Strategy for British Columbia*, through the necessary support from the **Invasive Species Council of BC**. The ISCBC would serve as the strategy's steward by facilitating implementation of the next steps, reviewing and updating the strategy within five years, and monitoring the strategy's overall success.

Glossary

Alien species: species of plants, animals (including fish), and micro-organisms introduced outside their natural past or present distribution. Alien species are also referred to as exotics, foreign, or non-native.

Aquatic ecosystem: a system of plants, animals, nutrients, and elements that are found in water (not on land) and the interactions between them.

Centre of Excellence: a team, a shared facility, or an entity that provides leadership, best practices, research, support and/or training for a focus area.

Collaboration: the process in which two or more people or organizations work together to realize shared goals.

Ecological restoration: the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed (Society for Ecological Restoration International 2004).

Ecosystem function: the interactions between organisms and the physical environment, such as nutrient cycling, soil development, water budgeting, and flammability (Biology Online 2012).

Ecosystem management: an approach to guiding human activity using collaborative, interdisciplinary, and adaptive methods with the long-term goal of sustaining desired future conditions of ecologically bounded areas that, in turn, support healthy, sustainable communities (Quinn 2002).

Ecosystem services: resources and processes that are supplied by natural ecosystems, such as clean drinking water and pollination.

Funding mechanism: a method or source through which funding is made available.

Invasive alien species: harmful alien species whose introduction or spread threatens the environment, the economy, or society, including human health.

Invasive species: the simplified version of “invasive alien species” used in the *Invasive Species Strategy for British Columbia*.

Monitoring: gathering information on physical, chemical, and/or biological variables before and after proposed activities take place (Mazzotti et al 2009).

Pathways: the geographic routes by which invasive species enter and move around BC. Pathways may be natural—such as wind and water currents; or human—such as roadways.

Risk assessment: the determination of quantitative or qualitative value of risk related to a concrete situation and a recognized threat.

Social marketing: an approach used to develop activities aimed at changing or maintaining peoples’ behaviour for their benefit.

Terrestrial ecosystem: a system of plants, animals, nutrients, and elements that are found exclusively on land (not water), and the interactions between them.

Vectors: the means by which invasive species from a source population follow a pathway and spread to a new destination. An example is vehicles transporting invasive species.

References

Action Plan on Ocean Conservation and Coastal Climate Change Adaptation. 2011. Pacific Coastal Collaborative. Available at http://www.pacificcoastcollaborative.org/Documents/Q006922%20Action%20Plan%20CCCA_MOU_WEB.pdf

Associated Press. 2011. Forest service draws line against invasive species. Dec. 6. Available at <http://mynorthwest.com/174/589285/Forest-Service-draws-line-against-invasive-species>

Aukema, J.E., B. Leung, K. Kovacs, C. Chivers, K.O. Britton, et al. 2011. Economic impacts of non-native forest insects in the continental United States. PLoS ONE 6(9):e24587. doi:10.1371/journal.pone.0024587. Available at <http://www.plosone.org/80/article/info:doi/10.1371/journal.pone.0024587>

BC Bat Action Team. 2009. White-nose syndrome alert. Bat Conservation Fact Sheet 1. Fall.

Biology Online. 2012. Biology online dictionary. Available at <http://www.biology-online.org/dictionary/Ecosystem_function>

Colautti, R., S. Bailey, C. van Overdijk, K. Amundsen, and H. MacIssac. 2003. Characterised and projected costs of nonindigenous species in Canada. Cited in: Government of Canada. 2004. An invasive alien species strategy for Canada. Sept. 40 pp.

Frid, L., D. Knowler, C. Murray, J. Myers, and L. Scott. 2009. Economic impacts of invasive plants in BC. Prepared for the Invasive Plant Council of BC by ESSA Technologies Ltd., Vancouver, BC. IPCBC Rep. #12. 105 pp.

Garry Oak Ecosystems Recovery Team. 2011. Invasive species. Available at <http://www.goert.ca/about_invasive_species.php>

Government of Alberta, Agriculture and Rural Development. 2011. Norway rat exclusion in Alberta. Available at < [http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/prm2579](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/prm2579)>

Government of Canada. 2004. An invasive alien species strategy for Canada. Sept. 40 pp.

Horsch, E.J. and D.J. Lewis. 2008. The effects of aquatic invasive species on property values: evidence from a quasi-random experiment. Available at <<http://www.aae.wisc.edu/pubs/sps/pdf/stpap530.pdf>>

- Japanese Knotweed Alliance. 2012. The natural control of Japanese knotweed: information pack. Available at <<http://www.cabi.org/japaneseknotweedalliance/>>
- Leech, S., A. Wiensczyk, and J. Turner. 2009. Ecosystem management: A practitioners' guide. BC Journal of Ecosystems and Management 10(2):1-12. Available at <www.forrex.org/publications/jem/ISS51/vol10_no2_art1.pdf>
- Link, S. O., C. W. Keeler, R. W. Hill, and E. Hagen. 2006. *Bromus tectorum* cover mapping and fire risk. International J. of Wildland Fire. 15(1):113-119. Available at <<http://www.publish.csiro.au/paper/WF05001>>
- Mazzotti, F.J., N. Hughes, and R. G. Harvey. 2009. Why do we need environmental monitoring for Everglades restoration? Univ. of Florida. University Cooperative Extension Prog. Available at <<http://edis.ifas.ufl.edu/uw283>>
- McNeely, J.A., H.A. Mooney, L.E. Neville, P. Schei, and J.K. Waage (eds.). 2001. A global strategy on invasive alien species. IUCN, Gland, Switzerland, and Cambridge, UK. 50 pp.
- National Social Marketing Centre. 2006. What is social marketing? Available at <<http://thensmc.com/content/what-social-marketing-0> >
- Quinn, M.S. 2002. Ecosystem-based management. *In: Tools for environmental management*. D. Thompson (ed.). New Society Publishers, Gabriola Island, BC. pp. 370-382.
- Rankin, C. & Associates, Madrone Environmental Services Ltd., The Nature Conservancy of Canada, Jacqueline Booth & Associates, S. Cannings, and Osiris Wildlife Consulting. 2004. Invasive alien species framework for BC: identifying and addressing threats to biodiversity. Prepared for BC Ministry of Water, Land and Air Prot. May. Available at www.env.gov.bc.ca/wld/documents/alien_species_framework_BC_0205.pdf
- Society for Ecological Restoration International. 2004. The SER international primer on ecological restoration. Science & Policy Working Group. Available at <http://www.ser.org/content/ecological_restoration_primer.asp#3>
- US Environmental Protection Agency. 2011. Great Lakes. Invasive species. Available at <<http://www.epa.gov/glnpo/invasive/>>
- West Coast Governors' Agreement on Ocean Health. 2011. WCGA action plan progress report, 2008-2010: Exec. Summ. April. Available at <http://www.westcoastoceans.org/media/wcgabiennialreportexecsummaryfinal.pdf>>
- Western Regional Panel on Aquatic Nuisance Species. 2010. Quagga and zebra mussel action plan for western U.S. waters. Available at <http://www.anstaskforce.gov/QZAP/QZAP_FINAL_Feb2010.pdf>

Appendix 1. Strategy Development Process

The *Invasive Species Strategy for British Columbia* is the result of a collaborative, inclusive process that engaged a wide range of contributors in a variety of ways. The strategy was developed over 2011 and into early 2012 through broad consensus that relied on a series of province-wide and regional workshops.

An invasive species strategy Writing Advisory Team included members with a wide range of interests to provide overall guidance through the strategy's development. The Invasive Species Council of BC organized and facilitated eight workshops during which the draft strategy was presented and made available for feedback and input from interested participants. Coleen Hougen, A.Ag. and Jane Perry, RPF managed input and undertook the writing. Contributors participated through workshops, emails, telephone calls, and a blog. The *Invasive Species Strategy for British Columbia* public consultation schedule was as follows:

Date	Format	Location
May 4th, 2011	Provincial Workshop	Richmond
September 29th, 2011	Provincial Workshop	Richmond
November 7th, 2011	Regional Workshop	Kelowna
November 8th, 2011	Regional Workshop	Nelson
November 14th, 2011	Regional Workshop	Prince George
November 15th, 2011	Conference Call	Province-wide
November 21st, 2011	Regional Workshop	Nanaimo
November 22nd, 2011	Provincial Workshop	Richmond
January 24th, 2012	Provincial Workshop	Richmond

Appendix 2. Federal and Provincial Invasive Species Legislation

One of the challenges to effective regulation of invasive species is the multitude of legislation and regulations that require and enable different results. Below are lists of some key federal and provincial legislation, as of 2012, that addresses invasive species.

Federal Legislation

For more information on each of these Acts, visit the Government of Canada website at <http://laws-lois.justice.gc.ca>.

1. *Canada National Parks Act*
2. *Canada Shipping Act*
3. *Canada Wildlife Act*
4. *Canadian Environmental Protection Act*
5. *Canadian Environmental Assessment Act*
6. *Department of Natural Resources Act*
7. *Fisheries Act*

8. *Forest Act*
9. *Oceans Act*
10. *Pest Control Products Act*
11. *Plant Protection Act*
12. *Seeds Act*
13. *Species at Risk Act*
14. *Transportation of Dangerous Goods Act*
15. *Wild Animal and Plant Protection and Regulation of the International and Interprovincial Trade Act*

Provincial Legislation

For more information on some of these Acts, visit the Province of British Columbia's Laws website at www.bclaws.ca.

1. Community Charter
2. *Forests and Range Practices Act*
3. *Integrated Pest Management Act*
4. *Oil and Gas Activities Act*
5. *Plant Protection Act*
6. *Water Act*
7. *Weed Control Act*
8. *Wildlife Act*

Appendix 3. Potential Collaboration Participants

Candidate agencies and representatives to be offered an opportunity for their involvement in the implementation of the *Invasive Species Strategy for British Columbia* include, but are not limited to:

- Federal departments and agencies: Environment Canada, Fisheries and Oceans Canada (DFO), Canadian Food Inspection Agency, Canada Border Services Agency, Parks Canada, Transport Canada, Northern Affairs Canada, and federal invasive species groups
- Provincial ministries: Agriculture; Environment; Forests, Lands and Natural Resource Operations; Tourism; Transportation and Infrastructure; and the Inter-Ministry Invasive Species Working Group
- Local government: Union of BC Municipalities, regional districts, and individual municipalities
- Aboriginal governments and groups, including Bands and councils, Aboriginal Forestry Council, fisheries, tribal councils, forestry, mining association, BC Union of Indian Chiefs, and the First Nations Summit
- Other provinces and territories, Alaska, and the Pacific Northwest states of Washington, Oregon, Montana, and Idaho (all of which share the Columbia drainage with BC)
- Countries that import and export species that are known to be, or potentially, invasive
- Regional committees and their working groups
- British Columbia Plant Protection Advisory Committee
- Invasive Species Council of BC

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- Academia, training institutions, research institutions, and individuals (e.g., retired government specialists or professors emeriti)
 - Information transfer organizations, such as Forrex
 - Industry groups and associations, including those affiliated with agriculture, aquaculture, energy, fisheries, forestry, horticulture, landscaping, mining, oil and gas, pet businesses, recreation, and tourism
 - Non-government organizations, such as groups with technical expertise (e.g., Garry Oak Ecosystems Recovery Team, BC Bat Action Team, and northern leopard frog recovery team), cattlemen's associations, environmental groups, gardening clubs, and recreational groups (e.g., equestrian, all-terrain vehicle, sport fishing, boating, mountain biking, geo-caching, and others)
 - Pest management community, including businesses, technical specialists, and researchers
 - Border agencies
 - Local beekeepers or a representative of the BC Honey Producers, and others associated with pollinating organisms (e.g., bats, hummingbirds, native bees, and bumblebees)
 - Organic producers needing to maintain accreditation with respect to local chemical treatments
 - Ethnic groups that rely on invasive species
 - School, outdoor recreation, and youth clubs (e.g., 4-H, Girl Guides, Boy Scouts)
 - Professional associations (e.g., agrologists, biologists, engineers, geoscientists, foresters and technologists) for best management practices
 - Utilities and railway authorities
 - Real estate groups and associations
 - Community groups
 - General public
 - Media

