An Invasive Alien Species Strategy for Canada

September 2004

Canada

NOTES ON THIS STRATEGY

This Strategy represents the collective efforts of several federal government departments and agencies as well as numerous provinces. Suggestions to consider particular sources of invasive species (e.g. agronomic species and varieties bred in Canada) or specific management strategies (e.g. suggestions regarding pest management and the use of biological control) will be incorporated into the action plans under development. In addition, references for many of the important facts and figures contained in the document will be added along with the requisite "literature cited" section.

This Strategy seeks to establish a framework to address invasive alien species by meeting four strategic challenges, including:

- Integrating *environmental considerations* into decision-making with economic and social factors;
- Enhancing *co-ordination and co-operation* to respond more rapidly to new invasions and pathways of invasion;
- Strengthening *programs* to protect natural resources under pressure from increased global trade and travel; and
- Maximizing *collaboration between adhoc and regional/issue specific efforts* to ensure the limited resources are used on highest priority issues

The Action Plans will be completed by the Fall 2005 and will articulate the actions required to address the agreed-upon priorities and established objectives/results. The plans will also identify the timelines and those agencies/jurisdictions with a responsibility in successfully achieving the results.

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EXECUTIVE SUMMARY

The introduction and spread of Invasive Alien Species is affecting Canada's environment, economy, and society, including human health. The current threats posed by existing and potential invasive alien species are significant and are growing at an alarming rate. The need for Canada to take measures to address invasive alien species and protect and conserve Canada's natural resources and associated industries as well as the health of wildlife and humans, is essential.

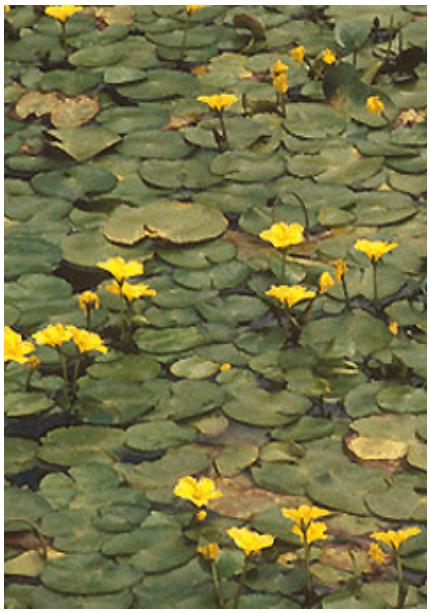
Alien species are species of plants, animals, and micro-organisms introduced by human action outside their natural past or present distribution. *Invasive alien species* are those harmful alien species whose introduction or spread threatens the environment, the economy, or society, including human health. Invasive alien species can originate from other continents, neighbouring countries, or from other ecosystems within Canada.

The ways in which invasive alien species are introduced or spread, are called *pathways.* Introductions can be both intentional (purposeful) or unintentional (accidental) and they can be "authorized" or "unauthorized" (illegal). There are many pathways of introduction (vectors) including ballast water, recreational boating, aquarium trade, pet trade, horticultural trade, "hitchhikers" on commodities, stowaways in various modes of transportation, and disease in wildlife. Canada's strategic approach to address invasive alien species, as discussed in more detail later in this document, will focus on pathways of introduction.

According to the World Conservation Union, invasive alien species are the second most significant threat to biodiversity, after habitat loss. In their new ecosystems, invasive alien species become predators, competitors, parasites, hybridizers, and diseases of our native and domesticated plants and animals. The impact of invasive alien species on native ecosystems, habitats and species is severe and often irreversible.

A preliminary report of the economic costs resulting from invasive alien species conservatively estimated annual cumulative costs for 16 species is between $13.3 and $34.5 billion. These estimates are known to be incomplete, and it is widely estimated that the damage resulting from past introductions of harmful invasive plant pests on agricultural crops and forestry is $7.5 billion annually.

Invasive alien species can result in significant social costs, especially to rural Canadian and Aboriginal communities that remain dependent upon agricultural and natural resources. Introductions can also have significant wildlife and human health dimensions as recently demonstrated with the introduction and spread of West Nile Virus.



Yellow-floating heart.

Photo Credit: University of Florida.

In September 2001, federal, provincial, and territorial Ministers for Wildlife, Forests, and Fisheries and Aquaculture called for the development of a draft plan to address the threat of invasive alien species by the fall of 2002. At their meeting in September 2002, Ministers approved a 'blueprint' for a National Plan and requested the creation of four thematic working groups to advance the 'blueprint' including: Aquatic Invasive Species; Terrestrial Animals; Terrestrial Plants; and, Leadership and Co-ordination. The progress-to-date of these thematic working groups has been incorporated into this Strategy.

This Strategy proposes to respond to the invasive alien species challenge through a hierarchical approach that prioritizes:

1) *prevention* of new invasions;
2) *early detection* of new invaders;
3) *rapid response* to new invaders; and
4) *management* of established and spreading invaders (containment, eradication, and control).

Prevention

For intentional introductions, prevention focuses on the application of risk analysis and prior approval of all proposed introductions. An integrated approach will be used that integrates environmental, socio-economic and human health considerations, and is consistent nationally and internationally across sectors.

Measures to reduce unintentional introductions will likewise involve the use of risk analysis as well as technical measures to minimize the risk of introductions through pathways such as commodities and transportation vectors. Management plans will be needed for risk commodities and vectors. Other measures may include increasing risk assessment capacity, conducting scientific research to better predict the invasiveness of alien species, and developing public education programs with stakeholders.

A surveillance strategy that includes pre-border and border inspection and interception is essential to verify authorized introductions, detect illegal introductions, and detect unintentional introductions through key commodities, pathways, and vectors, as is the capacity to implement the strategy.

Early Detection

A co-ordinated program of site-specific and general monitoring around critical points of entry, protected areas, and urban and agricultural ecosystems is essential for early detection. A core capacity of diagnostics, taxonomic expertise and innovative taxonomic research are critical to accurately identify invasive species once they are detected and distinguish them from native or long established species.

Rapid Response

When invasive alien species circumvent prevention measures and enter Canada, it is essential to respond rapidly before – or immediately after - they become established and spread. Integrated rapid response networks are required, and contingency plans and emergency funds for quarantine and eradication measures are essential to eradicate, contain, or control invasives immediately upon entry. This necessitates the development of an integrated economic, environmental, and human health risk analysis to determine appropriate options for rapid response. It is critical that emergency response be exempt from lengthy approval processes.

Management – Containment, Control, Eradication

Invasive species impacting aquatic, animal, and plant health should be prioritized for targeted management activities, research, and innovation to minimize their long-term costs. Risk analysis, benefit-cost analysis, and other tools can be used to identify and prioritise the most appropriate and cost-effective mitigation measures to be undertaken. Eradication, containment, and control measures of agreed-upon priority invasive species can involve physical, chemical, biological or integrated strategies. Scientific research on eradication, containment, and control methods and technologies for priority invasive alien species is also important.

The introduction of the Zebra Mussel (*Dreissena polymorpha*) has permanently altered the Great Lakes ecosystem, negatively impacted native mussels, and has resulted in millions of dollars in expenditures to keep water intake pipes clean.

Photo Credit: Randy Westbrooks, Invasive org.

DEFINITIONS

The following highlights the definitions used within the scope of the Strategy and Action Plans. *Alien species* are species of plants, animals (including fish), and micro-organisms introduced by human action outside their natural past or present distribution[1]. They are also known as exotics, or specified as being foreign or non-native. Introductions of alien species may be deliberate or accidental, and may be beneficial, as in the examples of corn, wheat, and domestic livestock, or damaging, such as leafy spurge, zebra mussels and wild boars.

Invasive alien species are those harmful alien species whose introduction or spread threatens the environment, the economy, or society, including human health[2]. Alien bacteria, viruses, and fungi, and aquatic and terrestrial plants, mammals, birds, reptiles, amphibians, fish, and invertebrates (including insects and molluscs) can all become invaders.

Risk is a critical concept that is fundamental to responding to the challenge of invasive alien species. Even within the context of invasive alien species, there are many accepted definitions of risk and associated concepts in use, which vary across international agreements and, in turn, national policies and programs. Risk can be defined as the uncertainty that surrounds future events and outcomes[3], a function of the probability (chance, likelihood) of an adverse or unwanted event, and the severity or magnitude of the consequences of that event[4].

Risk analysis can be considered as a systematic approach to decision making regarding the use of alien species through hazard identification, risk assessment, risk management, and risk communication. While differences in terminology do exist, we can draw upon key international agreements to provide an illustrative understanding of the basic components of risk analysis.

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[1] Decision VI/23 of the Convention on Biological Diversity
[2] United States National Invasive Species Council Management Plan, 2001
[3] Treasury Board Secretariat of Canada, 2001
[4] Privy Council Office, 2000

Hazard identification is defined as "the process of identifying the pathogenic agents which could potentially be introduced in the *commodity* considered for importation"[5]. *Risk assessment* is defined as the "evaluation of the probability of the introduction and spread of a pest and of the associated potential economic consequences", where economic consequences are interpreted to include environmental consequences. *Risk management* is defined as the "evaluation and selection of options to reduce the risk of introduction and spread of a pest"[6]. *Risk communication* is defined as "… the interactive exchange of information on risk among risk assessors, risk managers and other interested parties"[7].

Mosquito/ West Nile Virus

Photo Credit:

[5] The World Organization for Animal Health (OIE) Terrestrial Animal Health Code, 11th Edition, 2003
[6] International Plant Protection Convention (IPPC) Glossary of Phytosanitary Terms Reference Standard, ISPM No. 5, 2002
[7] The World Organization for Animal Health (OIE) Terrestrial Animal Health Code, 11th Edition, 2003

SCOPE

The Invasive Alien Species Strategy for Canada seeks to protect Canada's aquatic and terrestrial ecosystems, and their native biological diversity and domestic plants and animals, from the risks of invasive alien species. While invasive alien species can also affect human health, the human health dimension is largely covered under existing human health programs. However, it is important to note that addressing the fundamental causes of invasions – the movement of species through both global and national trade and travel can prevent some future health problems.

The scope of this initiative is broad and inclusive. It is applicable to all intentional (purposeful) introductions, both authorized and unauthorized (illegal), and all unintentional (accidental) introductions. It includes those alien species that are imported and introduced from other countries, as well as those alien species that are native to some regions of Canada, but have been introduced by human activity into areas outside of their historic distribution. It also considers those alien species that are developed or introduced into Canada and then exported to other countries. This initiative is applicable to a wide range of sectors, including agriculture, fisheries and aquaculture, wildlife, forests, transportation, industry, and human health. This initiative recognizes the roles and responsibilities of all levels of governments in regulating and managing alien species, and as proponents and facilitators of intentional introductions of alien species.

Round Goby.

Photo Credit: Edward G. Lines Jr., University of Wisconsin Sea Grant Institute

RATIONALE FOR ACTION

A. The Problem

Invasive alien species do not respect political boundaries, and can originate from other continents, neighbouring countries, or even other ecosystems within regions of Canada. In Canada, alien species include at least 27 percent of all vascular plants, 181 insects that feed on woody plants, 24 birds, 26 mammals, 2 reptiles, 4 amphibians, several fungi and molluscs, and 55 freshwater fish. The World Conservation Union's list of the world's 100 worst invasive alien species includes many established in Canada, including Dutch elm disease, leafy spurge, Japanese knotweed, purple loosestrife, green crab, spiny water flea, gypsy moth, common carp, rainbow trout, starling, domestic (feral) cat, and rats.

In addition to the list of species presently in Canada, new invasive alien species are continually arriving at Canada's borders by air, land and water. An increase in the volume of trade and a decrease in transport times necessary to deliver goods have both contributed to an increase of pest introductions occurring globally. Use of mail order and Internet to acquire goods from around the world, and an increase in recreational and business travel worldwide may also be facilitating introductions.

In addition, not all invasive alien species originate from outside of Canada's borders. Species that have been moved across provincial and territorial boundaries within Canada, or between ecosystems within a particular jurisdiction or region within Canada may become invasive. For example, deer introduced to the Queen Charlotte Islands from mainland British Columbia are impacting plant diversity and forest regeneration on the island archipelago. Some agronomic and horticultural species and varieties that are developed within Canada could have invasive potential within both Canada and elsewhere. In addition, there are species native to Canada that have been exported and introduced into other countries and have become invasive, for example, the beaver.

B. Environmental Threats

Invasive alien species are biological pollution, able to persist and spread in their new environments. According to the World Conservation Union (IUCN), invasive alien species are the second most significant threat to biodiversity, after habitat loss. In their new ecosystems, invasive alien species become predators, competitors, parasites, hybridizers, and diseases of our native and domesticated plants and animals. The impact of invasive alien species on native ecosystems, habitats and species is severe and often irreversible, and it often takes several years before the extent of the problem is recognised. They have caused the extinction of over 110 vertebrate species around the world and have affected nearly every type of ecosystem.

Purple Loosestrife (*Lythrum salicaria*), a species introduced from Europe, has had significant environmental impacts in riparian and wetland habitats.

Photo Credit: Corel Corporation

In 2002, about 24 percent[8] of Species at Risk in Canada listed by the Committee on the Status of Endangered Wildlife in Canada may be threatened with extinction by invasive alien species. Ancient murrelets, island blue butterfly, golden paintbrush, tiger salamander, northern prairie skink, American chestnut, eastern flying squirrel and ginseng are just some of about 90 native Species at Risk threatened by invasives. In the Great Lakes, now home to more than 160 alien species, sea lamprey have been implicated in the extinction of the deepwater cisco, and zebra mussels have extirpated native mussels from some areas.

Invasive alien species can alter habitats and essential ecosystem functions, including hydrology, nutrient cycling, contaminant absorption, natural fire regimes, and energy flows and cycles. Essential ecosystem functions can be placed at risk, including greenhouse gas absorption by forests, pest control by native species, water filtration by wetlands, and the use of native biodiversity for the bio-based economy (including pharmaceuticals and other biotechnology).

Many of Canada's major ecosystems (both terrestrial and aquatic) have already been invaded by invasive alien species. For

[8] Stronen, Astrid Vik. Impacts on Canadian Species at Risk from Invasive Alien Species. Canadian Wildlife Service, Environment Canada, 2002.

example, species such as zebra mussels and sea lampreys have permanently altered the Great Lakes ecosystem. Even Canada's urban areas cannot escape the impacts of invasive alien species. In 1945 Dutch elm disease was introduced to Quebec from the United States. Since then, it has killed 600,000 elm trees in Quebec and in one year alone killed 80 percent of Toronto's 35,000 elm trees. Dutch elm disease is now found in most of North America, and has irrevocably changed the composition of many Canadian urban forests. More recently, emerald ash borer and Asian longhorn beetle have been threatening hardwoods in Windsor and Toronto respectively.

C. Economic Threats

A preliminary review of the economic costs of invasive alien species in Canada provides insight into the magnitude of the problem. Examining just 16 species for which published information is available, a conservative estimate of cumulative annual costs is between $13.3 and $34.5 billion[9]. These estimates are known to be incomplete, and it is widely estimated that the damage resulting from past introductions of harmful invasive plant pests on agricultural crops and forestry is $7.5 billion annually. Manitoba alone estimates its economic losses due to Dutch Elm disease at roughly $30 million, and a single invasive alien thistle species impacting a single crop, canola, carries an annual cost of $320 million on the prairies. Estimates of the cumulative impact of zebra mussels range from $3 billion to $7.5 billion for the Great Lakes.

Invasive alien species are a major concern in Canada's forest sector. Between 1981 and 1995, both native and invasive alien forest pests affected over six million hectares of Canada's forests. The detection of Asian long-horned beetle in Toronto is alarming because this beetle poses a threat to both the hardwood products industry and the maple syrup industry, whose products were valued in 1997 at $480 million and $130 million respectively. The brown spruce longhorn beetle invaded Point Pleasant Park in Halifax in the 1990s, resulting in wide-spread public concern and the destruction of more than 6000 trees in an eradication program initiated by the Canadian Food Inspection Agency (CFIA). These beetles, if not controlled, could impact Canada's multi-billion dollar softwood lumber industry.

[9] Colautti, Robert, Sarah Bailey, Colin van Overdijk, Keri Amundsen, and Hugh MacIssac. 2003. Characterised and projected costs of nonindigenous species in Canada.

Invasive alien species also have significant impacts in the agriculture sector. Many significant pests affecting agriculture are not native to Canada - for example, 80 percent of agricultural weeds are invasive aliens - and many crops cannot be grown without protection from invasive alien species. The problem results in significant losses in crop yields, direct control costs, indirect environmental costs of chemical control, and potential devaluation and market losses from commodity contamination.

The European Green Crab (*Carcinus maenas*), introduced to the Pacific and Atlantic coasts of North America, competes with native crabs and consumes and depletes prey species, resulting in potential impacts to Canada's marine shellfish industry.

Photo Credit: Smithsonian Environmental Research Centre.

Invasive alien species impact aquatic systems, often with cross-boundary implications. In the Great Lakes, for example, treatment and control costs for zebra mussel and associated damages reach hundreds of millions of dollars each year. The initial costs of zebra mussel control measures for Ontario Hydro were $20 million, with an annual $1 million in operating costs. Annual sea lamprey control costs are over $21 million, shared by Canada and the United States. Canada's oceans and coastal areas have not escaped invasions of harmful alien species either. The European green crabs impact native clams, mussels and oysters on the East Coast, and they have recently arrived in British Columbia where they threaten the West Coast shellfish. The invasive algae codium also threatens shellfish on both coasts, including the lobster, oyster, kelp, sea urchin and eel industries.

D. Social and Human Health Threats

The introduction of invasive alien species can result in significant social costs. Socio-economic impacts are diverse, from lost incomes, reduced land values, and private property damage to life-threatening allergies, the loss of traditional medicinal plants, and uncertainties over 'social values', including controversies over the use of pesticides for control programs. Hundreds of rural Canadian and Aboriginal communities remain dependent upon agricultural and natural resources such as crops, livestock, fisheries, forestry, and wildlife for their livelihoods, and these can be severely disrupted or lost with the introduction of invasives. Noxious weeds are a national problem, particularly affecting the agriculture sector, recreational areas, and rural communities. The

costs and benefits of introductions of alien species are often unequally distributed between sectors that are pathways of invasion and sectors that are affected by those species. For example, species accidentally introduced in ballast water have affected freshwater fisheries and biodiversity, not shipping *per se*. Some sectors such as aquaculture, agriculture, forestry, and wildlife management are pathways for the introduction of invasives while themselves being impacted by others. For example, many hay and forage plants are invading prairie ecosystems.

Some invasive alien species can also threaten human health. While the health and safety risks to humans of invasive alien diseases are largely addressed under human health initiatives, the recent invasion of West Nile Virus is highlighting the link between the spread of alien species and human health. Infectious zoonotic diseases such as West Nile Virus have the potential to impact both human and wildlife health, and wildlife populations may additionally serve as hosts and reservoirs of such diseases. Foreign animal diseases including Newcastle disease, foot and mouth disease, rinderpest, hog cholera, rift valley fever, and many others, as well as endemic diseases such as brucellosis and bovine tuberculosis illustrate how invasives can impact both native fauna and domestic livestock, as well as community well-being. In addition to micro-organisms, global experience shows that invasive alien plants and animals can also threaten human health, including venomous species that hitch-hike on imported goods or migrate across borders.

E. Threats to International Trade

Invasive alien species can impact trade relationships. Under the World Trade Organization Agreement on Sanitary and Phyto-Sanitary Measures, least-trade-restrictive measures can be applied to the movement of goods to prevent the entry of recognized pests that may threaten agriculture and forest crops. While measures can be applied to prevent the importation of various pests and diseases into Canada to protect agriculture and forestry, Canadian business and industry and regulators must take all reasonable measures to ensure that unwanted pests and diseases are likewise not exported from Canada to other countries. Vigilance to prevent the export of invasive alien species is essential for protecting Canada's export markets.

Recent examples demonstrate the need to prevent the introduction and spread of invasive alien species to protect trade relationships. The detection of Asian long-horned beetle and subsequent requirements of fumigation or heat treatment of wood packaging materials from China and Hong Kong in 1998 threaten to interrupt over $30 billion in trade between Canada and China-Hong Kong. In the fall of 2000, the United States imposed a prohibition on all imports of Prince Edward Island potatoes fearing the spread of potato wart, a disease which is believed to have been eradicated from the United States. By time the import ban had been lifted in 2001, lost sales were estimated at $30 million, which resulted in affected farmers requiring government assistance. More recently, the discovery of a single cow infected with Bovine spongiform encephalopathy (BSE) in Alberta resulted in the immediate closure of valuable export markets, with subsequent reductions in related domestic industries. The losses due to this closure are projected to cost the Canadian economy $550 million per month. Canada's NAFTA and inter-continental trading partners will be increasingly concerned if measures to prevent the import or export of invasive species are not effective.

F. International Obligations

Article 8(h) of the Convention of Biological Diversity obliges signatories to control invasive alien species. Several countries including Australia, New Zealand and the United States have developed national strategies or action plans to this end. While some plans focus on priority sectors, including Australia's 1997 National Weeds Strategy and South Africa's Working for Water Program, others are broader. The United States National Invasive Species Council Management Plan (2001) and New Zealand's Biosecurity Strategy (2003) are comprehensive in scope, co-ordinated across jurisdictions, and integrated to address environmental and economic considerations. Many countries have made program and policy changes and allocated and/or re-allocated significant resources, and the "on the ground" results of their efforts are significant. These countries, and others, are signatories to international conventions and are members of the associated international standard setting bodies. Many of their efforts have been driven by these conventions/organizations. Canada too, is a signatory to the International Plant Protection Convention (IPPC), the Organization des Epizooties (Animal Health Organization), the Convention on Biological Diversity (CBD) and the International Maritime Organization (IMO). Canada must ensure it is in a position to respond to the regional (North American) implementation aspects of these conventions. Similar initiatives are underway in the

European Union, Japan, and China. If Canada fails to adopt similar invasive species initiatives/approaches, it could result in international repercussions affecting trade, travel or international relationships with our global partners.

Bull Elk with Chronic Wasting Disease.

Photo Credit: Wyoming Game and Fish Department

CHALLENGES

A. Pathways of Invasion

Introductions of alien species are increasing with the growing volume of trade, broadening of trading partners, and increased travel and tourism that accompany globalization. Global trade results in intentional (deliberate) and unintentional (accidental) introductions of invasive alien species that can have severe and irreversible impacts. The different ways that invasive alien species can be introduced are called pathways. Pathways of invasion include direct trade in ornamental or horticultural alien species that are later found to be invasive; alien species that hitch-hike on goods and packaging materials; and the ships, planes, trains, and vehicles that transport goods (transportation vectors). There is also the possibility of agricultural or forest pests being maliciously introduced (bioterrorism). Once introduced, species can spread from one region of Canada to another by intentional transport or by hitchhiking on vehicles, boats, or in packaging material. There is a particular concern about vehicles entering remote areas.

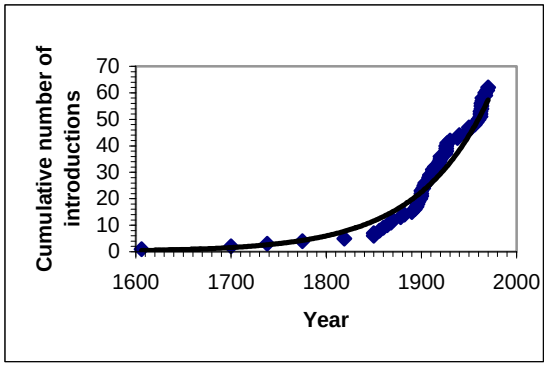


Figure 1. The number of mammal, bird, amphibian, and reptile established introductions in Canada has increased exponentially since the first introduction in the early 1600's.

Invasive alien species can also be introduced from other parts of Canada into new areas. Seeds and propagules can be distributed on trucks and all-terrain vehicles. This can especially become a problem as formerly pristine areas become open for resource extraction. Invasive aquatic species are transported to new watersheds on boats. Since these pathways do not involve an international border, they are more difficult to monitor and control. Introductions of mainland species onto coastal islands can be especially detrimental.

B. Existing Capacity

Invasive alien species is a new term for an old problem, and governments have been taking action for decades to respond to plant quarantine pests and diseases, endemic and foreign animal diseases, aquatic invaders, and other non-native species for decades. Canada's efforts to address these and other invaders are highly regarded by the global community, particularly our plant and animal health programs of the Canadian Food Inspection Agency (CFIA).

Nevertheless, the increasing volume and diversity of trade and travel both within and outside Canada's borders are overextending existing capacities, and resulting in new invaders and new pathways of invasion that are not adequately addressed under existing legislation, policies, and programs. Departments and agencies are working together to respond to this challenge, with many increasingly involved in federal and inter-jurisdictional partnerships and co-ordination mechanisms on a range of national and international issues. Departments are also working together to identify their common interests and concerns in the interests of national biosecurity. Many provinces and territories including Ontario, British Columbia, Saskatchewan, and Alberta have also made significant progress in addressing invasive alien species, including noxious weeds and aquatic invaders. Outside government, many stakeholders are increasingly stepping forward to manage invasive alien species of concern to their own activities and communities. Continued and enhanced collaboration among governments, economic sectors, stakeholders, and with the international community will be essential in meeting the current and future challenges of invasive alien species.

C. Inadequacy of Current Measures

Invasive alien species are entering Canada with increasing frequency, and posing a growing threat to our domestic biosecurity. In 2000, the Canadian Food Inspection Agency reported over 1000 interceptions of alien pest species, and three new species, namely brown spruce longhorn beetle, Plum pox virus, and woolly cup grass, were detected in Canada for the first time. Since then, first outbreaks of Asian Long-horned Beetle and Emerald Ash Borer were discovered in Toronto and Windsor, Ontario, respectively.

While the number of interceptions is impressive, less than one percent of marine container shipments are inspected for hitchhiking alien species at Canadian ports because of the volume of trade. Increasing trade volumes from air, land, and sea may also stress Canada's ability to monitor certain commodities such as animal and plant products that require a 100 percent inspection rate. In the Great Lakes – St. Lawrence basin, the number of recorded introductions has increased throughout the 20th Century. Even with increased attention in the 1990s, 15 additional alien species became established in this waterway. Furthermore, there is a regulatory gap with regards to alien species that are not specifically prohibited under existing legislation. These species that are neither illegal nor approved could nonetheless prove to be invasive.

Hydrilla.

Photo Credit: USDA, APHIS

To be effective, national efforts to address invasive alien species must respond to three strategic challenges. First, national strategies and action plans must integrate environmental considerations into decision-making with economic and social (including human health) factors. Historically, domestic and international regimes have sought to prevent the unintentional introduction of pests and diseases based on their potential economic impact on agriculture or forestry. Other potential impacts were not considered in the decision-making process. The increasing diversity of species in trade and the emergence of new trade pathways, however, mean that a greater diversity of potential invasive species are being transported globally and ecosystems, habitats, and native species are now at greater risk and require focused attention. To date, environmental considerations have constituted only a small component of risk analysis procedures used to authorize proposed introductions. As a result, the unintended environmental impacts of introductions have often not been predicted or mitigated, with additional indirect economic costs. In addition, only a small percentage of the world's species are restricted, which allows for species whose invasive qualities are unknown to be brought legally into Canada.

Second, national strategies and action plans must enhance coordination and cooperation within and between governments to respond more rapidly and effectively to new invasions and pathways of invasion. Coordination will enhance the protection of

resource sector industries, including agriculture, fisheries, forestry, and wildlife, as well as native biodiversity. Lack of capacity and a poor understanding of 'who-does-what' can result in slow responses to emerging pathways such as the internet and mail order, the pet and aquarium trade, and others. Although responsibilities for environmental protection are shared across federal departments and agencies, a lack of coordination has meant that these accountabilities have not been fully instituted. Key departments with environment mandates do not have the program capacities they need, while others with the right programs are either not mandated or have inadequate capacity to do the work.

Third, national strategies and action plans must strengthen programs to protect natural resources and resource sector industries (including agriculture, fisheries, forestry, and wildlife) under pressure from increased global trade and travel. Capacity in critical areas for the management of invasive alien species has eroded. Although taxonomic expertise should be the cornerstone of Canada's biosecurity, departments no longer have the capacity and expertise to identify accurately many of the invasive alien species that are intercepted at Canada's borders, nor to determine invasive species already present in Canada. While Canada's inspection capacity has similarly eroded, New Zealand inspects upwards of 25 percent of all containers at its ports. Departments are under growing stress to meet their existing obligations, and will require new resources or the re-allocation of existing resources to respond to new pathways and environmental obligations.

POLICY AND MANAGEMENT FRAMEWORK

Purpose

To establish a coordinated policy and management framework (see Appendix 1) that minimizes the risk of invasive alien species to the economy, environment, and society.

Vision

A comprehensive, coordinated, and efficient system that protects Canada's aquatic and terrestrial ecosystems, domestic animals and plants, and native biodiversity, by preventing, detecting, responding to, and managing the risks associated with invasive alien species.

Principles

Principles

1. Work within existing international agreements to develop a Canadian invasive alien species strategy that is compatible with these agreements;
2. Develop a strategy that is science-based and utilises the best available knowledge
3. Adopt an adaptive management approach that incorporates and continually improves on policies and practices by learning from the outcomes of operational programs.
4. Co-operate at all levels of government, industry and non-governmental organizations within Canada and internationally;
5. Engage the public and encourage universal stewardship; and
6. Respect the rights of Aboriginal peoples and others, and integrate traditional knowledge with other sources of knowledge to address the threat of invasive alien species.

Leadership and Co-ordination

Dedicated federal, provincial/territorial and national leadership is imperative for a successful response to the challenge of invasive alien species. Leadership is a precursor to effective co-ordination that moves beyond sectoral and jurisdictional approaches to respond to new invaders and pathways of invasion decisively. Sustainable co-ordination and consultation mechanisms are important to ensure efficient responses to threats that will change with the evolving nature of global trade and travel. These co-ordinating mechanisms are important not only between jurisdictions, but also within federal, provincial, and territorial governments.

Tasks envisioned for leadership and co-ordination activities are as follows:

Federal departments and agencies:

- Recognize the Minister of Agriculture and Agri-Food, the Minister of Fisheries and Oceans, the Minister of Natural Resources, and the Minister of the Environment as lead federal Ministers on invasive alien species.
- Establish/designate appropriate interdepartmental committees at the level of Director-General, Assistant Deputy Minister, and Deputy-Minister for coordination and decision making on invasive alien species.

Joint federal/provincial initiatives:

- Establish an inter-jurisdictional co-ordination mechanism with multiple representatives from provinces and territories and responsible federal departments and agencies.

Stakeholders and public:

- Establish an independent multi-stakeholder Advisory Committee on Invasive Alien Species

Strategic Goals

The Strategy is guided by four equally essential strategic goals that are the foundation of the management of invasive alien species:

1. *Prevent* harmful intentional and unintentional introductions;
2. *Detect* and identify new invaders pre-border and upon entry;
3. *Respond* rapidly to new invaders upon detection; and
4. *Manage* established and spreading invaders through eradication, containment, and control.

While priority is placed on preventing new invasions of alien species, at the same time there is a need to, eradicate, contain, and control priority established invasive alien species.

Goal 1: Prevention

Preventing harmful introductions before they occur is the most effective means to avoid or minimize risk. Investments in prevention are cost effective, avoiding significant long-term economic, environmental and social costs. A surveillance strategy that includes pre-border and border inspection and interception is essential to verify authorized introductions, detect illegal introductions, and detect unintentional introductions through key commodities, pathways, and vectors. At the same time, many countries are increasingly looking toward pre-border activities that aim to intercept invasive alien species at their source or point of origin. Prevention activities will ultimately result in fewer unintended introductions, and fewer intentional introductions with unintended consequences.

For intentional introductions, prevention focuses on the application of risk analysis - risk assessment, risk management, and risk communication - for the prior approval of all proposed introductions. Enhancing prevention will require a risk assessment model that integrates environmental, economic, social and cultural factors, and human health considerations, along with a new federal coordinated decision-making process. Full consideration of environmental factors may require broadening the mandates and strengthening the capacity of some departments and refining or consolidating legislative and regulatory tools.

Measures to reduce unintentional introductions will involve the use of pathways analysis to determine the means by which introductions occur, such as commodities, and transportation vectors, along with risk analysis and technical measures to minimize the risk of introductions through these pathways. Prevention efforts should increasingly focus on the country of origin - not just Canada's own borders - to reduce further the risks of introducing of invasive alien species. A similar approach can be used for malicious intentional introductions.

Key Actions:

Critical:

- Increase risk assessment capacity
- Conduct pathways analysis to prioritise pathways according to risk.

- Ensure that risk assessments are conducted of all pathways and potential pathways of unintentional introductions, including commodities and transportation vectors.
- Ensure that risk assessments of all proposed introductions of alien species and all currently traded alien species are conducted.
- Develop and implement plans for managing high-risk pathways, intentional and unintentional, international and domestic.

High Priority

- Develop a co-ordinated federal risk management process that is consistent both nationally and internationally and across sectors.
- Increase capacity for inspections and enforcement at Canada's borders for import commodities, pathways, and vectors.
- Cooperate internationally to prevent invasive alien species introductions at their source/point of origin.
- Develop and implement a national public education campaign and targeted outreach initiatives (including codes of conduct) in partnership with stakeholders.
- Develop a national database for invasive alien species information that is easily accessible to the public and provides data on the risks associated with each invasive alien species.

Medium Priority

- Conduct and support research on methods/technologies to treat/interdict commodities, pathways, and vectors to reduce impacts or risks of introduction to acceptable levels.
- Conduct and support research aimed at developing tools to better predict the invasiveness of alien species.

Important Commodities, Pathways, and Vectors:

The consideration of commodities, pathways, and vectors responsible for the introduction of invasive alien species is vital for designing an effective *prevention plan.* The pathways that therefore need to be addressed are shown in Table1. (For more detail see Appendix II).

Table 1: Pathways of Invasion

Alien Species	Intentional Introductions [1]	Unintentional Introductions
Aquatic Invasive Species	o Live food fish o Aquarium & horticultural pond trade o Live bait fish o Authorized stocking o Unauthorized transfer or stocking	o Commercial shipping (ballast water management, hull fouling) o Recreation/tourism – boating, float planes o Garbage o Water diversions, canals, & dams o Natural transboundary spread
Invasive Animals & Animal Pests	o Wildlife/pet trade o Game or fur farming/ranching o Livestock, poultry, apiculture o Research & development o Zoos (etc.) o Malicious introductions	o Animal products (meat, dairy, eggs, pet food) o Packing/packaging materials (containers, etc.) o Commercial transport – containers, airplanes, boats, trains, trucks, cars o Recreation/tourism (baggage) o Natural transboundary spread
Invasive Plants & Plant Pests	o Viable seeds & grains o Live plants & plant parts for propagation	o Live plants & plant parts for human or animal consumption o Wood products and other plant products o Other "carriers" and means of dispersion (animals, garden materials, garbage) o Natural transboundary spread

[1] Note: Intentionally introduced species can also be associated with unintentionally introduced species (pests/hitch-hikers). Intentional introductions may be both authorized and unauthorized/illegal.

Goal 2: Early Detection

When invasive alien species circumvent prevention measures and enter Canada, it is essential to detect and identify them before - or immediately after - they become established. Site-specific and general monitoring around critical points of entry, protected areas, and urban and agricultural ecosystems are also important. Detection efforts must be complemented by the ability to identify new invaders. Taxonomic expertise and innovative taxonomic research are critical to properly identify invaders once they are detected.

Key Actions:

High Priority

- Undertake surveillance activities in geographic areas at high risk from invasives
- Establish a coordinated public monitoring network to detect and report invasive alien species.
- Monitor the results and impacts of approved introductions and re-evaluate decisions to allow introduction if there are unexpected consequences.
- Establish nationally a core capacity of diagnostics and taxonomic expertise to accurately identify invasive alien species.

- Cooperate internationally to develop a network of diagnostic and taxonomic expertise in key areas.

Medium Priority

- Conduct research to develop new diagnostic tools to identify invasive alien species.
- Support existing diagnostic tools of biological collections and taxonomic libraries.
- Develop a coordinated surveillance network of critical / high risk points of entry and ecological baseline sites to verify authorized introductions and detect unauthorized introductions.
- Support taxonomic research.

Goal 3: Rapid Response

When invasive alien species circumvent prevention measures and enter Canada, it is essential respond rapidly before they become established or spread and cause harm to the economy, environment or society. Integrated rapid response networks are required and contingency plans and emergency funds for quarantine and eradication measures are essential in order to eradicate, contain, or control invasive species immediately upon detection before they can establish and spread.

Key Actions:

Critical

- Develop systems and networks for rapid decision-making, communication and implementation of emergency response plan
- Develop contingency/emergency response plans.

High priority

- Establish an emergency fund and ensure it can be accessed in a timely fashion to respond rapidly to invasions upon detection.
- Where appropriate, co-operate internationally to respond rapidly to invasive alien species.
- Develop education and outreach initiatives that are targeted to ensure public support for rapid response measures.

Goal 4: Containment, Control and Eradication

Invasive alien species that become established in Canada should be managed through eradication, containment, and control efforts in

order to minimize their environmental and economic impacts and prevent their spread, particularly across ecological boundaries. Restoration and recovery initiatives are also important to ensure that native and managed ecosystems are not re-invaded once invaders are eradicated or controlled. Invaders impacting aquatic, animal, and plant health should be prioritized for targeted management activities, research, and innovation to minimize their long-term costs. Risk analysis, benefit-cost analysis, and other tools can be used to identify and select the most appropriate and cost-effective mitigation measures to be undertaken. Eradication, containment, and control measures can involve physical, chemical, biological, and integrated strategies. An ecosystem approach should be used to managing invasive alien species within Canada and across international boundaries.

Key Actions:

High Priority

- Risk assessment to prioritize and identify options for managing invasive alien species of concern.
- Develop indicators for monitoring impacts of invasive alien species.
- Develop education and outreach initiatives to generate support for eradication, containment and control plans.
- Conduct research on eradication, containment, and control methods/technologies for priority invasive alien species.

Medium Priority

- Develop and implement management plans for priority invasive alien species through a partnership/stewardship approach.
- Develop and implement restoration plans for vulnerable ecosystems to provide conditions more suitable for native biota.
- Develop and maintain a national database containing information on the control and management of invasive alien species that is easily accessible to land managers.

Implementation Strategies

Risk Analysis

Effective decision making on the use of alien species must ultimately define an acceptable level of risk that considers the benefits of using an alien species against the likelihood that it may become invasive and the potential magnitude of its unintended economic,

environmental, and social costs. Decision-making on the purposeful introduction of alien species is difficult because it is based on incomplete information, attempting to differentiate between their potential benefits and their potential to cause harm. While risk assessment is grounded in the best available science and predictive tools, risk management must balance potential benefits and costs within the precautionary approach as defined in Principle 15 of the Rio Declaration on Environment and Development, 1992. This approach presumes risk and assigns the burden of proving an introduction will not have unacceptable impacts. Effective risk communication is critical.

Risk identification, assessment, management, and communication are fundamental tools for achieving the strategic goals of prevention, rapid response, and management. The development of an integrated, shared and harmonized approach to risk assessment (see Goal 1: Prevention) is consistent with international trends in the management of global trade, and will provide the basis for more informed decision making on the intentional introduction and use of alien species.

Science

Science is a critical component of any effort to address the threat of invasive alien species. Taxonomic benchmarks and expertise for the proper identification of invasive alien or native species are essential, but currently lacking in Canada, a gap that undermines Canada's biosecurity. Sufficient knowledge of the distribution, abundance, and biology of both native and invasive alien species and their potential impact on native and introduced domestic species is essential for responding to a wide range of invaders, including infectious zoonotic diseases, aquatic invasives, quarantine plant pests and noxious weeds. Research must move invasion ecology from a reactive to a predictive discipline and develop technological innovations to reduce the impacts and risks of invasive alien species. Capabilities should be improved for the science-based disciplines of ecosystem management, natural resource management and integrated pest management.

The general neglect of taxonomy in academia as well as in museums and other Canadian institutions has created a weakness in our ability to measure impact of species invasions. For example, for many invertebrate groups in all environments and regions of the country, the native flora and fauna is not fully known nor have all invasives been properly documented or in some cases clearly differentiated from native "Holarctic" species.

A coordinated invasive species science strategy is required to develop a strategic approach that contributes effectively to the prevention, detection, and management of invasive alien species. This strategy should include National Centres of Excellence and government-university research chairs, targeted funding for research and training in diagnostics and research, international cooperation to establish networks of taxonomic and research expertise, and partnerships with industry and other stakeholders to foster technical innovation and solutions. The development of a co-ordinated national network of databases containing information on the biology and distribution of native or introduced species already present in Canada, and invasive alien species not yet present or newly introduced, and their control and management is vital to provide easily accessible information for land managers and the public.

Legislation and Regulations

The use and enforcement of regulatory measures is an important component of managing the movement of invasive alien species both within and from outside Canada. Legal and regulatory roles and responsibilities will be clarified through the development of a co-ordinated legislative 'road map' that incorporates all relevant federal legislation and linkages to provincial and territorial legislation.

As appropriate, and where feasible, federal departments and agencies and their provincial and territorial counterparts will develop legal and regulatory tools and amend existing legislation and regulations to strengthen measures to prevent, detect, respond, and manage invasive alien species.

Education and Outreach

Targeted national public education initiatives will be essential for responding to key pathways of invasion where consumer choice and individual actions are drivers of invasive alien species problems in both urban and rural communities alike. Focused efforts must be complemented by broader outreach efforts, including the development of education

Elm tree with Dutch Elm Disease.

Photo Credit: Minnesota Department of Natural Resources Archives

curricula, which raise awareness of the need to prevent future introductions of invasive alien species, both intentional and unintentional. Central to this is the need to provide data and information on invasive alien species to the public, particularly travellers, in accessible formats and through readily available portals or networks.

Education and outreach initiatives should facilitate on-the-ground action through stewardship programs that involve communities directly in the management of invasive alien species. Stewardship activities will be integrated into efforts to manage priority invasive alien species in both aquatic and terrestrial ecosystems. Stewardship recognizes the shared responsibilities of governments and stakeholders, as well as the benefits of collective action. Public-private partnerships to manage invasive alien species should be encouraged.

International Co-operation

International cooperation is essential for effective prevention, detection, response, and long-term management of shared invaders. The Government of Canada is engaged in many international fora on invasive alien species, including the International Plant Protection Convention, the Office International des Epizooties, the International Maritime Organization, the Convention on Biological Diversity, as well as regional organizations and bodies. Bi-lateral cooperation with the United States and tri-lateral/regional cooperation with Mexico are international priorities for Canada. Canada must also work with other like-minded international partners to ensure that national initiatives are complemented within the international regime that governs the use and trade of alien species. As a responsible trading partner, Canada has an obligation to ensure that invasive alien species are not exported to other countries.

Priority-setting Criteria

Priority setting is critical for the development and implementation of a Policy and Management Framework for Invasive Alien Species. The following criteria are proposed to guide decisions on priorities for action across and within the strategic areas of: 1) prevention; 2) early detection; 3) rapid response; and 4) long-term management (eradication, containment, and control).

- *Compelling public objectives* are served in both the near and long term;

- *High probability of success.* Actions to address selected issues must be practical, realistic, and achievable to maintain and enhance confidence in the government's ability to respond to and prevent crises. Other jurisdictions, stakeholders, trading partners, and the international community are looking to the federal government for visible leadership;

- *Economic pressures to react*. Some policy approaches, pathways, and invasive alien species will have more significant economic benefits and costs than others, both direct and indirect. Decision-making analyses should consider both near and long term costs and benefits.

- Risk analysis indicates that the pest presents an *unacceptable risk* to the environment, economy, society, or human health unless the proposed action is undertaken.

- *Proposed action is not irreversible*. Priorities can change within moments with the detection of a new invader, and the National Plan must provide a flexible and responsive policy and management framework.

- *Funding is available* for the foreseeable duration of the proposed action. Priorities will differ in their respective requirements for ongoing or short-term funding. While some prevention activities that require legislative and regulatory changes may require ongoing funding for implementation, some management measures may achieve their intended results within a 5-year window or less.

- The proposed action is fulfils international obligations and other strategic goals

Survey of Roles and Responsibilities

Work is currently underway through the development of operational plans to identify priority actions and associated roles and responsibilities of governments and stakeholders. The following lays out a general framework for discussion.

1. Federal government

Shared responsibilities for the management of agriculture, forests, fisheries and aquaculture, and wildlife between federal and provincial governments are reflected in arrangements for the

management of invasive alien species in Canada. With key responsibilities for international import/export and inter-provincial trade, federal departments have primary roles in prevention, detection, and rapid response – in cooperation with the provinces and territories - as well as in the long-term management of established invaders. The Government of Canada is also responsible for authorizing or prohibiting intentional introductions across many sectors and uses, and for the delivery of various national certification and inspection programs. The invasive alien species issue is a horizontal one that requires a commitment to co-ordination and co-operation across most federal departments and agencies.

A suite of existing federal legislation manages invasive alien species, including the *Plant Protection Act, Health of Animals Act, Canadian Environmental Protection Act, Environmental Assessment Act, Seeds Act, Pest Control Products Act, Forestry Act, Natural Resources Act, Transportation of Dangerous Goods Act, Oceans Act, Fisheries Act, Canada Wildlife Act, Wild Animal and Plant Protection and Regulations of International and Interprovincial Trade Act, Canada National Parks Act*, and others. As noted previously, many federal legislative obligations inform and respond to international commitments including the International Plant Protection Convention, Office International des Epizooties, International Maritime Organization, Convention on Biological Diversity, World Trade Organization Agreement on Sanitary and Phytosanitary Measures, and others (Appendix 1).

Asian Long Horn Beetle.

Photo Credit: ArtToday/Photos.com

2. Provincial and Territorial Governments

As predominant landowners and managers of agriculture, forests, freshwater fisheries, and wildlife, the provinces and territories could be seen to have broad responsibilities for the *management* - eradication, containment, and control - of established and spreading invaders. Some view the provinces and territories as having important responsibilities regarding the *prevention and detection* activities in such key areas as weeds. There are also a range of economic activities and trade pathways which are under provincial and territorial jurisdiction that will have to be considered under the broad umbrella of prevention. Finally, there are already a number of examples of successful co-operative efforts between the federal departments/agencies and provinces in *rapid response* to new invaders.

Provincial and territorial governments play a significant role in authorizing/prohibiting intentional introductions of alien species on crown and private lands, a substantial portion of the national land base. Provincial, territorial and federal departments in the agriculture, forestry, wildlife, fisheries, and parks sectors must continue to work closely on invasive alien species issues.

3. Aboriginal Governments

Aboriginal peoples are impacted by invasive alien species across the country, with invasive alien weed species a primary issue of concern on some reserves. As primary land managers on reserves, First Nations have authority over forests, agriculture and wildlife. Band Councils are empowered under the *Indian Act* to make by-laws related to noxious weeds, and the protection of fish and wildlife. First Nations with delegated authority under sections 53 and 60 of the *Indian Act* have additional land management authority and can make decisions on behalf of the Minister. Those First Nations who operate under the *First Nation Land Management Act* have the authority to create their own legal environmental and land management regimes. Provincial legislation rarely applies on reserve lands. First Nation governments therefore should play a significant role in *detection, rapid response*, and *management* of invasive alien species on reserve lands. Traditional Ecological Knowledge will help contribute to detection and management.

4. Municipalities

Municipalities play an important role in the *management* of invasive alien species such as forest pests in urban environments, and control of noxious and invasive vegetation on municipal land. Municipalities have a major role in the *detection* of new introductions and the management of new and established invaders. For example, in many provinces they contribute to the enforcement of provincial weed and pest control legislation. These responsibilities may increase with amalgamations and the downloading of responsibilities by provincial governments. It is also important for municipalities to develop and apply local invasive alien species management strategies and support the activities of local organizations interested in undertaking management activities. Co-operation between municipalities and private landowners is vital for successful management activities.

5. Stakeholders

Stakeholders including industry, non-governmental organizations, academic researchers, and the general public, are all essential

players for successfully responding to the challenge of invasive alien species.

In some cases, industry is both a source of introduction of invasive alien species, as well as a sector significantly impacted by other introduced invasive species. It can be both directly and indirectly impacted, with many costs being passed to consumers in the form of higher prices for goods. Non-governmental organizations are increasingly taking action by working to manage established invaders in their own right, lobbying for increased government action, or developing public education and outreach initiatives to reach their audiences and prevent further intentional and unintentional introductions. Academic researchers conduct important research that is enhancing capacity to predict invasiveness, better understand the impacts of invasion, and create management and technical innovations to reduce risks and impacts of invaders. The general public is an essential partner in efforts to address the threat of invasive alien species, and there is much to be gained from engaging the public to ensure they are aware of how they can prevent the introduction and spread of invasive alien species. Hobbyist organisations and associations such as hunter and angler groups, boaters associations, garden clubs, horticultural societies, and aquarium clubs can influence their members to adopt practices that will reduce the introduction of invasive alien species.

Those museums in Canada that have collections- based natural history programs already provide the structure for a network of taxonomic research efforts. Most of these institutions have achieved adequate curatorial standards and provide electronic access to data. The reference collections and literature resources in these museums are a national heritage resource.

ACTION PLANS (TO BE FINALIZED SEPTEMBER 2005)

1. A Canadian Action Plan to Address the Threat of Aquatic Invasive Species
2. A Canadian Action Plan to Address the Threat of Invasive Alien Plants and Plant Pests
3. Terrestrial animals (National Wildlife Disease Strategy and a Plan to Address the intentional introductions of animals into Canada)

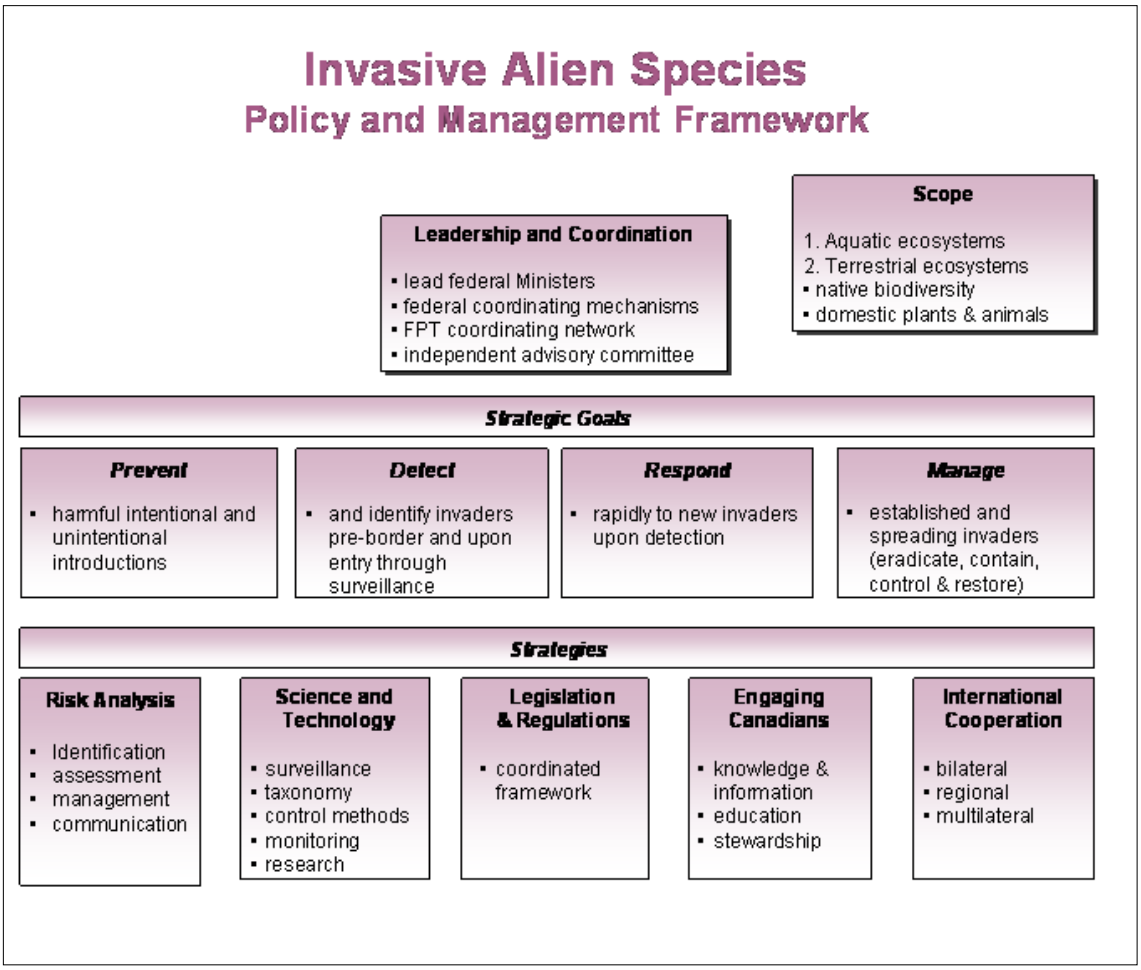
Emerald Ash Borer.

Photo Credit: Department of Agriculture, Michigan.gov.

APPENDICES – TO APPEAR IN FINAL STRATEGY

1. Policy and Management Framework
2. Important Commodities, Pathways and Vectors
3. Glossary
4. Views and Perspectives on An Invasive Alien Species Strategy for Canada

Appendix I: Policy and Management Framework



Appendix II: Important Commodities, Pathways, and Vectors

The consideration of commodities, pathways, and vectors responsible for the introduction of invasive alien species is vital for designing an effective *prevention plan.* Planned actions must therefore address the following:

Pathways of Invasion

Alien Species	Intentional Introductions [1,2]	Unintentional Introductions
Aquatic Invasive Species	**1. Production/Propagation** **a) Developed Ecosystems** [3] o Live food fish o Aquarium & aqua garden trade o Aquaculture/mariculture **b) Natural Ecosystems** o Live bait fish o Authorized stocking o Unauthorized stocking o Aquatic weed control	**2. Consumption/Processing** o Fish products (fish, shellfish, fish eggs, etc.) **3. Transportation** o Commercial shipping (ballast water management, hull fouling) o Recreation/tourism – boating, float planes o Garbage **4. Range Expansion** o Canals, dams & diversions o Natural transboundary spread
Invasive Animals & Animal Pests	**1. Production/Propagation** **a) Developed Ecosystems** [3] o Wildlife/pet trade o Game farming/ranching o Fur farming o Livestock & poultry o Vermicomposting/earthworms o Research & development o Zoos (etc.) o Apiculture/beekeeping o Malicious introductions **b) Natural Ecosystems** o Stocking (hunting, food, forestry, etc.)	**2. Consumption/Processing** o Animal products (meat, dairy, eggs, pet food, etc.) **3. Transportation** o Packing/packaging materials (containers, etc.) o Commercial shipping – containers, airplanes, boats, trains, trucks, cars o Recreation/tourism (baggage) **4. Range Expansion** o Natural transboundary spread
Invasive Plants & Plant Pests	**1. Production/Propagation** **a) Developed Ecosystems** [3] o Horticulture (ornamentals, nursery stock, bulbs, house plants, etc.) o Agriculture crops o Forestry o Biological control o Botanical gardens, butterfly farms, etc. o Research & development o Malicious introductions **b) Natural Ecosystems** o Environmental remediation o Ecosystem restoration/reclamation o Habitat enhancement (eg. shelterbelt plantings, wildlife habitat) o Bait stations for hunting (forage) o Hay/forage transport	**2. Consumption/Processing** o Plant products (seed, forage, grain, birdseed, produce (fruits & vegetables), wood products (timber, pulpwood, bamboo), garden supplies (mulch, compost), cut flowers, etc.) o Animals for production / propagation (livestock, poultry, game farming, fur farming) o Aggregate and garden materials (sand, soil, gravel) o Garbage **3. Transportation** o Solid wood packing materials o Commercial shipping – containers, airplanes, boats, trains, trucks, cars o Military equipment o Fire-fighting equipment o Recreation/tourism (baggage, camping equipment, horses, ATVs, etc.) 4**. Range Expansion** o Natural transboundary spread o Resource extraction in pristine areas

1 Note: Intentionally introduced species can also be associated with unintentionally introduced species (pests/hitch-hikers).
2 Note: Intentional introductions may be both authorized and unauthorized/illegal. Many pathways of introduction can consist of both legal and illegal introductions (e.g. pet trade, seed trade). Unauthorized introductions typically circumvent existing legal and regulatory systems, federal and/or provincial/territorial. Vectors of unauthorized introductions may include recreation/tourism (undeclared alien species hidden in baggage or vehicles), internet and mail-order (seeds), commercial shipments, and bio-terrorism.
3 Note: Developed ecosystems include landscapes managed for or modified by agriculture (crops and livestock), forestry-silviculture, aquaculture, and urban environments (including private gardens and municipal parks).

Appendix III: Glossary

Definitions

Note: The definitions below illustrate key concepts but are not intended to be definitive. While some definitions differ across sectors in regard to specific details, these definitions share common concepts and ideas.

Adaptive management – a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs (Canadian Environmental Assessment Agency, Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners)

Alien species – species of plants, animals, and micro-organisms introduced by human action outside their natural past or present distribution (based on the definition contained in the Convention on Biological Diversity Decision VI/23)

Ballast water – means water with its suspended matter taken on board a ship to control trim, list, draught, stability or stresses of the ship (International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004)

Biodiversity – variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems
(Convention on Biological Diversity, 1992)

Biosecurity – measures that are intended to prevent the introduction of invasive alien species (pests and diseases) which pose a risk to plant and animal health, ecosystems, and human health

Commodities – a type of organism, product, or other article being moved for trade or other purpose (based on the definition in the International Plant Protection Convention ISPM #05 Glossary of Phytosanitary Terms, 2002)

Containment – application of measures in and around an infested area to prevent spread of an invasive alien species beyond a defined area (for a sector-specific definition, see the International

Plant Protection Convention ISPM #05 Glossary of Phytosanitary Terms, 2002)

Ecosystem approach – a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way (Convention on Biological Diversity Decision V/6).

Endemic – 1) occurring constantly at low population levels; 2) used by zoogeographers to describe a species belonging or native to an area and occurring nowhere else (Source: http://biocontrol.ifas.ufl.edu/glossary.htm)

Eradication – application of measures to eliminate an invasive alien species from a defined area (for a sector-specific definition, see the World Organization for Animal Health (OIE) Terrestrial Animal Health Code, 2003)

Exotic species – see “alien species”

Hybrid – Offspring of two animals or plants that are of different species (Department of Fisheries and Oceans, National Code on Introductions and Transfers of Aquatic Organisms)

Intentional introduction – the deliberate movement and/or release by humans of an alien species outside its natural range

Invasive species – harmful alien organisms whose introduction or spread threatens the environment, the economy, or society (based on the definition contained in the Convention on Biological Diversity Decision VI/23)

Introduced species – see “alien species”

Noxious weed – undesirable invasive plant (weed) that is referred to as such and controlled by legislation
Pathway – the routes by which species move from one locale to another, either within a country or between countries (Global Strategy on Invasive Alien Species, 2001)

Quarantine – official confinement of regulated articles for observation and research or for further inspection, testing and/or treatment (International Plant Protection Convention ISPM #05 Glossary of Phytosanitary Terms)

Risk – the uncertainty that surrounds future events and outcomes (Treasury Board Secretariat, 2001), a function of the probability (chance, likelihood) of an adverse or unwanted event, and the

severity or magnitude of the consequences of that event (Privy Council Office, 2000)

Risk analysis – the process that includes risk identification, risk assessment, risk management and risk communication (Department of Fisheries and Oceans, National Code on Introductions and Transfers of Aquatic Organisms)

Risk assessment – the evaluation of the probability of the introduction and spread of a pest and of the associated potential economic consequences (International Plant Protection Convention ISPM #05 Glossary of Phytosanitary Terms, 2002), where economic consequences are interpreted to include environmental consequences

Risk communication – the interactive exchange of information on risk among risk assessors, risk managers and other interested parties (World Organization for Animal Health (OIE) Terrestrial Animal Health Code, 11th Edition, 2003)

Risk management – the evaluation and selection of options to reduce the risk of introduction and spread of a pest ((International Plant Protection Convention ISPM #05 Glossary of Phytosanitary Terms)

Species – A group of interbreeding organisms that differs from and are reproductively isolated from other such groups

Taxonomy – The theory and practice of describing, naming and classifying plants and animals (Source: http://www.nwfsc.noaa.gov/resources/lingo.cfm)

Unintentional introduction – all other introductions which are not intentional

Vector – the means by which species from a source populations follows a pathway to a new destination (Global Strategy on Invasive Alien Species, 2001)

Appendix IV: Views and Perspectives on An Invasive Alien Species Strategy for Canada

Information sessions on a draft Strategy to Address the Threat of Invasive Alien Species were held across Canada during the spring and summer of 2004. The draft Strategy and associated draft action plans were also posted for public review on Environment Canada's website.

The information sessions were well attended, with both government and non-government interests expressing broad support for the Strategy and associated draft action plans. Participants were well informed of invasive alien species issues within their own areas of expertise, as well as more generally across Canada. Participants provided many helpful comments and suggestions, the majority of which identified and emphasized important operational details and issues that should be addressed in each of the action plans to ensure effective implementation of the Strategy.

Highlights from the information sessions include the following:

- Consider **terrestrial invertebrates** that are not plant pests as a significant gap in the scope and coverage of Canada's existing policy, legislative, and program framework
- Consider situating IAS within the context of "**biosecurity**"
- Collaboration is essential: continue to **build new partnerships** and coalitions with all key sectors (including industries and urban and rural municipalities) while moving forward
- Confirm federal, provincial, territorial **commitment to implementation**
- **Balance who benefits and who pays** (polluter-pays approach) by developing measures to ensure that the benefits and costs of alien species are shared fairly
- Address the issue of **compensation**
- Develop a **communications plan** to disseminate the Strategy and educate Canadians on the threat of invasive alien species
- Consider **organizational and institutional changes** within governments – including fiscal mechanisms - to implement the Strategy
- Seek to maintain an appropriate **balance of actions** that address aquatic invasive species, invasive alien plants and plant pests, and invasive alien animals and wildlife diseases
- Identify the **roles, responsibilities, and accountabilities** (including associated timelines) of government and non-

governmental stakeholders throughout implementation of the Strategy and action plans

- Continue to build and **strengthen understanding** of the environmental, economic, and social impacts of invasive alien species in Canada, including understanding of their impacts on Aboriginal Peoples
- Seek to **enhance capacities** in critical areas including surveillance, inspection and enforcement, and taxonomic/diagnostic expertise