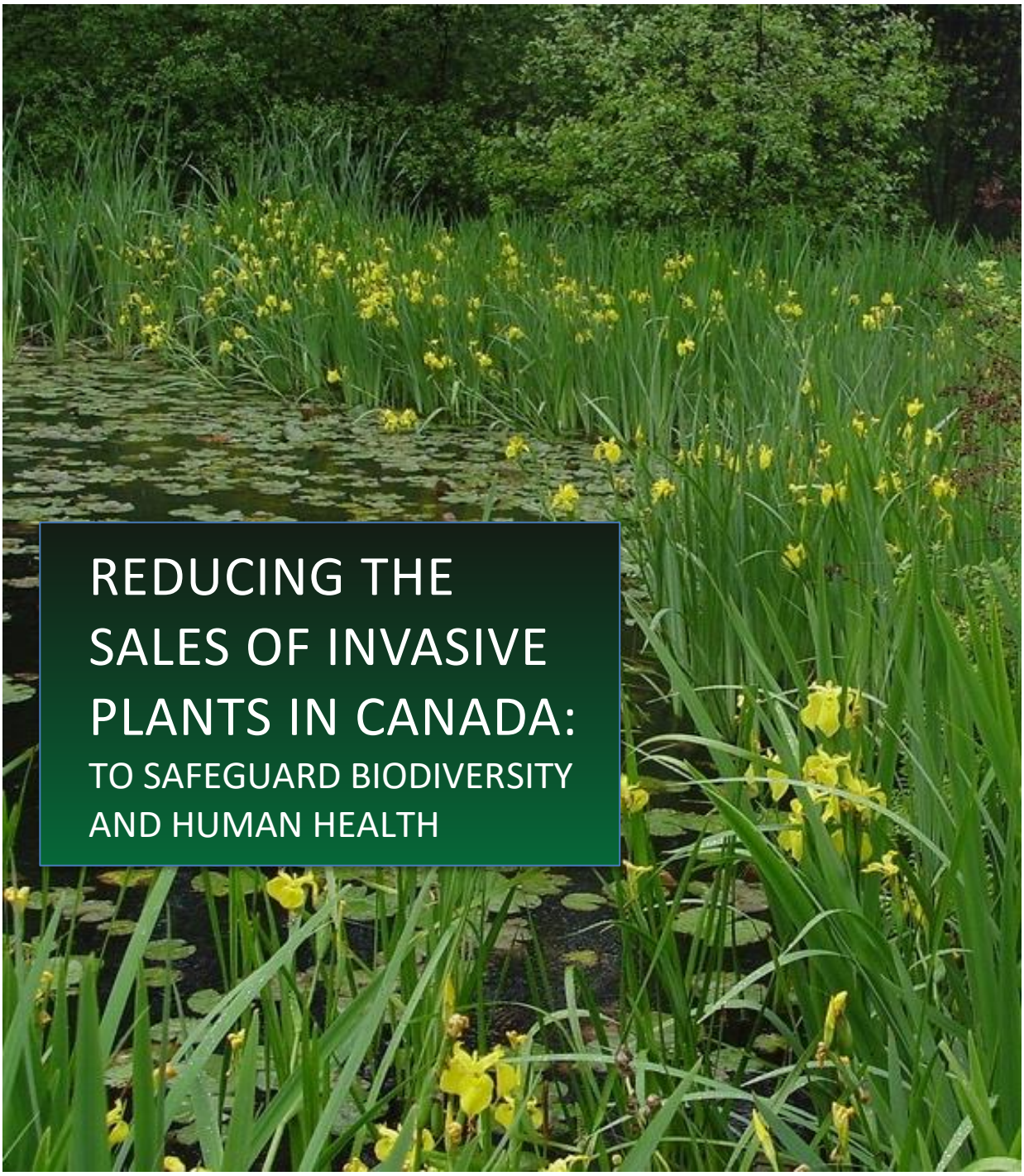

REDUCING THE SALES OF INVASIVE PLANTS IN CANADA:

TO SAFEGUARD BIODIVERSITY AND HUMAN HEALTH

Yellow flag iris (*Iris pseudacorus*). Source: Donald Cameron & the Native Plant Trust.

Prepared by Cathy Kavassalis and Claudette Sims with editorial assistance from Katherine Baird, Candi Jeronimo, Lynne Patenaude, Renee Sandelowsky, and Freyja Whitten - May 10, 2023.
On behalf of the Canadian Coalition for Invasive Plant Regulation - CCIPR.ca

EXECUTIVE SUMMARY

Invasive alien species **harm biodiversity, human health, and economies.** Canada must reduce the rate of introduction and establishment of invasive alien species by at least 50 percent by 2030, in order to protect biological diversity.[i] Biodiversity is crucial because it encompasses the entire variety of life on our planet, playing a fundamental role in supporting ecological systems that also provide essential services, including food, medicine, and economic benefits. In addition, it contributes significantly to cultural and recreational values. Preserving biodiversity is imperative for sustaining a healthy planet and ensuring the survival of all living organisms.[ii]

The number of invasive plant species in Canada is growing and will increase with climate change. The federal government needs to act NOW to reduce ever-increasing environmental damage and escalating management and mitigation costs.

The ornamental/horticultural industry is **the primary pathway** for the introduction of non-native invasive plants entering Canada. However, Canada's policies, regulatory tools, and resource allocations are inadequate to control the flow of ornamental invasive plants sold through the nursery, pet/aquarium trade or ecommerce.

To protect our environment, economy and public health from invasive plant species, the Canadian Coalition for Invasive Plant Regulation (CCIPR) believes Canada should improve policies, tools, and regulations by taking the following measures:

- Create a science-based national plant risk assessment database.
- Require that all imports of plants new to Canada undergo risk assessments.
- Ban the sale and movement of high-risk invasive plant species.
- Require point of sale labelling to educate the public about invasive plants and provide instructions to prevent their spread.
- Provide continued and stable funding for public education.
- Encourage the adoption of the National Voluntary Code of Conduct for the Ornamental Horticultural Industry as a short-term corrective measure.

Currently, federal invasive plant regulatory actions focus on safeguarding Canada's food supply and plant resources. The scope of laws used to regulate plants does not fully protect the health of the environment, humans, and other living beings. New regulatory tools are needed to minimize the adverse effects of invasive species on biodiversity and related ecosystem services, as well as human health and safety. The *European Union's regulation 1143/2014*, *New Zealand's Biosecurity Act* (1993), and *Australia's Biosecurity Act* (2015) can serve as models for change.

Canada must build its capacity to perform risk assessments and improve its ability to translate environmental concerns into economic terms to better meet obligations under the *Convention*

[i] This is Target 6 in the Kunming-Montreal Global biodiversity framework (Convention on Biological Diversity – 15th Conference of the Parties [CBD COP-15.], 2022).
[ii] World Health Organization (WHO), "Biodiversity and Health," 2015.

on Biological Diversity (CBD). Failure to value nature in monetary terms underpins the global diversity crisis.[iii] CCIPR is looking for the Federal Government to deliver on its commitments to the Convention and believe that action is urgently needed.

Lack of knowledge and resources hampers regional efforts to address the growing threats. Enhanced federal support to build knowledge is necessary for the public good, transparency, fairness, and for equity. Information about invasive plants should be shared in a central information depot. This information should be on-line and publicly available wherever possible.

CCIPR believes that improving legislation and oversight, building a knowledge base, and providing education and awareness programs can all form the basis of a successful strategy to safeguard our natural world from invasive ornamental plants. This is essential for human health and well-being, economic prosperity, as well as food safety and security.

Tree of heaven, round leaf bittersweet, pilewort, Chinese silver grass, and parrot feather are among the many taxa escaping from gardens in North America according to a recent study by a consortium of public gardens (Culley et al., 2021): Source C. Kavassalis, 2022

[iii] According to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Service (IPBES) Secretariat: "The way nature is valued in political and economic decisions is both a key driver of the global biodiversity crisis and a vital opportunity to address it" (IPBES, "Media Release: IPBES Values Assessment - Decisions Based on Narrow Set of Market Values of Nature Underpin the Global Biodiversity Crisis," 2022); "Nature underpins all economic activities and human well-being" (Organisation for Economic Co-operation and Development [OECD], "Biodiversity, Natural Capital and the Economy: A Policy Guide for Finance, Economic and Environment Ministers," 2021).

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PART 1: BACKGROUND

WHAT IS AN INVASIVE PLANT?

According to the *Invasive Alien Species Strategy for Canada* (2004), invasive alien species are those harmful alien plants, animals, and micro-organisms whose introduction or spread threatens the environment, the economy, or society, including human health.[1]

Approximately 30 percent of plants in Canada are not native and have been introduced from somewhere around the globe.[2] Many of these introduced plants, for instance most food crops, benefit Canadians and do not pose significant threats. However, those introduced plant species that cause harm or have the potential to cause harm are classified as Invasive Alien[3] Species (IAS) by the Government of Canada. The spread of these invasive species poses grave risks to biological diversity, reduces food security, impacts our quality of life, and even human health.[4] The numbers of invasive plants in Canada are increasing.[5]

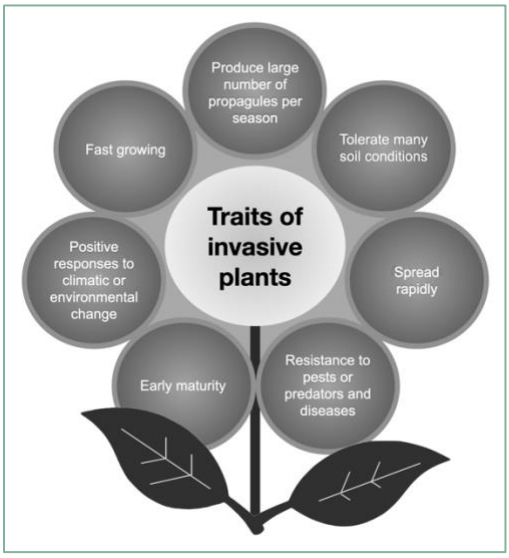

Figure 1. Traits of invasive plants. Adapted from: Ratnayake, 2014.

While the traits that make non-native invasive plants successful are diverse,[6] there are a variety of common characteristics (Figure 1). Invasive plants typically have high rates of seed production and/or spread vegetatively to form dense monocultures, crowding out native species. Some show rapid growth early in the growing season, maturing faster than more desirable plants. Some alter their invaded environment, changing soil or water chemistry, modifying nutrient cycling processes, impacting water availability, and often making the environment more receptive to invasion. Because they originated in different geographic locations, introduced plants may have few co-occurring herbivores, parasites, and/or pathogens to keep their populations in check. Finally, invasive plants that can tolerate a range of environmental and climatic conditions present the greatest risks.

The horticultural industry continues to actively search the globe for new plants that may be of interest to consumers, but they are often introduced without testing for invasive tendencies.[7] In addition, breeders seek to develop new cultivars, which are plants with desirable traits like improved hardiness. As they do so, they may inadvertently be selecting more successful invaders.[8]

PATHWAYS TO INVASION

According to Canada's Federal-Provincial-Territorial Biodiversity Working Group, "the key to dealing with invasive species is to identify the pathways of introduction - the routes they take to spread to new areas - and cut them off."[9] Studies from around the globe indicate that the ornamental/horticultural[10] pathways are **THE** primary routes for invasive plant introductions (Figure 2).[11] This has been confirmed in Canada by the Canadian Food Inspection Agency (CFIA).[12]

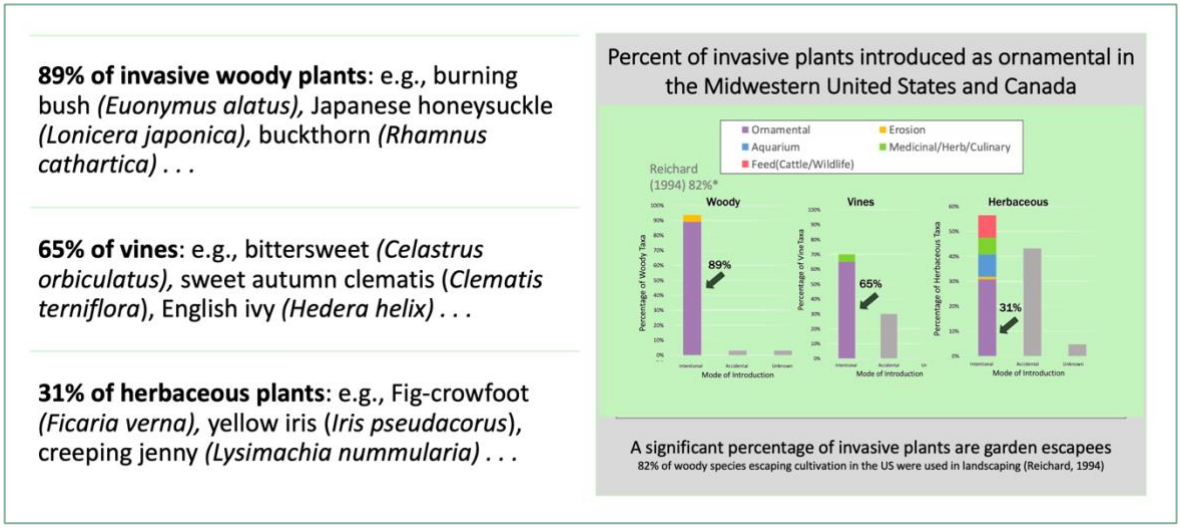

Figure 2. Gardens are the primary pathway for invasive plants. Adapted from "Update of Reichard's (1994) Review." Source: Culley et al, 2020.

Plants sold to the public can be spread intentionally when home gardeners share plants with neighbours and friends. Spreading can also be unintentional. People may discard unwanted plant material allowing it to take root in new locations. Additionally, seeds and plant parts can be spread by wind, water, birds and mammals, or hitchhike on vehicles, people, and pets (Figure 4).

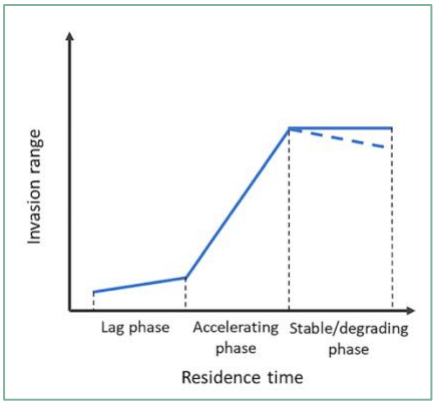

Figure 3. Three Phases of Invasion. Source: Ni, 2022.

Upon introduction, there can be a long lag time, from decades to over a century, where there is no to little spread from sites of introduction.[13] Long lag times are attributed to a variety of causes including biological traits and environmental factors.[14] This is followed by an accelerating phase as the plant quickly expands its range (Figure 3).[15]

The frequency of introduction events has a significant influence on the population expansion phase and the ultimate success of the invasion.[16] The greater the frequency of introduction events and the greater the number of plants/seeds introduced at each event, the greater the

propagule pressure, and the greater the invasion success. This is called the **Propagule Pressure Hypothesis**.[17]

Planting frequency and sales volume are all measures of propagule pressure.[18] Each time a vendor sells an invasive plant, the chances for invasion success increase. "Biological invasions can largely be considered a *numbers game*, in that the probability that a population becomes established increases with both the number of individuals and the number of introduction events."[19]

Because the impact of introduced species is not always immediate, the risks posed by plants can easily be missed by gardeners, scientists, and policymakers alike.[20] When an ornamental plant's biological traits, native biogeography, and invasion history indicate that the plant could pose significant risks, it is important to reduce propagule pressure as soon as possible to reduce long-term harm.[21]

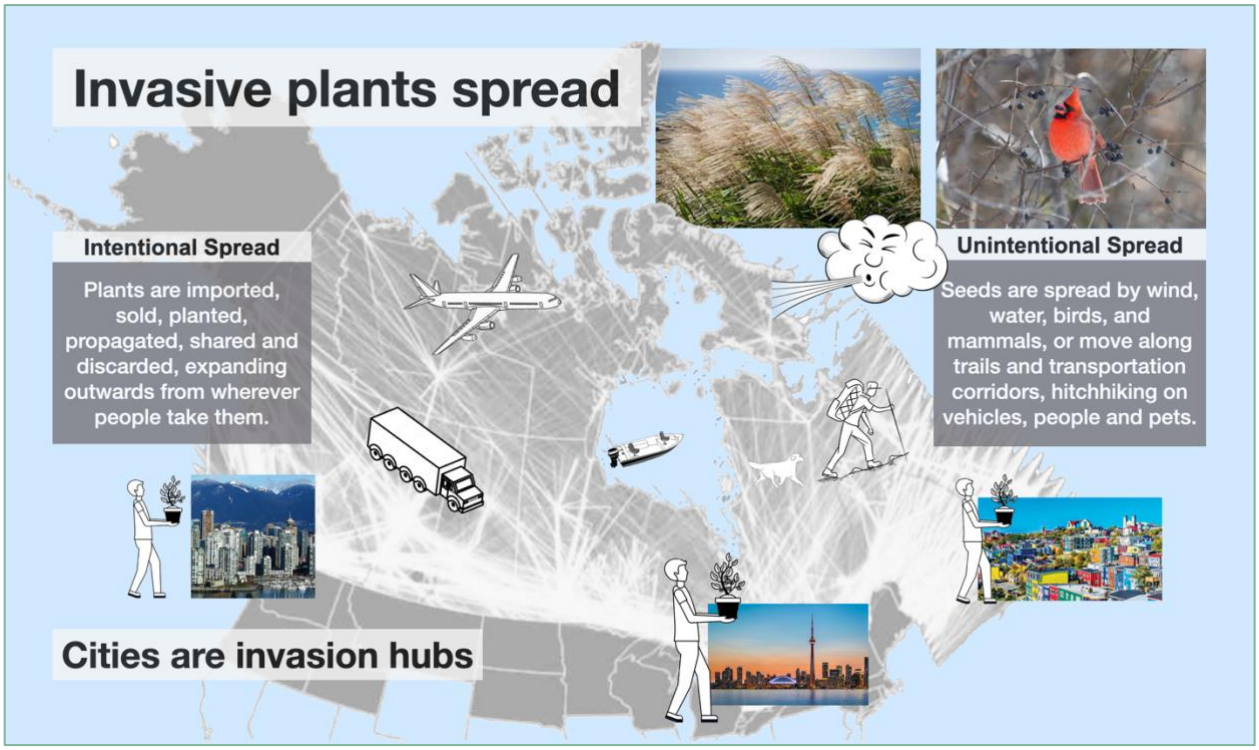

Figure 4. Intentional and unintentional pathways. Source: C. Kavassalis, 2022.

IMPACTS OF INVASIVE PLANTS

Invasive plants can have serious and long-lasting impacts, including directly threatening human health.[22] Others harm biodiversity and ecosystem[23] functions, which in turn have associated socio-economic costs and can result in cultural losses.[24] Some impacts are irreversible.[25]

Here are several examples of introduced ornamental plants known to cause harm.

- Giant hogweed (*Heracleum mantegazzianum*) can displace native understory and wetland species; contains phytotoxins that can cause severe burns on human skin.[26]

- Japanese barberry (*Berberis japonicum*) can host a rust disease that impacts grain production and threatens food security;[27] can increase the prevalence of ticks that carry Lyme disease;[28] and can alter ecosystems.[29]
- Salt cedar (*Tamarix* spp.) can lower water tables and create large deposits of salt in the soil threatening water quality and availability.[30]
- Multiflora rose (*Rosa multiflora*) can form dense thickets that threaten habitats, ecosystems and Species at Risk; can increase tick populations.[31]
- Bohemian knotweed (*Reynoutria* x *bohemica*) can damage infrastructure.[32]
- Amur honeysuckle (*Lonicera maackii*) threatens Species at Risk in Canada;[33] can cause a significant increase in mosquito populations that are vectors for West Nile. [34]
- Carolina fanwort (*Cabomba caroliniana*) produces dense mats displacing native aquatic plants; can impede recreational activities and navigation.[35]
- Norway maple (*Acer platanoides*) can alter landscapes displacing native understory plants and seedlings of iconic species like sugar maple that are part of Canada's cultural identity; can impact lifeways of Indigenous and local peoples.[36]
- Tree-of-heaven (*Ailanthus altissima*) can be a vector for pests that cause damage to crops; can produce copious pollen, aggravating allergies; and can damage ecosystems.[37]

As invasive plants spread, they damage Canada's natural assets and interfere with critical services[38] provided by healthy well-functioning natural systems. Invasive plants can do great harm by:

- Diminishing native habitats by displacing or suppressing native plant species.
- Disrupting essential food webs and impacting wildlife.
- Changing soil formation, composition, and chemistry, along with the abundance, variety, and distribution of soil organisms.
- Reducing the availability of resources, including water and nutrients.
- Impairing essential ecosystem function and services, e.g., pollination.
- Reducing genetic diversity and global biodiversity.
- Increasing hazards to human health (poisonings, allergies, dermatitis, injuries, disease – Lyme disease, West Nile virus).
- Threatening food production.
- Diminishing recreational opportunities (e.g., bird watching, hiking, camping, use of urban green spaces).
- Transforming our unique natural legacy (e.g., Indigenous cultural heritage, national parks and wildlife areas,[39] maple sugar production, beauty of Canadian landscapes).
- Negatively impacting the mental health of people who feel a sense of loss as landscapes are changed or who must deal with management issues.
- Creating an ongoing financial burden for costs of removal, control, and restoration.
- Reducing revenues in the agriculture, forestry, and fisheries sectors.
- Reducing revenues from tourism, hunting, fishing, and recreation.
- Damaging infrastructure and increasing maintenance costs (e.g., drainage systems, transportation corridors).
- Increasing risks of fire, erosion, and property damage.

While there are numerous ways that invasive plants can cause harm, the displacement of native plants and the resulting loss of biodiversity and ecosystem function are a major concern.[40] Canada is not adequately addressing these threats.[41] To accurately determine the costs to society, we must recognize the full range of potential harm they can cause. [42]

THE COSTS OF INVASIVE PLANTS

The costs of invasive plants in Canada are **massive and under-reported**.[43] Some market impacts of invasive plants have been determined (e.g., crop loss, pesticide costs, labour costs). However, the valuations of impacts on biodiversity and the benefits that nature provides to people are lacking. Understanding the costs of plant invasions to animal and human health is also critical.[44]

In the 2008 *Invasive Alien Plants in Canada Technical Report*, the Canadian Food Inspection Agency (CFIA) states that "a comprehensive, nationwide estimate of the economic impacts of invasive alien plants, and of invasive alien species in general is needed in Canada."[45] In that study, the CFIA reported yield loss and invasive plant control costs of approximately $2.2 billion annually in the agricultural sector alone. The breakdown of costs associated specifically with plants of ornamental origin is not readily available.

A broader accounting of all invasive species (animals, plants, pathogens) in Canada has been made available in the public database InvaCost, but there is insufficient data specific to invasive plants.[46] Using the available data, it has been determined that Canada has directed at least USD $12.1 billion since 1960 toward invasive plant management, with the majority expended over the last two decades.[47] The management costs across all invasive species appear to be doubling every six years.[48]

Within the provinces and territories, the costs often fall on municipalities and non-governmental stakeholders.[49] Across Canadian municipalities, recent surveys indicate that an average of $142,101 was spent on invasive species management, with plants of ornamental origin like Japanese knotweed, giant hogweed, milfoil, buckthorn, and English ivy being reported as high priority species.[50] Often small communities and local groups are forced to fundraise to mitigate invasive plant infestations.[51] Currently, such costs are not well reported[52] to provincial or federal databases and volunteer hours are not quantified.

Accounting of direct economic impacts should include the costs from a variety of stakeholders including:

- The agricultural and forestry sectors – protecting plant resources.
- The transportation sector – ensuring safe transit corridors on land and water.
- The recreation sector – maintaining attractive, safe, accessible spaces.
- The hunting and fishing sectors – safeguarding wildlife and fishing areas.
- The Canadian power and utilities sectors – responsible for removing invasive plants that could cause fire, erosion, and flooding.
- Land managers – responsible for the removal of invasive plant species from parks, green spaces, and waterways.

- Private landowners – trying to manage infested private properties.

While a price tag can be attached to the equipment or labour required to remove invasive plants, or for restoration efforts, a true costing of the impact of invasive plants would need to include an assessment of the **environmental damage**, in particular damage to **biodiversity,** as well as impacts to **public health** and to **cultural heritage**.[53]

A number of modern tools[54] exist to recognize the value of nature and nature's contributions to people.[55] For instance, the International Union for Conservation of Nature (IUNC) uses the well-reviewed Environmental Impact Classification for Alien Taxa (EICAT) to help quantify impacts to nature.[56] A more recent companion scheme to assess the impacts of invasive plants on human well-being and social structures has also been developed.[57] Canada currently does not use these risk assessment tools.

The costs of invasive species management significantly increase over time.[58] While a full accounting of the impact of invasive plants is challenging, preventing the initial introduction, and spread of invasive species will save in long-term damages, management, and restoration costs. Regulatory actions that prohibit imports or reduce propagule pressure during early phases have the greatest impact and cost savings (Figure. 5).[59]

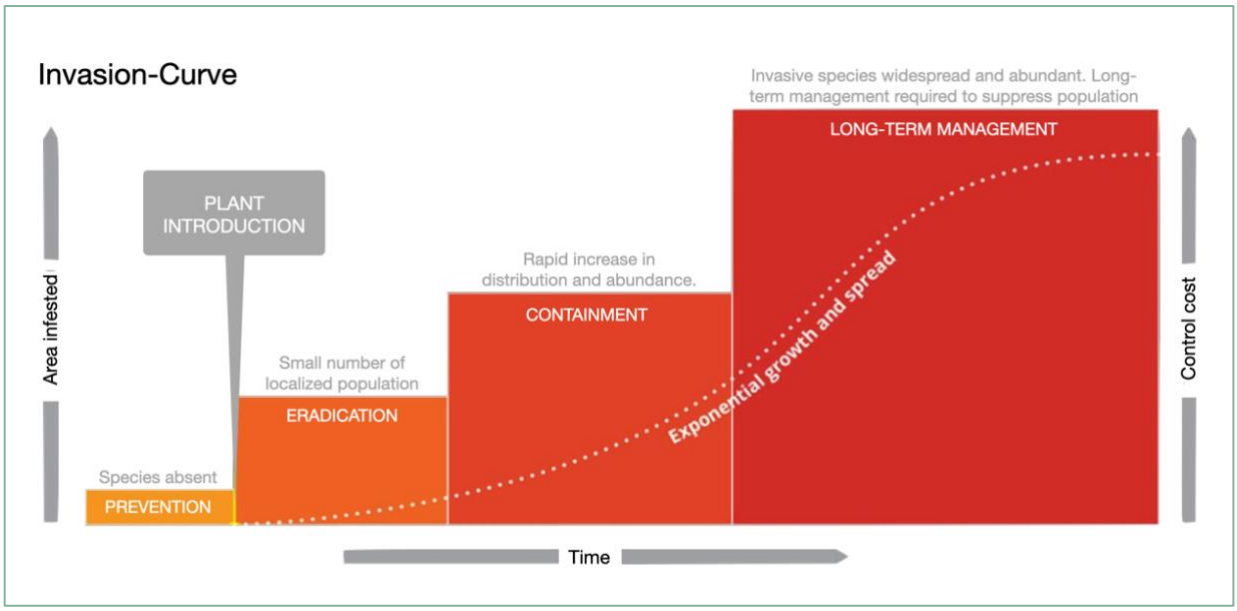

Figure 5. Invasion curve illustrating how costs rise with time and spread. Source F. Herald, 2022.

PART 2: REGULATIONS IN CANADA

WHO'S IN CHARGE?

Environment and Climate Change Canada (ECCC), whose focus is on protecting the environment, developed the *Invasive Alien Species Strategy for Canada* in 2004.[60] As the federal lead for biodiversity in Canada, the ECCC played a key role in the development of the recent Kumming-Montreal Agreement (2022) in which Canada pledged a percent reduction in the rate of introduction and establishment of invasive species. However, the ECCC does not have explicit regulatory authority over invasive plants.

The Canadian Food Inspection Agency (CFIA) has regulatory control over invasive plants, but their focus is mainly food security.[61] It is important for Canada to regulate plants that harm agriculture, but protection of the environment and human health is equally important and has not been the focus of regulation. Current policies and regulatory tools are not adequate to meet Canada's biodiversity commitments or to address all the threats posed by invasive plants.

For instance, in 2013, aquatic invasive plants in trade were identified by Fisheries and Oceans Canada (DFO) as a serious threat to waterways.[62] Shortly thereafter, DFO updated the *Fisheries Act* with *Aquatic Invasive Species Regulations* (SOR/2015-121).[63] However, plants were not included on the list or regulated species, as it was unclear who was responsible.

> 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 accountability has not been fully instituted.[64]

Over the past two decades, the CFIA has reported being hampered by a lack of legislative tools, scientific capacity, and interdepartmental policies.[65] In 2019, the Office of the Auditor General of Canada noted serious gaps in oversight of invasive species. The report recommended that the Federal Government develop a more cohesive national approach to invasive species prevention and management.[66] This echoed the recommendations of the Invasive Alien Species Task Force that called for improved federal leadership, coordination, and regulatory tools in 2017.[67]

The Federal-Provincial-Territorial Invasive Alien Species National Committee was established in 2018 to increase policy coordination and information sharing about all invasive species, but it does not track implementation of national or international targets on invasive species. It is co-chaired by Environment and Climate Change Canada, who also provides secretariat functions, but its work plan is not a public document and no further information about its plans are available on-line.[68]

Given limited federal action, the responsibility for regulation of invasive plants present in Canada is largely pushed onto various regional governments, Indigenous communities, and

non-governmental actors where resources and tools are scarce. Many regional problems have been reported.[69]

- Some jurisdictions have no regulatory systems for invasive plants.
- Several regulate invasive plants along with other noxious weeds, but there are gaps in existing regulations. Enforcement activities are infrequent and inconsistent.
- Several provinces report lack of knowledge and information (e.g., name confusion, lack of standard definitions, uncertainty about distribution and impacts).
- Some report a lack of clear legal jurisdiction.
- Most report a lack of resources.[70]

The public is not being served consistently or equitably across jurisdictions. For the public good, Canada should improve its federal biosecurity efforts to protect natural ecosystems, along with the economy and public health.[71] The Canadian Coalition for Invasive Plant Regulation (CCIPR) is looking for the Federal Government to deliver on the commitments of the 2022 *Convention on Biological Diversity* and believe that change is urgently needed.

INTERNATIONAL OBLIGATIONS

As a signatory to the *Convention on Biological Diversity*, Canada has committed to conserving biological diversity, including ecosystems, species, and genetic resources, both within its borders and beyond. Reduction of invasive plants is a critical component of Canada's obligations under that Convention. However, invasive plant regulation in Canada is largely influenced by two other international agreements, the *International Plant Protection Convention* (IPPC) and the *Agreement on the Application of Sanitary and Phytosanitary Measures* (the "SPS Agreement").

In 1951, recognizing that the spread of pests and diseases caused by the global trade of goods was an international problem, countries around the world entered into a multilateral treaty to protect plant health referred to as the *International Plant Protection Convention* (IPPC).[72] Under the IPPC, standards known as the *International Standards for Phytosanitary Measures* (ISPMs)[73] were developed to control the movement of pests, including invasive plants.

In 1995, the World Trade Organization (WTO) added a layer of complexity and set out additional constraints to ensure that the trade of goods was not unfairly restricted by plant health concerns. The WTO *SPS Agreement* "allows countries to set their own standards. But it also says regulations must be based on science. They should be applied only to the extent necessary to protect human, animal or plant life or health."[74] Signatories to the *SPS Agreement* must justify restrictions to trade in an open and transparent manner. Canada has chosen to use the internationally accepted standards (ISPMs) as the basis for pest regulation.

Adherence to these international standards has both facilitated and interfered with Canada's ability to regulate the importation and movement of plants. While the standards have helped to reduce the spread of pests internationally, the process has prioritized free trade over environmental protection. As a result, the Federal Government regulates few invasive plants.

FEDERAL LAW

The CFIA can use two federal laws to regulate invasive plants, the *Seeds Act*[75] and the *Plant Protection Ac*t.[76] The *Seeds Act* protects the quality of seed sold in Canada from weed seed contaminants. The *Plant Protection Act* can be used to prohibit the sale of plants. Neither law was intended to protect the environment or public health.[77] Additional legislative measures are required to address the broader impacts of invasive plants on the environment, biodiversity, and the health of humans and other animals.

The ornamental invasive plant, purple loosestrife, is regulated as a noxious weed under the *Seeds Act*. This Act limits the amount by weight of noxious weed seed that can be present in seed products. Regulating purple loosestrife under the *Seeds Act* has done little to stop its spread because seed contamination is not a significant pathway for its introduction.[78] Historically, the sale of the plant was responsible for its invasion success, but the sale of purple loosestrife was not prohibited federally.[79]

To prevent the sale of plants, they must be regulated under the *Plant Protection Act*.[80] That act was written "**to protect plant life and the agricultural and forestry sectors**." For instance, Japanese barberry was prohibited in Canada because it can carry a rust disease that is harmful to grain production. Cultivars resistant to the rust disease were exempted from the ban,[81] even though they pose a threat to biodiversity, and human health.[82]

Before a plant like barberry can be prohibited under the *Plant Protection Act*, it must be assessed. As part of a three-stage pest risk assessment process, the CFIA must first determine if a plant meets the basic criteria to be considered a pest under international standards.[83] Secondly, the plant must be categorized as a quarantine pest.[84] In the third and final stage, a Risk Management Document (RMD) is developed, which summarizes the findings of the pest risk assessment process and provides the justification for measures required to prevent the introduction or spread of the pest.[85]

To be a **quarantine pest**, an invasive plant must cause impacts of potential **economic importance**. The plant must either not be present in Canada, or be **limited in distribution**, and there must be **control** efforts in place.[86] Under current policy, few plants satisfy these requirements, the assessment process stops, and no risk management documents are completed. This can be confusing, so let us consider an example.

Kudzu, an invasive ornamental vine, meets the definition of a quarantine pest. According to the official Weed Risk Assessment,[87] kudzu is present in Canada, but is limited in distribution to Southwestern Ontario, where there are efforts underway to control the population. It can cause direct economic losses in industries reliant on the production of shrubs and trees. Import and sales of this plant are prohibited across Canada as that was considered the best management option.[88]

For comparison, let's go back to purple loosestrife. There have been numerous costly efforts across Canada to monitor, manage, and reduce populations of purple loosestrife.[89] Because the CFIA deemed it "widely distributed," it was not categorized as a quarantine pest. Therefore,

national measures such as a country-wide sales ban were not put in place.[90] It is regulated under the *Seeds Act*, which has done little to control its spread. Regional jurisdictions must shoulder the burden of regulating, managing, and mitigating the environmental damage caused by plants like purple loosestrife in the horticultural trades.

MISINTERPRETATIONS OF INTERNATIONAL STANDARDS

Misinterpretations of standards have hindered Canada's ability to meet invasive species targets. In 2005, the IPPC stated: "It has not been clearly understood that the **IPPC can account for environmental concerns** in economic terms. This has created issues of consistency with other agreements, including the *Convention on Biological Diversity*."[91]

According to IPCC guidelines, if an invasive plant can still spread into new areas and can cause economic loss, the plant is not "**widely distributed**." They go on to say that **environmental impacts** should be considered as part of the assessment of economic loss. Historically, the CFIA assessed economic loss separately from environmental consequences.[92] As the definition of "widely distributed" hinges on economic loss, it is important that policy aligns with this new understanding[93] and plants assessed under the former understanding should be revisited.

How would this affect the evaluation of purple loosestrife? Purple loosestrife does occur in all provinces but has potential to expand its range. If this expansion can cause significant negative environmental impacts, it should be classified as a quarantine pest.[94]

While bad press has largely removed purple loosestrife from the marketplace, similar species are on the horizon and are being actively distributed. Tree-of-heaven, yellow flag iris, and parrot feather are a few examples deserving national attention.[95] Invasive ornamental plants sold across Canada are a national problem that requires federal action.

To remedy this CCIPR believes that Canada should consistently endeavour to translate environmental concerns into economic terms.[96] The IPPC Secretariat and the Standards and Trade Development Facility have further advised parties to the IPPC and the SPS Agreement to enhance laws and policies to legally enshrine the protection of the environment and biodiversity.[97]

PART 3: RECOMMENDATIONS

RECOMMENDATIONS FOR LEGISLATIVE CHANGE

As a nation, we have pledged to reduce the rates of introduction and establishment of non-native invasive species by at least 50 percent by 2030.[98] In the past, as recently as 2015, Canada had made similar commitments to take action, but has not made any significant progress on invasive plants.[99] To achieve the current target, Canada must address the priority pathway for the introduction of invasive plants—the ornamental/horticultural highway.

This begins with the formal recognition that invasive species pose a threat to Canada's environment and human health, just as Canada recognizes that toxic substances pose a threat to Canada's environment and human health.

Through the *Canadian Environmental Protection Act* (CEPA), Canada committed to limit the introduction of pollutants and made eliminating persistent toxic substances an imperative. Under CEPA, the Federal Government has the authority to regulate and control the production, importation, and use of substances, including living organisms (animate products of biotechnology).[100] The Act requires that importers provide information on the potential risks of new substances to the environment and human health before they are allowed into Canada. The government can also use CEPA to require companies to take measures to reduce the risks associated with their products. For example, the government may require the use of a less harmful product or require the implementation of measures to prevent the release of a substance into the environment. Highly invasive species are organisms that cause long-term deleterious alterations to the environment and harm human well-being. Canada's regulatory tools and policies should reflect this understanding.

European Union (EU) member states recognized that legislative change was needed to meet their obligations under the *Convention on Biological Diversity*.[101] With the enactment of *EU regulation 1143/2014*, the EU began identifying *Invasive Alien Species of Union Concern*.[102] This legislation allows threats to biodiversity to be considered as a reason to restrict trade. Plants like oriental bittersweet, tree-of-heaven, Carolina fanwort, Himalayan balsam, and crimson fountain grass are on the growing list of species prohibited across all member states.[103] *Regulation 1143/2014* allows EU states to be in compliance with the *SPS Agreement* and meet obligations under the IPPC and *Convention on Biological Diversity*.

Other nations have drafted broader biosecurity laws. *New Zealand's Biosecurity Act 1993* provides a legal basis for excluding and eradicating unwanted organisms like invasive plants. This innovative regulation requires that **importers provide risk assessments** before any **new** non-native plants can be introduced to New Zealand.[104] Australia has enacted a similar *Biosecurity Act 2015*.[105]

Learning from these models, CCIPR believes that Canada should develop improved pre-border and post-border regulations.[106] Pre-border, Canada should require importers to provide evidence that any non-native plants, not yet present, pose **insignificant** risks to Canada's biosecurity before being introduced to the marketplace. Post-border, to reduce the escalation of costs associated with ongoing sales (propagule pressure), regulations should provide the means to **stop the sales** of invasive ornamental plants present in Canada that are of national concern.

For instance, the CFIA has recognized that tree-of-heaven is likely to harm Canada's environment, the economy, and public health. They issued an alert: "Do not plant tree-of-heaven. Consider removing tree-of-heaven from your property."[107] However, they have taken no regulatory action. This species has been prohibited across the EU, in New Zealand as well as in U.S. border states: ME, MN, NH, NY, VT, WA, WI.[108] Canada can and must do better. Federal

regulation of species like tree-of-heaven would avoid an inconsistent province-by-province approach to legislation and improve compliance.[109]

LABELLING REQUIREMENTS

Plants sold to the public are products. Canada's *Consumer Product Safety Act* (S.C. 2010, c. 21) prohibits the import and sale of products that pose a danger to human health or safety. In addition, labelling is required to inform consumers of the proper use of products. Invasive plants should be labelled to inform consumers about the potential risks they pose and should provide instructions for their proper handling.

Canada already uses labelling to drive change in the marketplace and protect the environment. The *Energy Efficiency Regulations* were introduced to reduce greenhouse gas emissions in Canada.[110] They prescribe labelling requirements (EnerGuide labels) for certain products. The goal of labelling is to accelerate the learning process by consumers and use market forces to eliminate products that have a harmful impact on our environment.[111]

A landowner in Ontario went to a nursery looking for a native tree and came home with a red maple, which they believed was native. They were aghast to learn that the 'Royal Red Maple' purchased was a cultivar of an invasive tree called Norway Maple (*Acer platanoides*) and not the locally native Red Maple (*Acer rubrum*).[112] The colourful label nowhere informed the purchaser of this distinction and the potential risks this tree posed to the local woodlands. In New York State (NYS), this tree would require an additional tag to notify the shopper so they could have made a more informed decision.[113]

> ***Acer platanoides* - NYS DEC [Department of Environmental Conservation] has deemed this plant an Invasive Species – Harmful to the Environment. Alternatives include Red Maple, Sugar Maple, Eastern Redbud, European Beech. To help prevent the spread of this regulated plant into natural areas:**
>
> - **Do not place this plant near wild or natural areas.**
> - **When possible, deadhead or remove seed debris.**
> - **Dispose of plant or plant debris responsibly.**
> - **Do not share seeds, seedlings or cuttings with other gardeners.**

Another example is plants labelled "Grown Locally." A gardener reported purchasing the yellow flag iris (*Iris pseudacorus*) marketed under this label as they understood it to mean the species was native to the area. They were frustrated to learn the plant was invasive.

Some invasive plants pose an insignificant risk to Canada's environment when grown as houseplants or kept in aquariums. However, when released into the wild, they can become significant problems. For instance, several highly invasive aquatic plants sold through the water-garden and pet/aquarium trade have infiltrated Canadian waterways causing serious and costly harm.[114]

Warning labels at point of sale would help consumers understand the risks posed by a potentially invasive plant. For instance, for a plant like Carolina fanwort (an invasive aquatic plant in Canada), the label should indicate why care is needed and clearly state:

> **Only use in aquariums, do not use outdoors, do not dispose of aquarium waste into ponds or watercourses. Keep this label with your plant.**[115]

This would help reduce future introductions and reduce costs for mitigation and restoration.

Risk assessments are the foundation of effective management and appropriate labelling programs. High-risk plants should be prohibited, or if sold "Red labelled". For species that present potential risk or some uncertainty, an "Amber" label should indicate that caution is required.[116] Labelling requirements can be one of various policy instruments integrated across the ornamental/horticultural supply chains.[117]

BUILDING RISK ASSESSMENT CAPACITY

Moving forward, Canada must improve its capacity to perform risk analyses.[118] The goal is to reduce the costs associated with the introduction and spread of harmful plant species.[119] By assessing potential risks, decision-makers can determine whether restrictions should be placed on the movement or sale of plants.

The cost of performing risk assessments should be shared with the horticultural industry. In New Zealand, when introducing new nursery stock, importers are required to pay fees on a cost-recovery basis for biosecurity advice and assessment.[120] This is a fair and effective way to ensure that the industry takes responsibility for the risks associated with introducing new plant species and varieties. Protocols for evaluating new varieties and cultivars are needed.[121]

For plants circulating in the nursery/aquarium trades, CCIPR believes the Federal Government should prioritize assessing plants with a history of doing harm.[122] Many plants used in landscaping have already been identified as risks by Fisheries and Oceans Canada, Parks Canada, and sub-national governments. Organizations like invasive plant councils have developed lists of problematic plants, both species already present and species to watch out for. Additionally, many U.S. states have begun regulating the sales of invasive plants.[123] Ornamental plants currently regulated south of our borders and those flagged in Canada should be placed on a priority list for assessment.

In addition, given climate change, it is expected that certain ornamental invasive plants may expand their range.[124] Potential "sleeper species" should be noted and carefully monitored.[125] Many of these are likely already an issue further south, Canada can use the scientific information gathered by others to help inform our prioritization.

Plants presenting potential major risks should undergo risk assessment using internationally recognized best practices. Minimum standards include:

- basic species description
- likelihood of invasion
- distribution, spread and impacts

- assessment of introduction pathways
- assessment of impacts on biodiversity and ecosystems
- assessment of impact on ecosystem services
- assessment of socio-economic impacts
- consideration of status (threatened or protected) of species or habitat under threat
- assessment of effects of future climate change
- completion possible even when there is a lack of information
- information sources
- a summary in a consistent and interpretable form
- an indication of uncertainty
- quality assurance [126]

Risk evaluations provide the critical foundation for national and/or regional regulatory actions and can be used to guide other management options, including reducing overall costs to society. During the process, effective communication with stakeholders is essential. To be most effective, information gathered in the risk assessments must be easily discoverable and accessible in one place.

A NATIONAL DATABASE

"Among the most significant risks identified in the plant health system are the information silos produced by different actors who fail to connect, or whose research remains unknown to each other without a shared information network," warned the Council of Canadian Academies.[127] CCIPR is advocating for the development of a national repository for information on invasive plants to support the activities of federal and regional governments, Indigenous communities, and non-governmental organizations (NGOs). The database would reduce duplication of efforts across Canada, ensure consistency and serve as a critical resource for jurisdictions that lack the capacity to assess invasive species risks.

The database can be built around existing systems, such as Plant Hardiness of Canada and the Database of Vascular Plants of Canada.[128] It can be initially populated with information on plant traits already compiled in various North American and global databases, along with distribution data from web-based mapping systems like EDDMapS and iMapInvasives.[129] Information can then be widely disseminated.

The many stakeholders in the ornamental/horticultural/aquarium/pet trade industries, non-governmental organizations (NGOs), government, and recreational sectors require reliable facts upon which to base decisions and actions. Industry professionals can use acquired knowledge to change production, sales, and landscaping designs. Land managers can prioritize management actions and be on the alert for potential threats. The Federal-Provincial-Territorial Invasive Alien Species Task Force called on the Federal Government in 2017 to build capacity to share information and data. Creating a national database is a **Key National Priority** along with the need for regulation of plants in trade.[130]

EDUCATION AND VOLUNTARY ACTION

The CFIA has tasked regional governments and stakeholders with the ornamental invasive plant problem.[131] They have recommended regional regulation, education, and voluntary accords with industry to prevent the propagation, sale, and distribution of invasive plants. Regional regulation has not been up to the task, leaving it to educational and voluntary initiatives.

Many hard-working invasive species councils and other NGOs are providing information to the public and working with industry leaders and public officials, to improve invasive species awareness and management.[132] Continued and stable funding is critical for the ongoing development of resources necessary for mitigating the damages caused by invasive plants. These educational efforts are vital and should be supported by appropriate point of sale labelling.

In 2019, the Canadian Council on Invasive Species released a "National code of conduct for the ornamental horticultural industry." This will not solve the problem,[133] but it does draw attention to the issue and will hopefully encourage stakeholders to begin making changes. To support the industry transition, Canada could provide recognition, incentives, or grants to those who voluntarily follow the code of conduct.[134]

CONCLUSIONS

Invasive alien species are known to have detrimental impacts on biodiversity, human health, and economies. In 2017, a Federal-Provincial-Territorial Invasive Alien Species Task Force identified key measures necessary to slow the spread of invasive species and called for Canada to improve national leadership and coordination of actions, but no tracking of progress is evident. A national, overarching inter-jurisdictional coordination mechanism for invasive species must take a consistent, fair, and just approach to the invasive plant problem.

Preventing the introduction of new invasive plants and reducing the distribution of harmful plants already present is key to protecting Canada's natural ecosystems, sustaining economic stability, and ensuring the safety and health of all Canadians. To achieve this, the Canadian Coalition for Invasive Plant Regulation is calling for an improved science-based national risk assessment system, a centralized plant database, and better regulations including the ban of sale and movement of high-risk invasive plant species. These measures are needed in conjunction with ongoing stable funding for invasive species management and research, as well as education and outreach programs including labelling requirements to raise awareness and promote responsible behavior among the public. This requires federal action.

There is strong public interest in securing a healthier future for all Canadians. Together we can move forward and better protect our land and waters, improve food security, and reduce the overall costs of invasive species by slowing the flow of invasive plants on the horticultural and ornamental pathways.

ENDNOTE

[1] Government of Canada, "An Invasive Alien Species Strategy for Canada," 2004, 1.

[2] There are approximately 3,858 species of native vascular plants in Canada and over 1,400 introduced. (Canadian Food Inspection Agency [CFIA], "Invasive alien plants in Canada: technical report," 2008a, 3). Introduced species have increased by 15% over the last decade. 555 were classified as invasive in 2019 an increase from 486 reported in 2008 (Castro, et al., "An updated status of introduced and invasive plants in Canada," 2019, 106).

[3] There is some controversy over the use of terms like "alien" and "invasive." Some argue for a more neutral terminology (e.g., Colautti & MacIsaac, "A neutral terminology to define 'invasive' species," 2004; Warren, 2007; Iannone et al., "Perspectives on the `alien' versus `native' species debate: a critique of concepts, language and practice," 2020). "Invasive alien species" is used by the federal government and international bodies. We will follow that protocol but will use the more neutral term non-native in place of alien when description is required and simply use the phrase "invasive plants" or harmful plants when speaking of non-native invasive plants.

[4] Convention on Biological Diversity COP-6 Decision VI/23, "Alien species that threaten ecosystems, habitats or species," 2002.

[5] Over the last decade, invasive plant species reported in Canada have increased by around 15% (Castro et al, 2019). The CFIA estimated that during the past century, 0.58 new invasive plant species established per year in Canada. (CFIA, 2008, 20).

[6] See for instance: Ratnayake, "Why plant species become invasive? Characters related to successful biological invasion ," 2014; Pyšek et al., "Naturalization of central European plants in North America: species traits, habitats, propagule pressure, residence time," 2015; Divíšek et al., "Similarity of introduced plant species to native ones facilitates naturalization, but differences enhance invasion success," 2018; Ni et al., "Invasion success and impacts depend on different characteristics in non-native plants," 2021.

[7] Drew, Anderson, & Andow, "Conundrums of a complex vector for invasive species control: a detailed examination of the horticultural industry," 2010, 2837.

[8] See for instance Smith et al., "Global gene flow releases invasive plants from environmental constraints on genetic diversity,"2020. Other specific examples include: Kitajima et al., "Cultivar selection prior to introduction may increase invasiveness: evidence from *Ardisia crenata*, 2006; Culley & Hardiman, "The Beginning of a New Invasive Plant: A History of the Ornamental Callery Pear in the United States," 2007.

[9] Biodivcanada, "Canada Target 11. By 2020, pathways of invasive alien species introductions are identified, and risk-based intervention or management plans are in place for priority pathways and species," 2016.

[10] Under the *Convention on Biodiversity* there are two distinct but closely connected pathways - **Ornamental and Horticultural**. It can be difficult to determine if plants initially escaped from commercial cultivation (horticultural pathway: e.g., cut/decorative flowers, medicine, plants for domestic markets, etc.), or from landscapes and gardens (ornamental pathway) (Harrower et al., "Guidance for interpretation of CBD categories on introduction pathways," 2018, 13-15).

[11] Invasive plant species enter Canada through multiple routes— land, air, and sea/water. They are introduced both **unintentionally** as contaminants of imported goods or hitchhikers (e.g., on livestock, vehicles, clothing), and **intentionally** as plants for ornamental landscaping, agricultural purposes, herbal/medical purposes, erosion control, and research, etc. However, ornamental horticulture is "the most important pathway for plant invasions world-wide" (Dehnen-Schmutz, "Determining non-invasiveness in ornamental plants to build green lists," 2011, 1374). This has been confirmed by many researchers, e.g., Reichard & White, "Horticulture as a Pathway of

Invasive Plant Introductions in the United States: Most invasive plants have been introduced for horticultural use by nurseries, botanical gardens, and individuals," 2001, 103; Environment and Climate Change Canada, 2004, 15; Dehnen-Schmutz et al., "The horticultural trade and ornamental plant invasions in Britain," 2007, 224; Niemiera & Holle, "Invasive plant species and the ornamental horticulture industry," 2009; Bradley et al., "Global change, global trade, and the next wave of plant invasions," 2012; Pergl et al., "Troubling travellers: are ecologically harmful alien species associated with particular introduction pathways?," 2017; van Kleunen et al., "The changing role of ornamental horticulture in alien plant invasions," 2018; Arianoutsou et al., "Alien plants of Europe: introduction pathways, gateways and time trends," 2021; McGrannachan et al, "A multiregional assessment of transnational pathways of introduction," 2021; European and Mediterranean Plant Protection Organization (EPPO), "EPPO activities on Invasive Alien Plants," 2021, Culley et al., "The potential role of public gardens as sentinels of plant invasion," 2022.

[12] Canadian Food Inspection Agency, 2008b, 10.

[13] This has been observed with plants like purple loosestrife (Welk, "Constraints in range predictions of invasive plant species due to non-equilibrium distribution patterns: Purple loosestrife (*Lythrum salicaria)* in North America," 2004) and Brazilian peppertree (Prince, "How long until a new species becomes invasive? Let's talk about the lag phase! ,"2022), and confirmed with a comprehensive review of herbarium records (Ni, "Herbarium records reveal multiple phases in the relationship between minimum residence time and invasion ranges of alien plant species," 2022).

[14] It should be noted that many introduced plants have historically posed little risk in Canada because they are not sufficiently hardy to overwinter. Over time, selection pressures and a changing climate can make plants with biological traits that have proven invasive in other climate zones a future risk in Canada (Bradley et al., "Breaking down barriers to consistent, climate-smart regulation of invasive plants: A case study of US Northeast states," 2022a; Bradley et al., "Invasive Species Policy Must Embrace a Changing Climate,"2022b).

[15] Ni, 2022.

[16] E.g., Rouget & Richardson, "Inferring Process from Pattern in Plant Invasions: A Semimechanistic Model Incorporating Propagule Pressure and Environmental Factors," 2004, Rejmanek et al., "Ecology of invasive plants: State of the art," 2005; Dehnen-Schmutz et al., 2007; Reichard & White, "Horticulture as a pathway of invasive plant introductions in the United States: Most invasive plants have been introduced for horticultural use by nurseries, botanical gardens, and individuals," 2001; Pyšek et al., "Planting intensity, residence time, and species traits determine invasion success of alien woody species," 2009; Ricciardi et al., "Expanding the propagule pressure concept to understand the impact of biological invasions," 2011; Maurel et al., "Introduction bias affects relationships between the characteristics of ornamental alien plants and their naturalization success," 2016; Duncan, "Time lags and the invasion debt in plant naturalisations," 2021; Block et al., "Ecological lags govern the pace and outcome of plant community responses to 21st-century climate change," 2022.

[17] Jeschke & Heger, "Propagule pressure hypothesis," 2018.

[18] "Propagule pressure is difficult to measure directly, but indirect measures have been used successfully for different species groups. For ornamental species, these include marketing time, planting frequency in a sample of gardens, volume, market frequency, and plant and seed prices . . .. (Dehnen-Schmutz, "Determining non-invasiveness in ornamental plants to build green lists," 2011, 1376). See also Downey & Glanznig, "Understanding and managing the risk of garden escapes to Australia's native flora: which future weed candidates are already here?," 2006, Pyšek et al., "Czech alien flora and the historical pattern of its formation: What came first to Central Europe?," 2003, Sullivan et al., "People and time explain the distribution of naturalized plants in New Zealand ," 2004. See Appendices: The Case of Purple Loosestrife as an example.

[19] Olden et al. "Invasive Species in Streams and Rivers," 2021.

[20] "There is considerable evidence that keeping propagule pressure low can drastically reduce establishment probability of potential invasive species (Stringham & Lockwood, "Managing propagule pressure to prevent

invasive species establishments: propagule size, number, and risk-release curve," 2021). Whereas current policies often focus solely on the species that are already recognized as invasive and the prevention of potential further invasions from new introductions, attention to non-invasive species that are already in the country and widely used may considerably advance policies for dealing with invasive ornamental species" (Dehnen-Schmutz, 2011). "[B]e aware that we're now dealing with a backlog of potential invasive plants introduced" (Bean, "Lag times in plant invasions: here today, everywhere tomorrow," 2015).

[21] See for instance: Herald, "The invasion curve explained," 2022; Mack & Erneberg, "The United States naturalized flora: largely the product of deliberate introductions," 2002; Leung et al., "An ounce of prevention or a pound of cure: bioeconomic risk analysis of invasive species," 2002.

[22] While dermatitis, allergies, and poisoning are recognized, the ability of invasive plants to serve as vectors for disease is often overlooked (Denóbile et al., "Public health implications of invasive plants: a scientometric study," 2023).

[23] An ecosystem is "a dynamic complex of plant, animal and microorganism communities and their abiotic environment interacting as a functional unit" (IPPC Secretariat, "Glossary of phytosanitary terms," 2022, 12).

[24] The impacts of invasive plants can be compounded by pollution, land use change, over-exploitation of resources, and climate change.

[25] Local extinction of native species can produce irreversible changes in the structure of communities and the composition of ecosystems. This can impact social or economic activity and may impact human health (Kendig et al., "Scanning the horizon for invasive plant threats using a data-driven approach," 2022). (Also see Bellard et al., "Looming extinctions due to invasive species: Irreversible loss of ecological strategy and evolutionary history Running title: Functional and phylogenetic extinctions due to biological invasions," 2021.)

[26] Page et al., "The Biology of Invasive Alien Plants in Canada. 4. *Heracleum mantegazzianum.* Sommier & Levier," 2006.

[27] Canadian Food Inspection Agency, "Technical reference R-004: Japanese barberry identification manual," 2013.

[28] E.g., Linske, "Lyme disease ecology: effects of habitat and hosts on the density and distribution of Borrelia burgdorferi-infected Ixodes scapularis," 2017; Ward et al., "Comparing effectiveness and Impacts of Japanese barberry (*Berberis thunbergii*) control treatments and herbivory on plant communities ," 2013; Williams et. al., "Long-term effects of *Berberis thunbergii* (*Ranunculales: Berberidaceae)* management on *Ixodes scapularis* (*Acari: Ixodidae*) abundance and *Borrelia burgdorferi* (*Spirochaetales: Spirochaetaceae*) prevalence in Connecticut, USA," 2017.; MN Dept. Ag. "Japanese barberry," 2022a.

[29] See Appendices: The Case of Barberry (*Berberis* spp.).

[30] Lindgren et al., "The Biology of Invasive Alien Plants in Canada. 11. *Tamarix ramosissima* Ledeb., *T. chinensis* Lour. and hybrids," 2008; U.S.D.A. National Invasive Species Information Center, Saltcedar, n.d..

[31] Warne, "Multiflora Rose (*Rosa multiflora*) Best Management Practices in Ontario," 2018.

[32] Invasive Species Centre, "Bohemian Knotweed (*Reynoutria x bohemica*)," 2023.

[33] Tassie & Sherman, "Invasive Honeysuckles (*Lonicera* spp.)." 2014, Ontario Invasive Plant Council.

[34] Gardner et al., "Asymmetric effects of native and exotic invasive shrubs on ecology of the West Nile virus vector *Culex pipiens* (Diptera: *Culicidae*)," 2015.

[35] Wilson et al., "The Biology of Invasive Alien Plants in Canada. 7. *Cabomba caroliniana* A. Gray," 2007.

[36] E.g., Roussy, "The sexual and vegetative propagation of sugar maple and its threat from Norway maple," 2014; Sloan, "The ecological effects of Norway Maple (*Acer platanoides)* on local plant diversity,"2010; related read: Cuerrier et al., "Cultural keystone places," 2015.

[37] Invasive Plant Atlas of the United States, "Tree-of-heaven *Ailanthus altissima* (P. Mill.) Swingle" 2018; Kron, "Tree-of-heaven is a preferred host for two invasive insect pests," 2020; CFIA, "Tree-of-heaven – Ailanthus altissima (Mill.) Swingle," 2021.

[38] As well as causing disservices, e.g., Shackleton et al., "Unpacking pandora's box: understanding and categorising ecosystem disservices for environmental management and human wellbeing," 2016; Diaz et al., "Assessing nature's contributions to people," 2018; Wu et al., "Classifying ecosystem disservices and comparing their effects with ecosystem services in Beijing, China," 2020.

[39] Most of Canada's national wildlife areas list invasive plants as a top risk (Environment and Climate Change Canada (ECCC), "Ecological integrity of national parks," 2022; Parks Canada, "Non-native plants: rooting out the invaders," 2022)

[40] Biodiversity loss represents a direct threat to Canada's well-being (IPBES, "UN Report: Nature's Dangerous Decline 'Unprecedented'; Species Extinction Rates 'Accelerating'," 2019a.

[41] Regional-scale loss and degradation of species and their habitats has been largely ignored as have meeting Aichi targets aimed at reducing invasive species (Ray et al., "The biodiversity crisis in Canada: failures and challenges of federal and sub-national strategic and legal frameworks," 2021).

[42] See for instance Smith et al., "Global gene flow releases invasive plants from environmental constraints on genetic diversity,"2020. Other specific examples include: Kitajima et al., "Cultivar selection prior to introduction may increase invasiveness: evidence from *Ardisia crenata*, 2006; Culley & Hardiman, "The Beginning of a New Invasive Plant: A History of the Ornamental Callery Pear in the United States," 2007.

[43] Haubrock, "Using the InvaCost project to infer implications of monetary impacts of invasive alien species in Canada," 2022. (In Session 1-B: "Risks, impacts, and innovative solutions." Haubrock begins at the 23min. mark).

[44] Denóbile, et al., "Public health implications of invasive plants: A scientometric Study," 2023.

[45] CFIA, 2008b.

[46] Diagne et al., "High and rising economic costs of biological invasions worldwide," 2021.

[47] Haubrock, 2022.

[48] Crystal-Ornelas et al., "Economic costs of biological invasions within North America," 2021.

[49] Non-governmental stakeholders include national organizations (e.g., Invasive Species Centre, Canadian Council on Invasive Species, Nature Conservancy, Ducks Unlimited etc.), regional groups (e.g., Coastal Invasive Species Committee, South East Alberta Watershed Alliance (SEAWA), Nature Trust of New Brunswick etc.), small community initiates like University of Waterloo Ecology Lab Buckthorn Pull, and private landowners.

[50] According to municipalities responding to provincial and national surveys put out by the Invasive Species Centre, the top five priority invasive species included Japanese knotweed (24.7%), giant hogweed (18.6%), milfoil (12.1%), buckthorn (6.5 %), common tansy (4.8%), and English ivy (3%) (Vyn, "Estimated annual expenditures on invasive species by Canadian municipalities: 2021 national survey results," 2022. P.8).

[51] For instance, to address milfoil problem in lakes, local groups have had to fundraise to pay for control programs, like the Drag and Spruce Lakes Property Owners Association in Haliburton Ontario, (DSLPOA, "Info updates - April 27/23," 2022), or the Lac Bernard Property Owners Association working with La Pêche municipality in Québec (L'agence de bassin versant des 7 [ABV des 7],"Delimitation of Eurasian watermilfoil beds at Lake Bernard, MRC des Collines-de-l'Outaouais," 2021).

[52] Efforts are hampered by lack of reporting, lack of standardised measurement, and a difficulty in placing a value on goods or services not traded in the marketplace, (e.g., Cuthbert et al., "Biological invasion costs reveal insufficient proactive management worldwide," 2022; Crystal-Ornelas et al., "Economic costs of biological invasions within North America.," 2021; Braat & Brink (Eds.), "The Cost of Policy Inaction," 2008).

[53] E.g., Australia Biological Diversity Advisory Committee, Land & Water Australia, "Making economic valuation work for biodiversity conservation," 2005; Pimental, et al., "Update on the environmental and economic costs associated with alien-invasive species in the United States," 2005; Coulatti et al., "Characterised and projected costs of nonindigenous Species in Canada," 2006; Diagne et al., "High and rising economic costs of biological invasions worldwide," 2021; Haubrock, 2022; Turbelin et al., "Introduction pathways of economically costly invasive alien species," 2022; Zenni et al., "The EPPO prioritization process for invasive alien plants," 2021.

[54] EPPO-PRI (Brunel et al., "The EPPO prioritization process for invasive alien plants," 2010), GB-NNRA (Mumford et al., "Invasive species risk assessment in Great Britain," 2010). These include questions about diverse impact types: environment, biodiversity, native species interactions, hybridization, economic losses, and human health. There are a number of well-reviewed assessment protocols: EICAT (Hawkins et al., "Framework and guidelines for implementing the proposed IUCN environmental impact classification for alien taxa (EICAT)," 2015), GISS (Nentwig et al., "A generic impact-scoring system applied to alien mammals in Europe," 2016) GABLIS (Essl et al., "Review of risk assessment systems of IAS in Europe and introducing the German–Austrian Black List Information System (GABLIS)," 2011), HARMONIA (D'hondt et al., "Harmonia+ and Pandora+: risk screening tools for potentially invasive plants, animals and their pathogens," 2015), EPPO-EIA (Kenis et al. "New protocols to assess the environmental impact of pests in the EPPO decision-support scheme for pest risk analysis*," 2012), ISEIA (Branquart et al. "ISEIA, a Belgian non-native species assessment protocol ," 2009). CEPA provides the framework for the identification, prioritization and assessment of existing substances that could be adapted for invasive plants (ECCC, "Assessment of substances under the *Canadian Environmental Protection Act*, 1999," 2022).

[55] Anderson et al., "Values assessment chapter 2: Conceptualizing the diverse values of nature and their contributions to people Intergovernmental," In: Methodological Assessment Report on the Diverse Values and Valuation of Nature of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), 2022b.

[56] The International Union for the Conservation of Nature (IUCN) is the world's oldest and largest conservation organization. Canadian Wildlife Service, Environment Canada, Fisheries and Oceans Canada are participating members (IUCN, "A unique and powerful Union," 2021). "The Environmental Impact Classification for Alien Taxa (EICAT) is the IUCN global standard for measuring the severity of environmental impacts caused by animals, fungi and plants living outside their natural range" (IUNC, "Environmental Impact Classification for Alien Taxa," 2023). The merits of this protocol are discussed by Vila et al., "A review of impact assessment protocols of non-native plants," 2019; EC Directorate-General for Environment, "Study on Invasive Alien Species – Development of risk assessments to tackle priority species and enhance prevention," 2020; and in Bernardo-Madrid et al.," Consistency in impact assessments of invasive species is generally high and depends on protocols and impact types," 2022.

[57] The Socio-Economic Impact Classification for Alien Taxa (SEICAT) framework has been developed to support the decision making process under the new EU Regulation (1143/2014) on invasive alien species (Roy et al. "Developing a framework of minimum standards for the risk assessment of alien species," 2017; Bacher et al. "Socio-economic impact classification of alien taxa (SEICAT) ," 2018).

[58] Herald, "The invasion curve explained," 2022, Australia Invasive Species Council.

[59] Leung et al. "An Ounce of Prevention Or a Pound of Cure: Bioeconomic Risk Analysis of Invasive Species," 2002; Rouget & Richardson, 2004; Burt et al., "Preventing horticultural introductions of invasive plants: Potential efficacy of voluntary initiatives," 2007; Beaury, Patrick & Bradley," Invaders for sale: the ongoing spread of invasive species by the plant trade industry," 2021; Bradley et al., "Breaking down barriers to consistent, climate-smart regulation of invasive plants: A case study of US Northeast states,"2022b.

[60] Gov. of Canada, 2004, p.39.

[61] Gov. of Canada, "Mandates and Roles of Canadian Federal Food Safety Partners," 2020. The *CFIA Act* (S.C. 1997) states the departments of Agriculture and Agri-Food, Fisheries and Oceans and Health are responsible for the costs of the agency and the Ministers of Health and Agriculture have administrative responsibilities. There is a

disconnect with the Environment and Climate Change Canada and environmental biosecurity has been a low priority.

[62] Gantz, Mandrak, & Keller, "Application of an Aquatic Plant Risk Assessment to Non-Indigenous Freshwater Plants in Trade in Canada," 2013.

[63] Gov. of Canada, Aquatic Invasive Species Regulations (SOR/2015-121). 2015.

[64] Gov. of Canada, 2004, 18.

[65] E.g., Champion, Hofstra, & Clayton, "Border control for potential aquatic weeds. Stage 3. Weed risk management," 2007. See Appendices: Case of Aquatic Plants, Case of Milfoils, Case of European Water-chestnut.

[66] Office of the Auditor General of Canada, "Report 1—Aquatic Invasive Species," 2019, 1.42.

[67] FPT IAS, "Recommendations of the Invasive Alien Species Task Force," 2017.

[68] ECCC, Personal Communication, April 2023.

[69] Environment Canada, 2004.; McClay, "Revising Alberta's Provincial Weeds List: Experiences and Lessons Learned," 2012; Bergunder et al., "Invasive Species Strategy FOR BRITISH COLUMBIA," 2017; Newfoundland and Labrador Wildlife Division, "Legislative review - invasive alien species," 2008; Reid et al., "The state of Canada's biosecurity efforts to protect biodiversity from species invasions," 2021; Council of Canadian Academies & Bennet, "Cultivating Diversity: The Expert Panel on Plant Health Risks in Canada," 2022; Pion, "Des plantes envahissantes toujours en vente libre," 2022.

[70] From the Auditor General's Report: "Conservation officers are insufficiently trained on invasive species and perform related enforcement activities infrequently and inconsistently. As of March 31, 2022, zero charges and only 11 warnings had been issued under the *Invasive Species Act*, 2015" (Office of the Auditor General of Ontario, "Value-for-Money Audit: Management of Invasive Species," 2022, p.4). See more in Appendices: Legislation in Provinces and Territories.

[71] Reid et al., "The state of Canada's biosecurity efforts to protect biodiversity from species invasions," 2021.

[72] WTO "Understanding the WTO *Agreement on Sanitary and Phytosanitary Measures*," 1998; ISPMs are non-binding guidelines for measures signatories to the Convention (IPPC) can take to limit the risks of pest introduction. With the introduction of the binding *SPS Agreement*, Canada elected to use ISPMs as the international standard (IPPC, "Adopted Standards (ISPMs)," 2022; IPPC, "IPPC and International Trade," n.d.; WTO, "Sanitary and Phytosanitary Measures: text of the agreement," 1995).

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[74] The *SPS Agreement* (WTO, 1998; 2010; 2022).

[75] See Appendices: *Seeds Act* for more complete description.

[76] *Plant Protection Act* (S.C. 1990, c. 22) – "An Act is to protect plant life and the agricultural and forestry sectors of the Canadian economy by preventing the importation, exportation and spread of pests and by controlling or eradicating pests in Canada."

[77] Canada's *Plant Protection Act* applies to the protection of plants. By contrast the U.S. *Plant Protection Act* has a broader scope and applies to the protection of the agriculture, environment, and economy of the United States (Pest Risk Analysis and Invasive Species Panels of the North American Plant Protection Organization, "DD 02: DD 03: The Role of the NAPPO in Addressing Invasive Alien Species," 2011).

[78] This species is present in BC, AB, SK, MB, ON, QC, NB, NS, PE and NF. In monitoring conducted between 2001 and 2007, one sample in 2001 was found to contain *L. salicaria*. *L. salicaria* has been regulated as a weed in Canada

since 2005 when it was added to the [*Weed Seeds Order*] WSO as a Primary Noxious weed" (CFIA, "6.0 Proposed Species Placement and Rationales," 2013f).

[79] See Appendices: The Case of Purple Loosestrife.

[80] Plants regulated under the *Plant Protection Act* are published in a Guidance Document Repository along with all pests (insects, molluscs, viruses etc.). As of May 2023, there were 30 regulated taxa of 412 listed in the Weed Risk Analysis Documents. Only 26 Risk Management Documents (RMDs) have been prepared (CFIA, "Weed risk management documents," 2021b). Most species are regulated under directive *D-12-01*. Another group of plants, which are host to rust diseases, are regulated under directive, *D-01-04*. A complete list of species regulated under the *Plant Protection Act* is presented in a database, 2022. There is an older *Consolidated list of Federally Regulated Plants* available (2016), which includes Noxious Weeds (including non-regulated quarantine pests).

[81] Cultivars are varieties of plants that have been produced in cultivation by selective breeding. Japanese barberry (*Berberis japonica*) cultivars sold in Canada include: 'Aurea Nana,' 'Bailgreen' (Jade Carousel®), 'Bailone' (Ruby Carousel®), 'Concorde,' 'Gentry' (Royal Burgundy®), 'Monlers' (Golden Nugget™), 'Monomb' (Cherry Bomb®), 'Monry' (Sunsation®), 'Rose Glow,' 'Royal Cloak,' and 'Tara' (Emerald Carousel®) (See: CFIA, "Technical reference R-004: Japanese Barberry Identification Manual," 2013a; CFIA, "Plant Protection Regulations (SOR/95-212) Prohibited Movement Within Canada," 2022d).

[82] See Appendices: Case of Japanese barberry.

[83] Three stages: initiation, pest risk assessment and pest risk management are described in ISPM-11 (IPPC, "Pest risk analysis for quarantine pests,"2021).

[84] QUARANTINE PEST: A pest of potential **economic importance** to the area endangered thereby and not yet present there, or present but **not widely distributed** and **being officially controlled** [FAO, 1990; revised FAO, 1995; IPPC 1997] (ISPM-5, "Glossary of phytosanitary terms," 2023c).

[85] Some "Pest Risk Management Documents" can be found here: CFIA 2019. However others, like RMD-10-11 for *Pueraria montana* (kudzu) must be requested, (though it is available from Richters, 2010).

[86] ISPM-5, 2023c.

[87] There was no RMD available in the CFIA online management documents, but a RMD-10-11 (Consultation) Pest Risk Management Document for *Pueraria montana* (kudzu) in Canada is available at Richters, 2010.

[88] CFIA, "List of pests regulated by Canada," 2016.

[89] Loosestrife is a prohibited plant in Alberta (AB Provincially Regulated Weeds, 2023) and Prince Edward Island (PEI *Weed Control Act Purple Loosestrife Control Regulations*, 2004). It is a Noxious Weed in British Columbia (BC Reg. 143/2011). It is regulated as an aquatic invasive plant in Manitoba (MB Water Protection Act C.C.S.M. c. W65). Control efforts are in place in Ontario (e.g., Louis, Stastny & Sargent, "The impacts of biological control on the performance of *Lythrum salicaria* 20 years post-release," 2020). Control projects in Alberta, Saskatchewan and Ontario cost $210,000 (Colautti et al., "Characterised and Projected Costs of Nonindigenous Species in Canada," 2006). In the U.S., loosestrife "has been spreading at a rate of 115,000 ha/year and is changing the basic structure of most of the wetlands it has invaded . . .. Competitive stands of purple loosestrife have reduced the biomass of 44 native plants and endangered wildlife, like the bog turtle and several duck species, that depend on these native plants" (Pimental, Zuniga, & Morrison, "Update on the environmental and economic costs associated with alien-invasive species in the United States," 2004, 275).

[90] From A. Blain, Plant Health Risk Assessor – Botany, CFIA email communication, Jan 11, 2023. "We have not done a formal pest risk analysis on purple loosestrife. The reason for this is that it would not have qualified as a quarantine pest since this plant is already well established and widely distributed in Canada. For the same reason, this plant cannot be prohibited under the *Plant Protection Act*."

[91] "The scope of the Convention applies to the protection of wild flora resulting in an important contribution to the conservation of biological diversity. However, it has been misinterpreted that the IPPC is only commercially focused and limited in scope" (ISPM-5, 2005, 27; restated in ISPM-5, 2023c, 27).

[92] Eight regulated species were identified as mainly environmental risks including kudzu (*Pueraria montana*). The rest were potential agricultural pests (CFIA, "Weed risk management documents," 2021). Regional Standards for determining "Economic Impacts" were developed by the North American Plant Protection Organization (NAPPO, "NAPPO Regional Standards for Phytosanitary Measures (RSPM)," 2008). Economic impacts were considered separately from environmental impacts. The Pest Risk Analysis and Invasive Species Panels (PRA-ISP) of the NAPPO discussion document describes "The role of the North American plant protection organization in addressing invasive alien species" (2011). The regional "Pest risk assessment for plants for planting as quarantine pests" standard has been superseded by ISPM 11 (NAPPO, "Regional Standards," 2023).

[93] Reid et al., "The state of Canada's biosecurity efforts to protect biodiversity from species invasions," 2021.

[94] Purple loosestrife is not yet present in the territories (CFIA, "6.0 Proposed Species Placement and Rationales," 2013f). According to the CFIA, purple loosestrife is a Primary Noxious Weed and therefore has not reached its potential ecological range (CFIA, "3.0 Weed Seeds Order Definitions," 2013b; Canadian distribution study (Lindgren & Walker, "Predicting the Spread of Purple Loosestrife (*Lythrum salicaria*) in the Prairies," 2012). This suggests it could be considered as a potential quarantine pest. Classification as a quarantine pest does not mean regulation would follow. It simply means that an RMD should be developed, and management options formally considered.

[95] See Appendices: Case of Tree-of-heaven, Case of Yellow flag Iris; Case of Milfoils.

[96] Food and Agricultural Organisation (FAO) International Sanitary and Phytosanitary Measures (ISPMs) Glossary: ISPM-5, 2023c pp. 27-30.

[97] IPPC, ISPMs, 2005; STDF, "International Trade and Invasive Alien Species," 2013, 9; Secretariat of the UN CBD (SCBD), "Strategic Plan for Biodiversity 2011–2020 and the Aichi Targets,"2010.

[98] Target 6 of the historic Kunming-Montreal Global Biodiversity Framework (agreed at the 15th meeting of the Conference of Parties to the UN Convention on Biological Diversity (SCBD, "A New Global Framework for Managing Nature Through 2030," 2022; Target 6, CBD COP-15, 2022).

[99] In 2015, Canada set Target 11 "By 2020, pathways of invasive alien species introductions are identified, and risk-based intervention or management plans are in place for priority pathways and species," (Gov. of Canada, "Biodiversity Goals and Targets for Canada," 2015). However, regulations to limit invasive plant introductions through the ornamental/horticultural pathway have not been put in place.

[100] ECCC, "Guidelines for the Notification and Testing of New Substances: Organisms," 2010 modified 2022; (*Canadian Environmental Protection Act*, 1999, S.C. 1999, c. 33; Gov. of Canada, *Canadian Environmental Protection Act*, 1999 (S.C. 1999, c. 33), 1999; "Understanding the *Canadian Environmental Protection Act*, 2022.

[101] The EU regulation was proposed in light of Target 5 of the EU 2020 Biodiversity Strategy (2011). The EU Target 5 like Canada's Target 11 set out in the 2020 Biodiversity Goals & Targets for Canada (Environment and Climate Change, 2016) required that risk-based intervention be put in place for priority pathways, like the ornamental/horticultural trades.

[102] The *Invasive Alien Species Regulation (Regulation (EU) No 1143/2014* of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species) aims to address the negative impact of non-native invasive species on biodiversity and ecosystem services (European Commission [EC], "Invasive alien species," 2023). In addition EU member countries are able to create their own regional lists (Brundu et al., "Managing plant invasions using legislation tools: an analysis of the national and regional regulations for non-native plants in Italy," 2020).

[103] European Commission (EC), Invasive alien species, 2022. There were 41 species of plants of Union concern as of May 2023.

[104] New Zealand Ministry for Primary Industries, "Importing plants, flowers, seeds, and plant-growing products," n.d.; Hulme et al, "Plant invasions in New Zealand: global lessons in prevention, eradication and control." 2020.

[105] The *Biosecurity Act*, Australia Dept. of Agric., Fisheries, & Forestry, 2021. The provision that deals with the import of plants is the *Biosecurity (Conditionally Non-prohibited Goods) Determination 2021* which replaced the previous *Quarantine Proclamation* 1998.

[106] Import regulations should also require that cultivars of plants, present in Canada, but known to be invasive be assessed before permitted introduction (e.g., Grice et al., "Tackling Contentious Invasive Plant Species: A Case Study of Buffel Grass in Australia," 2011).

[107] CFIA, "Tree-of-heaven – *Ailanthus altissima* (Mill.) Swingle," 2021a.

[108] Learn more about the U.S. regulatory process in the Appendices.

[109] This argument was given to justify the national prohibition for Giant Reed (*Arundo donax*), (CFIA, "RMD-16-02: Pest Risk Management Document for *Arundo donax* (giant reed) in Canada," 2017).

[110] Energy Efficiency Regulations, 2016 (SOR/2016-311) were introduced in 1995 under the *Energy Efficiency Act.* Certain products require EnerGuide labels to indicate how much electricity an appliance will use in a year. Natural Resources Canada also administers the *ENERGY STAR®* labelling program to clearly identify the preferred energy efficient products on the market.

[111] Government of Canada, "Canada Gazette, Part I, Volume 150, Number 18: Energy Efficiency Regulations, 2016: Regulatory impact analysis statement," 2016.

[112] Master Gardeners of Ontario Facebook Group, August 21 Post, 2022.

[113] While New York allows the sale of Norway maple with labelling, other states like Maine, New Hampshire and Vermont prohibit all sales. NYS labelling requirements are described here: "Invasive species regulations," n.d.

[114] Many research studies indicate water garden and aquarium trades are a primary source of aquatic invasive species in Canada, e.g., Marson et al., "Summary of a Survey of Aquarium Owners in Canada," 2009a; "Summary of a Survey of Water Garden Owners in Canada," 2009b; Azan, "Invasive aquatic plants and the aquarium and ornamental pond industries," 2011; Azan et al., "Invasive aquatic plants in the aquarium and ornamental pond industries: A risk assessment for southern Ontario (Canada)," 2015; Gordon et al., "Weed Risk Assessment for Aquatic Plants: Modification of a New Zealand System for the United States," 2012. See Appendices: Aquatic Invasive Species – flowing through a gap.

[115] Kelly, "Horticulture Code of Good Practice," 2012.

[116] The precautionary approach is in the preamble of the *Canadian Environment Protection Act* 1999 (Dept. of Justice, 2023) echoing the preambular text to the Convention on Biological Diversity (CBD, 1992). "*Where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat"* (Principle 15 of the *Rio Declaration on Environment and Development,* 1992). This principle has been fundamental in subsequent decisions (e.g., Decision II/10, COP-2. 1995; Decision V/6, COP-6, 2002; Decision VII/12, COP-7, 2004).

[117] Point of sale labelling can be an effective approach (Hulme et al., "Integrating invasive species policies across ornamental horticulture supply chains to prevent plant invasions," 2017; Hulme, "Plant invasions in New Zealand: global lessons in prevention, eradication and control," 2020).

[118] Under CEPA, Canada has performed thousands of risk assessments. Over 23,000 chemicals existing in Canada when CEPA was enacted in 1999 have been screened and 4,300 assessed. Canada should evaluate the 1,250 existing introduced vascular plants and prioritize potential invasion risks for formal assessment. See in Appendices: "The *Canadian Environmental Protection Act* as a Model for Invasive Plant Regulation."

[119] Bioeconomic analyses demonstrate risk management programs drive overall increases in ecosystem services and human well-being and are cost effective over the long-term (Lodge et al., "Risk analysis of species invasions links biology and economics," 2016, 463' Keller, Lodge, & Finnoff, "Risk Assessment for Invasive Species Produces

Net Bioeconomic Benefits," 2007). Note that the **bioeconomy** refers to production, utilization, conservation, and regeneration of biological resources within and across all economic sectors (Global Bioeconomy Summit Communiqué, "Expanding the Sustainable Bioeconomy – Vision and Way Forward. Communiqué of the Global Bioeconomy Summit 2020," 2020).

[120] New Zealand Ministry for Primary Industries, "Fees and charges when importing nursery stock," (2020).

[121] Datta et al., "Identifying safe cultivars of invasive plants: six questions for risk assessment, management, and communication," 2020.

[122] E.g., Brunel et al., "PM5/6(1) EPPO Prioritization process for invasive alien plants," 2010; Branquart et al., "A prioritization process for invasive alien plant species incorporating the requirements of EU Regulation no. 1143/2014," 2016; Rockwell-Postel, Bradley, & Laginhas, "Supporting proactive management in the context of climate change: Prioritizing range-shifting invasive plants based on impact," 2020.

[123] See Appendices: U.S. Regulations.

[124] E.g., Bradley, Wilcove, & Oppenheimer, "Climate change increases risk of plant invasion in the Eastern United States," 2011; Bradley et al., "Breaking down barriers to consistent, climate-smart regulation of invasive plants: A case study of US Northeast states," 2022b; Sun et al., "Addressing Climate Change: What Can Plant Invasion Science and Weed Science Learn From Each Other?," 2021; Meyerson et al., "Moving Toward Global Strategies for Managing Invasive Alien Species," 2022.

[125] Sleeper species are non-native species already present in an ecosystem that have potential to be invasive, but are limited by factors such as climate or other species (Invasive Species Centre, "Invasive species in a changing climate," 2023). Regional Invasive Species & Climate Change Management Networks (RISCCs) are assessing invasive plants given climate change, e.g., Northeast News: "Management Challenge - Do Not Sell! Ornamental Plants to Avoid with Climate Change;" "Sleeper Species coffee talk recording - Sept 13, 2022," 2023. See also: Rockwell-Postel, Bradley & Laginhas, 2020; Lopez et al., "Invasive Species Policy Must Embrace a Changing Climate," 2022; Beaury, Bradley, & Patrick, 2021.

[126] This framework was developed by Roy et al., (2017) to meet requirements of the *EU Regulation on IAS (1143/2014)* and international agreements including the SPS, CBD and IPPC.

[127] Council of Canadian Academies, & Bennett, "Cultivating Diversity: The Expert Panel on Plant Health Risks in Canada," 2022, xxiii.

[128] Plant Hardiness of Canada has been developed by Natural Resources Canada, 2022. Other systems like VASCAN (Brouillet et al., 2010+) has been developed at the Université de Montréal. Other taxonomy and nomenclature databases include: World Flora Online; Integrated Taxonomic Information System (ITIS); International Plant Names Index (IPNI), Global Biodiversity Information Facility (GRIF); The Germplasm Resources Information Network (GRIN); Index *Nominum Genericorum* (ING); the Index *Nominum Supragenericorum Plantarum Vascularium*; International Cultivar Registration Authority (ICRA).

[129] Many researchers have identified key traits of invasive plants, e.g., "TRY, a global database for plant traits," (Kattge et al., 2011). Global Biodiversity Information Facility (GBIF) has been up and down over the years but is one of the international databases that has been created to track invasive plants. From the U.S. government: the U.S. National Invasive Species Information Center Databases (2022), the U.S. Register of Introduced and Invasive Species (US-RIIS), the U.S. Dept of the Interior, NAS - Nonindigenous Aquatic Species (n.d.). and USDA PLANTS Database (2023) are all examples of systems under development. There are additional databases like the Invasive Plant Atlas, which provides information on over 1000 invasive plants, 2018. The Ontario Natural Heritage Information Centre (NHIC) and the NatureServe evaluate species and plant communities and assign conservation status ranks. A national system that provided this information and included invasive status as well would be most helpful (NHIC, "Natural heritage methodology," 2021). NatureServe developed an Invasive Species Impact Rank system (e.g., NatureServe, "Data Types: Invasive Species Impact Rank" n.d.a; NatureServe, "Tools for Understanding Impacts to Biodiversity," n.d.b; Morse, et al., "An Invasive Species Assessment Protocol," 2004;

Randall, et al., "The Invasive Species Assessment Protocol," 2008). INaturalist has several programs on invasive plants and is interfacing with iMapInvasives, a web-based mapping system for documenting invasive species distribution (n.d.; 2023). EDDsMaps performs a similar service 2023.

[130] Federal-Provincial-Territorial Invasive Alien Species Task Force (FPT IAS), "Recommendations of the Invasive Alien Species Task Force," 2017.

[131] Based on a series of federal, provincial, and territorial workshops, the CFIA developed a *Canadian Invasive Plant Framework* (Lindgren, 2012), which outlines the roles of various levels of government. This underpinned the CFIA's "Invasive Plant Policy," 2012.

[132] Canadian Council on Invasive Species (CCIS); Alberta Invasive Species Council (AB ISC); British Columbia Invasive Species Council (BC ISC); Manitoba Invasive Species Council (MB ISC); New Brunswick Council of Invasive Species (NBALA); Nova Scotia Invasive Species Council (NS ISC); ON Invasive Plant Council (OIPC); Prince Edward Island Invasive Species Council (PEI ISC); Saskatchewan Invasive Species Council (SK ISC); Yukon Invasive Species Council (YISC). There are many additional NGOs like the Invasive Species Centre (ISC) working to prevent and reduce the spread of invasive plants.

[133] Government-industry agreements and verifiable, industry codes of conducts have been recommended (e.g., Hulme et al. "Integrating invasive species policies across ornamental horticulture supply-chains to prevent plant invasions," 2017), but there is little evidence these are effective (e.g., Abbott & Snidal, "Hard and Soft Law in International Governance," 2000; Dietz et al., "Is private sustainability governance a myth? Evaluating major sustainability certifications in primary production: A mixed methods meta-study," 2022; Miteva, "Beyond the traditional: Voluntary market-based initiatives to promote land tenure security," 2021). For instance, voluntary forestry certification has declined over the past five years (Natural Resources Canada, "The State of Canada's forests: Annual report 2017," 2017; "The State of Canada's forests: Annual report 2022," 2022).

[134] The 'polluter pays' principle could be applied. Those who sell harmful plants should bear the costs of managing the damage caused, with proceeds funding management and restoration (e.g., Perrings, et al., "How to manage biological invasions under globalization," 2005; Tollington, et al., "Making the EU legislation on invasive species a conservations," 2015; Johnson, "Why the polluter pays principle is not a policy panacea for weedy but commercially valuable plant species either," 2016).