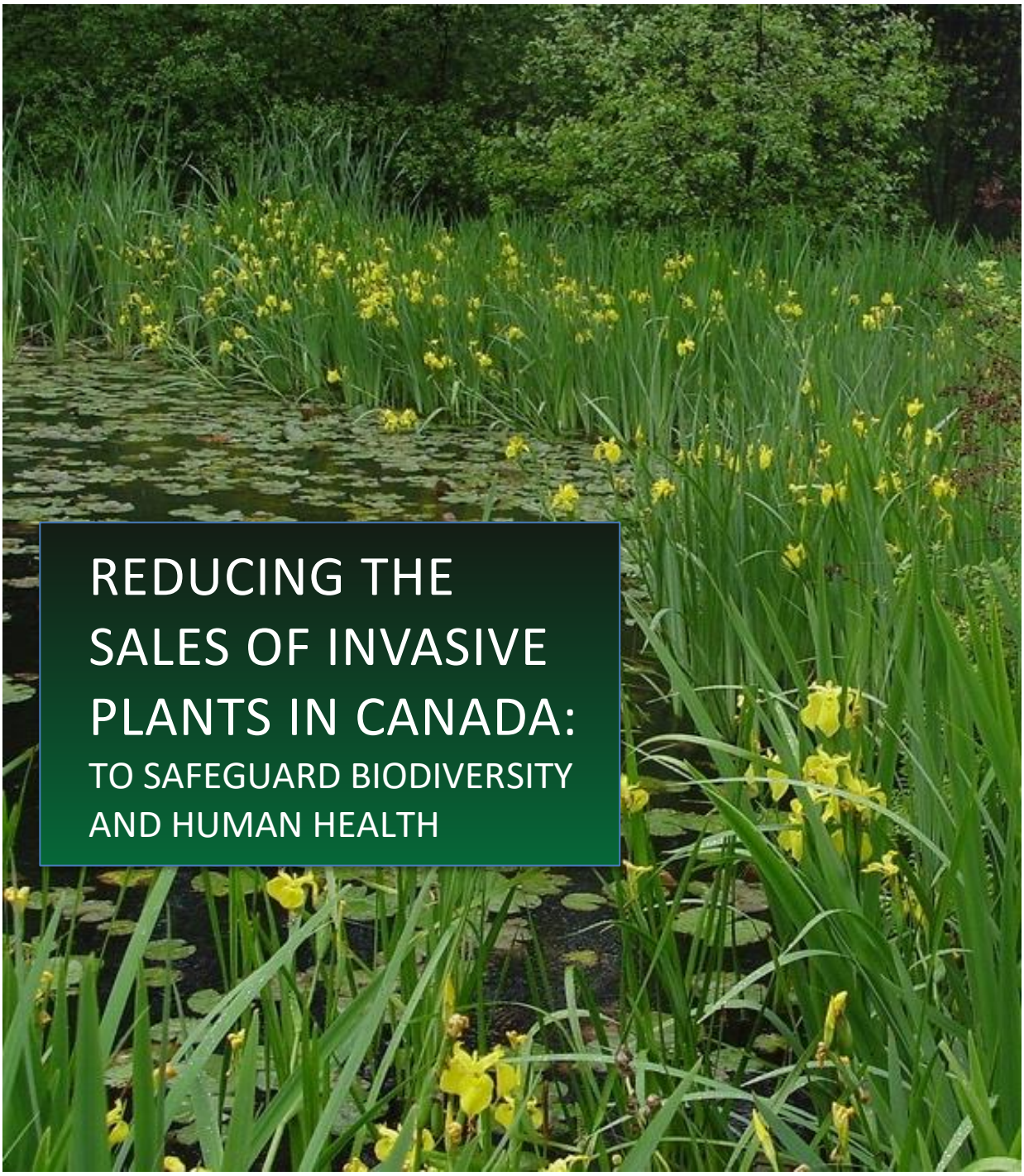

REDUCING THE SALES OF INVASIVE PLANTS IN CANADA:

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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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]

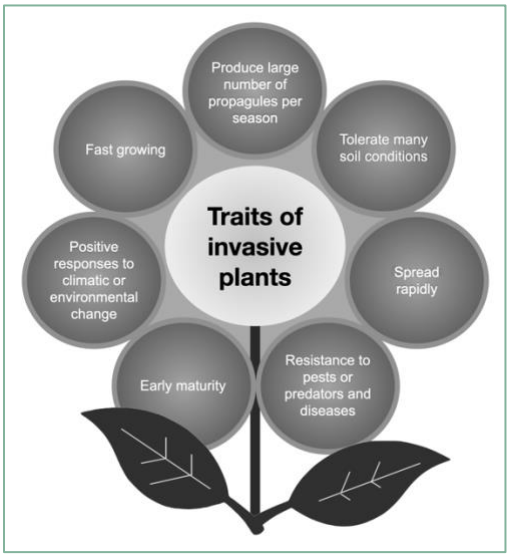

Figure 1. Traits of invasive plants. Adapted from: Ratnayake, 2014.

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]

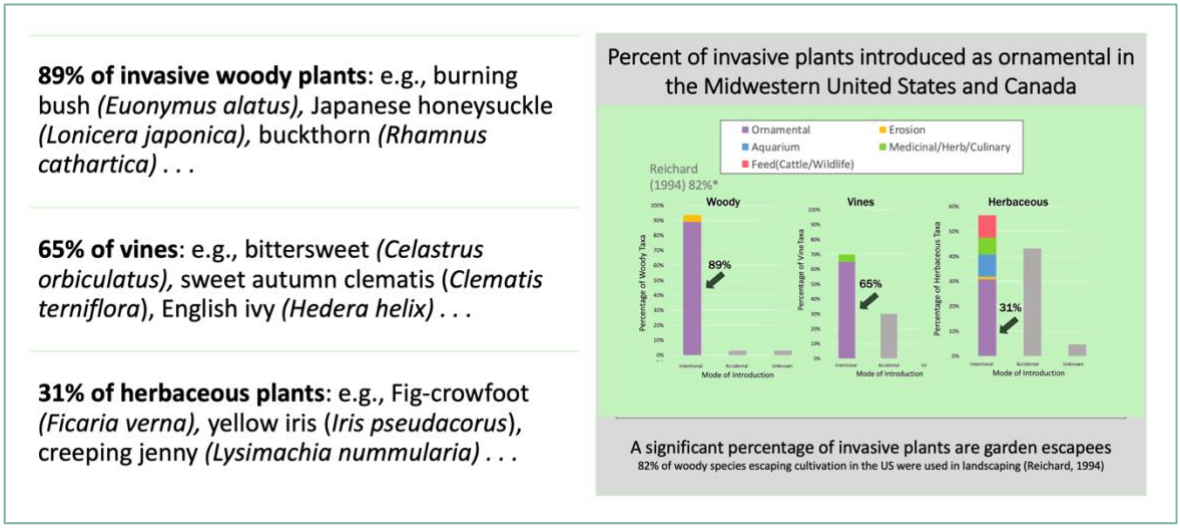

Figure 2. Gardens are the primary pathway for invasive plants. Adapted from "Update of Reichard's (1994) Review." Source: Culley et al, 2020.

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).

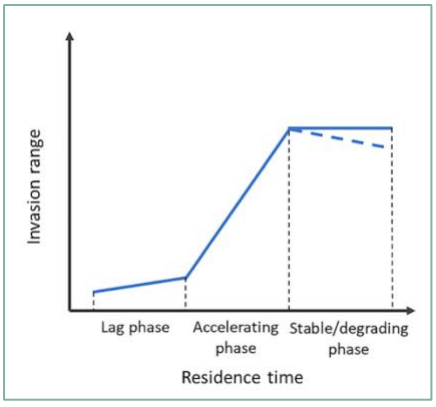

Figure 3. Three Phases of Invasion. Source: Ni, 2022.

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]

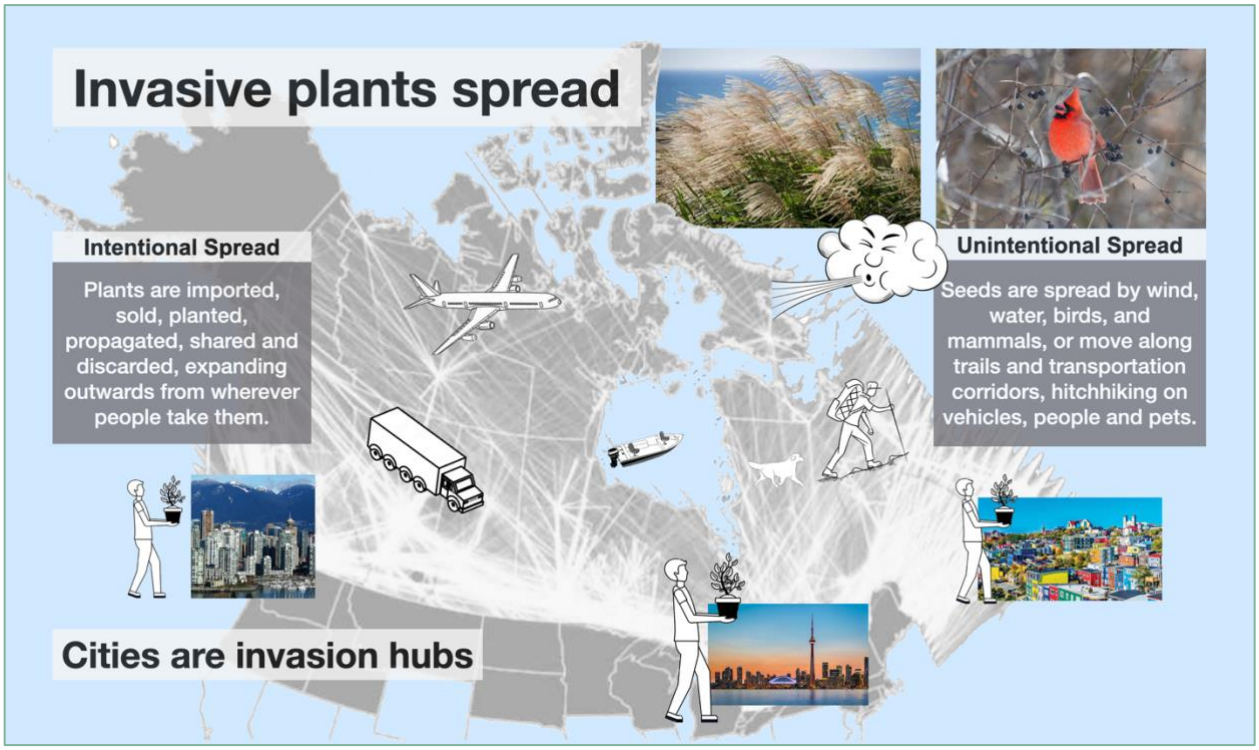

Figure 4. Intentional and unintentional pathways. Source: C. Kavassalis, 2022.

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]

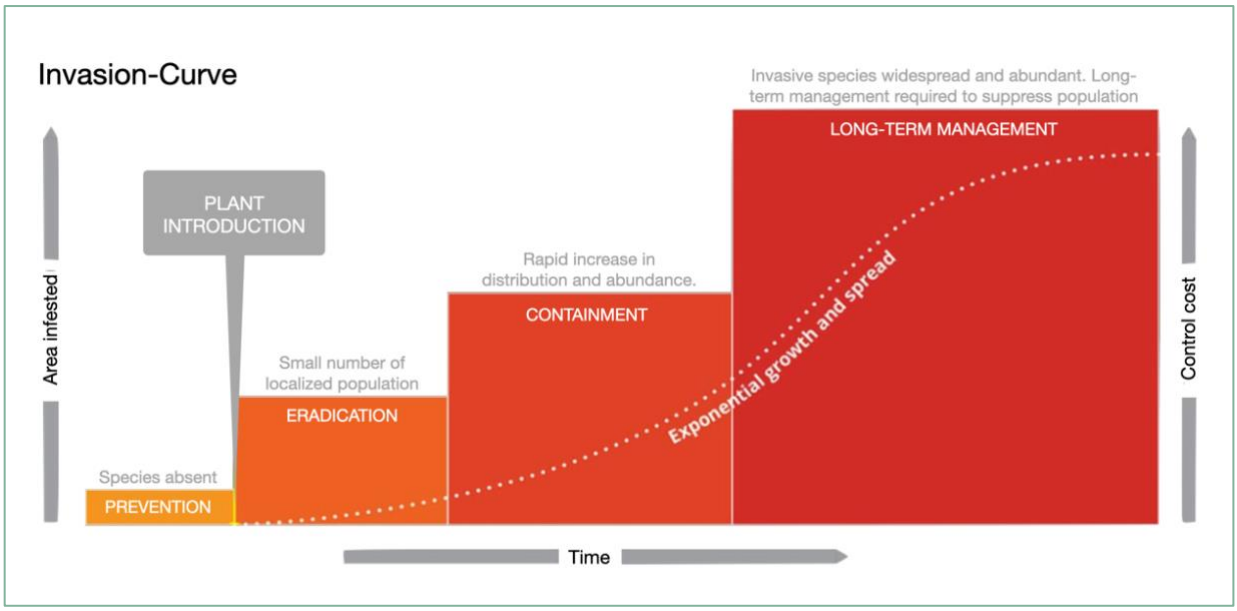

Figure 5. Invasion curve illustrating how costs rise with time and spread. Source F. Herald, 2022.

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).

[73] WTO "Understanding the WTO *Agreement on Sanitary and Phytosanitary Measures*," 1998; ISPMs are non-binding guidelines for measures signatories to the convention 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.

[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).

APPENDICES

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CANADA'S OBLIGATIONS UNDER THE CONVENTION ON BIOLOGICAL DIVERSITY

> We are facing an unprecedented biodiversity crisis with more than one million species facing extinction globally, including 640 at-risk species in Canada. This rapid decline of biodiversity has critical implications for humanity, from the collapse of food, economic, and health systems, to the disruption of entire supply chains. The Government of Canada is committed to taking ambitious actions to restore and protect the natural safety net granted by biodiversity (Minister Guilbeault).[1]

In December 2022, the Conference of the Parties to the *Convention on Biological Diversity* (CBD) adopted the Kunming-Montreal Global Biodiversity Framework to preserve and protect nature and its essential services to people. A key target is to **prevent or reduce the rate of introduction and establishment of invasive alien species by 50%, and control or eradicate such species to eliminate or reduce their impacts**.[2] To achieve this target for invasive plants, Canada **MUST** attend to their primary pathway – **the intentional introduction of ornamental plants**.[3]

Canada has been a party to the *Convention on Biological Diversity* (CBD) since its inception in 1992. The CBD is an international legally binding instrument for "the conservation of biological diversity a party to this convention.[4] As a signator, Canada has agreed to "**Prevent the introduction of, control, or eradicate those alien species which threaten ecosystems, habitats, or species**."[5] Under the CBD, "invasive alien species" is defined as a species whose movement by human agency, indirect or direct, outside of its natural range (past or present) threatens biological diversity.[6]

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[1] "This was part of Minister Guilbeault's statement on Canada's commitment to the protection and recovery of species at risk and restoring natural areas and biodiversity (Environment and Climate Change Canada, 2022). His words echo the words of Prof. Josef Settele who co-chaired the recent global assessment of biodiversity and ecosystem services: "Ecosystems, species, wild populations, local varieties and breeds of domesticated plants and animals are shrinking, deteriorating or vanishing. The essential, interconnected web of life on Earth is getting smaller and increasingly frayed. . .. This loss is a direct result of human activity and constitutes a direct threat to human well-being in all regions of the world" (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), 2019a).

[2] United Nations "Press Release: Nations Adopt Four Goals, 23 Targets for 2030 In Landmark UN Biodiversity Agreement," 2022; Target 6, CBD COP-15, 2022.

[3] CFIA, "Invasive Alien Plants in Canada Technical Report," 2008b.

[4] *Convention on Biological Diversity* (CBD), 1992. "The Convention on Biological Diversity (CBD) is the international legal instrument for "the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources" that has been ratified by 196 nations. Its overall objective is to encourage actions, which will lead to a sustainable future. The conservation of biodiversity is a common concern of humankind" (United Nations, "Convention on Biological Diversity, key international instrument for sustainable development," n.d.).

[5] Secretariat of the Convention on Biological Diversity, "The CBD and Invasive Alien Species," 2021. The CBD definition is distinct from that used by the IPPC. From the International Standards for Phytosanitary Measures (ISPM) glossary: "An invasive alien species is an alien species (CBD) that by its establishment or spread has become injurious to plants, or that by risk analysis (CBD) is shown to be potentially injurious to plants," (ISPM-5, "Glossary of phytosanitary terms," 2023).

[6] CBD COP-6, "Alien species that threaten ecosystems, habitats or species," 2002.

To meet our obligations under the CBD, Canada developed a *Canadian Biodiversity Strategy* (1995) directing the government to: "take all necessary steps to prevent the introduction of harmful alien organisms, ensuring that there is **adequate legislation** and enforcement **to control introductions or escapes** of harmful alien organisms and improving preventive mechanisms such as screening standards and **risk assessment** procedures." In 2010, the Conference of the Parties to the CBD adopted the "*Strategic Plan for Biodiversity 2011–2020 and the Aichi Targets*"[7] to motivate more effective and urgent global actions. In response, Canada prepared matching national biodiversity goals.[8] By 2020, Canada pledged "collective efforts by all governments to identify high **priority pathways** of invasive species into Canada, **improve national and regional regulatory** frameworks, and introduce education and outreach efforts to reduce the introduction and spread of IAPS."

By focusing primarily on the regulation of weedy plant species that cause economic losses in the agricultural sector, and failing to value environmental impacts,[9] the Canadian Food Inspection Agency (CFIA) has failed to close or slow the flow of invasive species through the plant trades. In this regard, the CFIA has done little to address Canada's obligations under the CBD. This has become a global issue.

According to the Secretariat of the *International Plant Protection Convention* (IPPC),

> The IPPC has historically maintained that the adverse consequences of pests, including those concerning uncultivated/unmanaged plants, wild flora, habitats and ecosystems, are measured in economic terms. References to the terms economic effects, economic impacts, potential economic importance and economically unacceptable impact and the use of the word economic in the IPPC and in ISPMs [I*nternational Standards for Phytosanitary Measures*] has resulted in some **misunderstanding of the application** of such terms and of the focus of the IPPC. 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. 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* . . .[10]

To remedy this misinterpretation, the IPPC Secretariat updated their guidelines to clarify that environmental concerns should be accounted for in economic terms **using monetary or non-monetary values**. Further they asserted that contracting parties have the right to take actions with respect to pests (including invasive plants) for which the economic damages **cannot be easily quantified**.

Transformative change is required to address the unprecedented biodiversity crisis. While claiming to dedicate attention to biodiversity, "there is little evidence of an integrated approach within provinces and territories and across the federation." [11] For Canada to address the problem and stop the sale of

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[7] The Aichi biodiversity targets were established by the UN CBD and consist of **20 specific targets to address and mitigate biodiversity loss across the globe**.

[8] Gov. of Canada, "2020 Biodiversity Goals & Targets for Canada," 2016.

[9] CFIA considers environmental impacts as a contributing factor for supporting the case for regulation, but not in determination of costs, which halts the assessment process. The CFIA follows Regional Standards for determining "Economic Impacts" developed by the North American Plant Protection Organization (NAPPO, 2008). This is contrary to guidelines developed under the IPPC in the International Sanitary and Phytosanitary Measures (ISPMs) Glossary: Food and Agricultural Organisation (FAO) ISPMs-5, 2022 pp. 27-30.

[10] ISPM-5, 2023c, p.28.

[11] Ray, Grimm & Olive, 2021. "The biodiversity crisis in Canada: failures and challenges of federal and sub-national strategic and legal frameworks." Facets. 6.

invasive plants, while complying with the *SPS Agreement* and IPPC, Canada must follow the guidelines of the Interim Commission for Phytosanitary Measures (ICPM):

- **Enhance plant protection laws and policies**, where needed, to include the protection of wild flora and biodiversity from plants that are invasive alien species; . . .
- Give particular attention, when carrying out **pest risk analysis**, to the possibility that introduced **plants** could act as **invasive** alien species, . . .
- **Improve communication** between national CBD focal points[12] and IPPC contact points."[13]

Synergies between the CBD and IPPC should be found to develop a more robust Canadian regulatory policy that can reduce the flow of invasive ornamental plants entering Canada and within Canada. Since these measures are trade-restrictive, they must be justified by a sound scientific understanding of the threats invasive plants can pose to biodiversity.[14]

It is therefore imperative that Canada develops **a robust national screening and risk assessment system** to provide the technical justification for regulatory action. It is crucial to prioritize actions based on the level of risk involved, where impacts on biodiversity are given the same level of importance as impacts on agriculture, forestry, and other economic sectors. This should involve cross departmental expertise from the Canadian Food Inspection Agency, Environment and Climate Change Canada, the Biodiversity Convention Office, Fisheries and Oceans Canada, Natural Resources Canada, and Parks Canada. It will also require "coordination with Regional Plant Protection Organizations (RPPOs), which also contribute to the objectives and activities of both the CBD and IPPC."[15]

FEDERAL LEGISLATION AND INVASIVE PLANTS

While several federal departments and or agencies have responsibilities to prevent the introduction or spread of substances or organisms considered harmful to life, health, property or the environment, the regulation of invasive plants falls primarily to the Canadian Food Inspection Agency (CFIA) (Table 1). Other departments and agencies have regulations that could apply to invasive plants, but in practice the CFIA has sole authority over plants under the *Plant Protection Act* and *Seeds Act*. Fisheries and Oceans Canada (DFO) can apply *Aquatic Invasive Species Regulations*, but do not address plants. Environment and Climate Change Canada (ECCC) have several regulations to protect the environment, like the *Canadian Environmental Protection Act* (CEPA). As will be discussed further below, none are used to restrict the flow of invasive ornamental plants.

[12] Biodivcanada is Canada's CBD focal point and the CFIA is the IPPC contact point.
[13] Food and Agriculture Organization of the United Nations, "Seventh Interim Commission on Phytosanitary Measures," 2005, 20; Secretariat of the Convention on Biological Diversity', "Notification of National level collaboration between agencies responsible for biodiversity and plant protection," 2006. Included in the FAO: "Recommendation on: Threats to biodiversity posed by alien species: actions within the framework of the IPPC," 2017. p.1-2.
[14] In 1998, European Communities imposed a general moratorium on the importation of bioengineered produce. This was challenged and found unlawful. "For an SPS measure to be legal, it must be intended to bring about sanitary or phytosanitary protection with a backing of scientific evidence in compliance with the SPS Agreement," (Mogomotsi, Mogomotsi & Moeti, "WTO Law and Jurisprudence on Invasive Alien Species in the Global South," 2022).
[15] Standards and Trade Development Facility (STDF) developed recommendations for parties to the IPPC, CBD and SPS Agreement in a report on International Trade and Invasive Alien Species, 2013.

Table 1: Departments and associated regulations that could be applied to invasive plants.

Department or Agency	Federal Legislation with indirect or direct reference to introduced species or substances
Canadian Food Inspection Agency	*Canadian Food Inspection Agency Act* – Establishes CFIA as responsible for the administration and enforcement of the *Canada Agricultural Products Act, Fish Inspection Act, Health of Animals Act, Plant Protection Act* and *Seeds Act*. The Minister of Agriculture is expressly designated as responsible for the Acts used to regulate invasive plants classified as pests. *Plant Protection Act* – Under this Act, the CFIA has the authority to restrict the import, sale, possession, and movement of certain plant pests. *Seeds Act* – No person shall sell, import or export in contravention of the regulations any seed that presents a risk of harm to human, animal or plant health or the environment.
Agriculture and Agri-Food Canada	See *Plant Protection Act* and *Seeds Act* above.
Environment and Climate Change Canada	*Canadian Environmental Protection Act* – Specific act for the purpose of preventing pollution or, to put it in other terms, causing the entry into the environment of certain toxic substances. This authority is already applied to plants and other organisms that are covered under the biotechnology provisions of the *New Substances Notification Regulations*. *Canadian Wildlife Act* and *Species at Risk Act* – Both acts provide for measures, where necessary, for the protection of any species of wildlife in danger of extinction. *Migratory Birds Convention Act* – Canada is responsible to take such measures as may be necessary to control the importation of live animals and plants which it determines to be hazardous to the preservation of birds. *Wild animal and Plant Protection and Regulation of International and Inter-provincial Trade Act* – The responsible minister may make regulations regarding the transport of animals and plants listed under the act between provinces where the minister of the province to where the species is being imported deems it harmful to the environment.
Parks Canada	*Canada National Parks Act* – The Minister is responsible for the maintenance or restoration of ecological integrity, through the protection of natural resources and natural processes.
Fisheries and Oceans Canada	*Fisheries Act* – No person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish (36-3). *Aquatic Invasive Species Regulations* – It is prohibited to possess, import or transport listed invasive species, but no plants are yet included. *Coastal Fisheries Protection Act* *Fisheries Development Act* *Oceans Act*
Health Canada	*Controlled Drugs and Substances Act* *Pest Control Products Act*
Industry Canada	*National Research Council Act*
Natural Resources	*Department of Natural Resources Act* *Forestry Act* – It is not permitted to release a deleterious substance into water, which would degrade or alter the quality of the water or habitat.

Public Safety and Emergency Preparedness-Canada Border Services Agency	*Customs Act*
Transport Canada	*Transportation of Dangerous Goods Act* – Provides for control of organisms considered by the Governor in Council to be dangerous to life, health, property or the environment when handled, offered for transport or transported and prescribed to be included in this class.

THE *CANADIAN ENVIRONMENTAL PROTECTION ACT* AS A MODEL FOR INVASIVE PLANT REGULATION

In 1988, Canada amalgamated laws to create the *Canadian Environmental Protection Act* (CEPA) and has since revised it several times to address gaps and shortcomings.[16] This Act is intended "to protect the environment, including its biological diversity, and human health" from the "risk of any adverse effects of the use and release of toxic substances."

The Act begins with the following declaration: THE PROTECTION OF THE ENVIRONMENT IS ESSENTIAL TO THE WELL-BEING OF CANADIANS.[17]

> . . . a substance is toxic if it is entering or may enter the environment in a quantity or concentration or under conditions that (a) have or may have an immediate or long-term harmful effect on the environment or its biological diversity; (b) constitute or may constitute a danger to the environment on which life depends; or (c) constitute or may constitute a danger in Canada to human life or health.

How similar is the definition of a toxic substance to an invasive alien plant species? Regulating invasive plants should be done to protect the environment, including biological diversity and human health from adverse effects. Toxic substances and invasive plants can both have immediate or long-term effects on the environment and its biological diversity.

Many of the arguments made in the preamble for this federal regulation could serve as a model for the regulation of invasive alien species. Consider these simple substitutions made in this extract:

Below is an edited Preamble [exchanging invasive alien species for toxic substances and biodiversity conservation for pollution prevention . . .]

> *Preamble ~~Canadian Environmental Protection Act, 1999~~ [Canadian Invasive Species Act],*
>
> Whereas the Government of Canada seeks to achieve sustainable development that is based on an ecologically efficient use of natural, social and economic resources and acknowledges the need to integrate environmental, economic and social factors in the making of all decisions by government and private entities;

[16] Environment and Climate Change Canada, "Timeline: Major milestones of Environment and Climate Change Canada," 2021.
[17] *Canadian Environmental Protection Act, 1999 (S.C. 1999, c. 33)* (CEPA). Act current to 2023-04-20 and last amended on 2021-05-01 2023.

Whereas the Government of Canada is committed to ~~implementing pollution prevention~~ [supporting biodiversity conservation] as a national goal and as the priority approach to environmental protection;

Whereas the Government of Canada acknowledges the need to virtually eliminate the most persistent and ~~bioaccumulative toxic substances~~ [highly invasive alien species] and the need to control and manage ~~pollutants and wastes~~ [invasive alien species] if their release into the environment cannot be prevented;

Whereas the Government of Canada recognizes the importance of an ecosystem approach;

Whereas the Government of Canada will continue to demonstrate national leadership in establishing environmental standards, ecosystem objectives and environmental quality guidelines and codes of practice;

Whereas the Government of Canada is committed to implementing the precautionary principle that, where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation;

Whereas the Government of Canada recognizes that all governments in Canada have authority that enables them to protect the environment and recognizes that all governments face environmental problems that can benefit from cooperative resolution;

Whereas the Government of Canada recognizes the importance of endeavouring, in cooperation with provinces, territories and aboriginal peoples, to achieve the highest level of environmental quality for all Canadians and ultimately contribute to sustainable development;

Whereas the Government of Canada recognizes that the risk of ~~toxic substances~~ [invasive alien species] in the environment is a matter of national concern and that ~~toxic substances~~ [invasive alien species], once introduced into the environment, cannot always be contained within geographic boundaries;

Whereas the Government of Canada recognizes the integral role of science, as well as the role of traditional aboriginal knowledge, in the process of making decisions relating to the protection of the environment and human health and that environmental or health risks and social, economic and technical matters are to be considered in that process; …

Whereas the Government of Canada is committed to ensuring that its operations and activities on federal and aboriginal lands are carried out in a manner that is consistent with the principles of ~~pollution prevention~~ [biodiversity conservation] and the protection of the environment and human health;

Whereas the Government of Canada will endeavour to remove threats to biological diversity through ~~pollution prevention~~ [invasive alien species prevention], the control and management of the risk of any adverse effects of the use and release of toxic substances, ~~pollutants and wastes~~ [invasive alien species], and the virtual elimination of ~~toxic substances~~ [highly invasive alien species];

And whereas the Government of Canada must be able to fulfil its international obligations in respect of the environment; …]

As CEPA states: “The Government of Canada must be able to fulfill its international obligations in respect of the environment.” Like federally regulated toxic substances, once introduced into the environment, invasive plant species cannot always be contained within geographic boundaries. New legislation is needed to respect our international obligations under the CBD and to respect our environment.

In 1999, CEPA was updated to address concerns about living organisms that are the product of biotechnology. Updated again in 2005, the *New Substances Notification Regulations (Organisms)* SOR/2005-248 allow for the assessment of new living organisms, including plants, prior to their

introduction into the Canadian marketplace and the imposition of control measures if deemed necessary.[18]

The new substance notification process begins with a pre-import or pre-manufacture notification of the substance, where any company or individual intending to import or manufacture a new substance in Canada must submit a package containing all information prescribed in the *New Substances Notification Regulations.* This information will be used to conduct a risk assessment. A key aspect of the information requested is a description of the biological and ecological characteristics of the organism to provide a basic understanding of the organism's behaviour in the environment. The information is that which is known from a review of the scientific literature and from results available in unpublished laboratory or experimental field studies. Notifiers are not required to generate data from tests to fulfil the information requirements outlined in the following. This must include:

- Life cycle and life history stages of the organism, including any means to survive environmental stresses, such as dormant stages.
- Reproductive biology, including species with which the organism could interbreed in Canada.
- Involvement in adverse ecological effects including pathogenicity, toxicity, and invasiveness.
- Descriptions of the global geographic distribution if not native to Canada
- Potential for dispersal of traits by gene transfer.
- Locations and situations where the organism have caused adverse ecological effects.
- Involvement in biogeochemical cycling (e.g., carbon, sulphur, and nitrogen).
- Interactions with other organisms in the environment (e.g., parasites, hosts, predators, prey, symbionts, competitors).
- Conditions required for survival, growth, reproduction, and overwintering.
- Capability of the organism to act as a vector for agents involved in adverse effects.
- Mechanisms of dispersal of the organism (e.g., its ability to spread to other sites) and modes of interaction with any dispersal agents.

The risks posed by the organisms are determined both by their hazardous properties and by the nature of the exposure that takes place. Under the purview of the Minister of Health and the Minister of the Environment, scientists assess new organisms to determine whether they present or may present a risk to the environment or to human health. Decisions are based on a scientific evaluation of the risk posed by a substance, which considers both the hazardous properties of the substance (such as toxicity to aquatic organisms) and the nature and extent of the exposure of Canadians or the environment to the substance. This allows the Government of Canada to determine whether a risk management measure is needed, and if so, what type of control is best suited for reducing or preventing the potential harm.[19]

To comply with CEPA, Environment and Climate Change Canada (ECCC) and Health Canada screened and categorized over 23,000 substances that existed in Canada prior to the Act. By 2006, 4,300 were prioritized for further assessment. Today, the evaluations for those priority substances have largely been completed.[20] Results are published online in Canada's Existing Substances Assessment Repository

[18] ECCC, "Guidelines for the Notification and Testing of New Substances: Organisms," 2010 modified 2022; (Gov. of Canada, "Understanding the *Canadian Environmental Protection Act*, 2022).
[19] ECCC (Environment and Climate Change Canada), "Risk assessment of chemical substances," 2022; ECCC, "Guidelines for the Notification and Testing of New Substances: Organisms," 2022.
[20] ECCC (Environment and Climate Change Canada), "UPDATE – Strengthening the Canadian Environmental Protection Act, 1999 and recognizing a right to a healthy environment" 2023.

(CESAR).[21] In addition, hundreds of new substances not yet in the market are screened annually. "Every year an average of 500 regulatory declarations are submitted for chemicals, polymers and living organisms under subsections 81(1), (3) and (4) and 106(1), (3) and (4) of the *Canadian Environmental Protection Act*, 1999 and around 100 waivers are granted."[22] The risk assessment process and the assessments are publicly accessible.[23] Canada needs to require the same level of screening, assessment and documentation for non-native plants existing and new to Canada.

It is worth considering expanding the regulatory authority of the ECCC to address invasive terrestrial plants whose risks and impacts are primarily environmental, while leaving regulation of invasive aquatic plants to Fisheries and Oceans under the *Aquatic Invasive Species Regulations,* and invasive plants whose impacts are primarily related to agriculture to CFIA under the *Plant Protection Act*. This would be consistent with the division of responsibilities for species at risk under the *Species at Risk Act.*

FEDERAL SEED LEGISLATION

Seed legislation includes the *Seeds Act* (RSC 1985, c S-8), *Weed Seeds Order* (SOR/2016-93), and *Seeds Regulations* (CRC, c 1400, 2022). The *Seeds Act* regulates seeds and seed potatoes.

> The main purpose of the *Seeds Act* is to ensure that farmers have access to seed that is high quality, meaning there are 'minimum standards for [varietal] purity, germination, quality, and disease for seeds' (S-8, s. 4c). There are also regulations surrounding grading, testing, inspection, naming, labeling, and documentation before being sold.[24]

The *Weed Seeds Order* (WSO) aims to prevent new weed species from being introduced into Canada from seed products.[25] The WSO states that "No person shall sell, import or export in contravention of the regulations any seed[26] that presents a risk of harm to human, animal or plant health or the environment" (RSC 1985, c S-8).

As of Nov. 2022, there were 96 plants identified as Noxious Weeds including: 26 Class 1 Prohibited Noxious Weeds, 36 Class 2 Primary Noxious Weeds, 29 Class 3 Secondary Noxious Weeds, five Class 4 Secondary Noxious Weeds, and 43 Class 5 Noxious Weeds (Class 5 includes Class 2 species).

The amount of weed seed that can be present in a seed product is listed in Grade Tables, described within Schedule I of the *Seeds Regulations*.[27] All products must be screened for Class 1 and 2 weeds, but not all products need to be screened for other classes. No Prohibited Noxious Weeds seeds may be

[21] ECCC and Health Canada. "Chemical substances fact sheets and frequently asked questions," 2022; Organization for Economic Co-operation and Development (OECD), "Canada's Existing Substances Assessment Repository," n.d..
[22] Department of the Environment, "Waiver of information requirements for living organisms (subsection 106(9) of the Canadian Environmental Protection Act, 1999," 2021.
[23] Government of Canada, "Risk assessment of chemical substances," 2022; Organisation for Economic Co-operation and Development (OECD) eChemPortal, "Canada's Existing Substances Assessment Repository,"n.d..
[24] Pham, "Let's Talk About Seeds: Recommendations for More Meaningful Public Participation in Canadian Seed Policy," 2019.
[25] CFIA, "Weed Seeds Order," 2019b.
[26] For the purposes of the Act, "seed means any plant part of any species belonging to the plant kingdom, represented, sold or used to grow a plant."
[27] *Seeds Regulations* (C.R.C., c. 1400) Schedule 1 (Regulations are current to 2023-04-20 and last amended on 2020-04-23); CFIA, "Weed Seeds Order to Grade Table Cross Reference," 2013.

present in any product.[28] Some seeds from Classes 2-6 may be permitted, depending on the grade (quality) of the product and the type of seed product e.g., cereal grains, vegetable seeds, turf seed mixtures.[29]

Noxious Weeds can be native or non-native, invasive or non-invasive. For instance, poison hemlock (*Conium maculatum*) is native to parts of Canada and not invasive but could be dangerous if included in certain seed products and is therefore classified as a Primary Noxious Weed. All dodders (*Cuscuta* spp.) are designated as Class 1 Prohibited Noxious Weeds in Canada, though there are several species native to Canada, like *C. campestris*.[30] Distinguishing between the seeds of the species would be arduous for seed distributors, so all dodder seed is prohibited.[31]

Similarly, *Prunella vulgaris,* commonly known as self-heal or heal-all, is categorized as a noxious weed with a native variant - *P. vulgaris* L. var. *elongata* Benth, and an introduced variant *P. vulgaris* L. var. *lanceolata* (W. Bart.) and they can hybridize. While it could be argued the introduced variant is invasive and places the native variant at risk, distinguishing between the seeds would be too onerous for distributors, so the species is regulated, rather than just the non-native variants.[32] Designating heal-all as a noxious weed does not prevent the sale of the native variant.

Noxious weeds may be further described as either **Quarantine Pests** or **Regulated Non-Quarantine Pests** (RNQP).[33] All Class 1 Prohibited Noxious Weeds are quarantine pests. Kudzu (*Pueraria montana*) described earlier is an example of a quarantine pest prohibited under the *Plant Protection Act* and a Class 1 Prohibited Noxious Weed. No seeds sold in Canada can be contaminated with any kudzu seeds and no plants can be imported or sold.

By comparison, purple loosestrife (*Lythrum salicaria*) is a **RNQP**. It was originally categorized as a Prohibited Noxious Weed in 2005 but was reclassified in 2016 as a Primary Noxious Weed to better align plants regulated under the *Plant Protection Act* and those regulated under the *Seeds Act*. Both Prohibited and Primary Noxious Weeds **have not reached their full ecological range**.

According to the IPPC, quarantine pests must be under official control "**with the aim of eradication or containment**." By comparison, an RNQP must be under official control "with respect to the specified **plants for planting** with the aim of suppression."[34] **Plants for planting** means plants intended for a particular purpose like grain crops, vegetables, cut flowers, or turf grass.

Purple loosestrife rarely occurs as a seed contaminant and does not pose a significant problem for areas where seed is sown.[35] If it grew in a dry wheat field (highly unlikely), it would require suppression, but

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[28] See "Weed Seeds Order Definitions" CFIA, 2013d.
[29] A plant may be listed in two classes. For instance, ox-eye daisy (*Leucanthemum vulgare* Lam. syn, *Chrysanthemum leucanthemum* L.) is listed both as a Class 3 Secondary Noxious Weed and as a Class 5 Noxious Weed, because it can be a problem for both agricultural field products and seed mixes used in landscaping (e.g., turf seed and ground cover seed mixtures). Not all types of products need to be screened for all weed seeds.
[30] Costeav & Tardif, "The biology of Canadian weeds. 133. *Cuscuta campestris* Yuncker, *C. gronovii* Willd. ex Schult., *C. umbrosa* Beyr. ex Hook., *C. epithymum* (L.) L. and *C. epilinum* Weihe," 2006.
31 Dodders are also prohibited under the *Plant Protection Act*, but native species are excluded (CFIA, "D-12-01: Phytosanitary Requirements to Prevent the Introduction of Plants Regulated as Pests in Canada," 2019).
[32] The species is regulated as a Class 5 Noxious Weed and is limited as a component of turf seed mixtures and ground cover seed mixtures.
[33] ISPM-16, "Regulated non-quarantine pests: concept and application," 2021e.
[34] ISPM-16, 2021e; CFIA, "Weed Seeds Order," 2013d.
[35] "In monitoring conducted between 2001 and 2007, one sample in 2001 was found to contain *L. salicaria*" (CFIA, "6.0 Proposed Species Placement and Rationales," 2013f).

no efforts are required to contain it or prevent its spread into a nearby wetland.[36] Regulating loosestrife as a noxious weed has very limited impact on its spread into natural ecosystems.

During the reshuffling of weeds in 2016, Ox-eye daisy was downgraded from a Primary Noxious Weed to a Secondary Noxious Weed. Some invasive species, like garlic mustard (*Alliaria petiolata*) were removed from the noxious weed list entirely, as the *Seeds Act* was not considered the appropriate regulatory tool for management. While some weeds were removed, new weeds were placed on the list.[37] Ironically, the CFIA imposes less strict regulations on a noxious weed once it becomes widespread, even though it continues to pose a threat to the economy, human health, or animal health. Clearly such a regulatory policy is not consistent with CBD goals and is driven by risks and costs to agriculture rather than the environment.

FEDERAL PLANT LEGISLATION

The legislative basis for the plant protection program in Canada is primarily the *Plant Protection Act* (PPA) and associated regulations. The purpose of the *Plant Protection 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."[38]

Plants currently regulated under the *Plant Protection Act* are published online.[39] Pests in this list are hyperlinked to policy directives. As of Dec. 2022, there were 30 regulated taxa with 21 taxa identified as "**pest plants**" under directive *D-12-01: Phytosanitary Requirements to Prevent the Introduction of Plants Regulated as Pests in Canada*. Another group of plants, which are host to rust diseases, are regulated under a different directive, *D-01-04: Plant Protection Import and Domestic Movement Requirements for Barberry (Berberis, Mahoberberis and spp.) under the Canadian Barberry Certification Program*.

Currently, federal regulatory actions are seldom taken for plants established in Canada, even when there is potential for further spread. This occurs because plants fail to make it through CFIA's **Pest Risk Assessment** (PRA) process. This is a three-stage process with steps prescribed under the *International Standards for Phytosanitary* Measures (ISPMs).[40] Stages include: initiation, pest risk assessment, and pest risk management. A formal PRA document is only prepared for invasive plants if all stages in the process are completed.

In stage one, the potential impact of the plant is considered. To be a pest, there must be indications that by its establishment or spread, a plant can become **injurious to plants**.[41] If a plant poses threats to human or animal health or to the environment in a manner that does not directly impact plant health, it would not be considered a pest. The pathways for introduction or spread are also considered.[42] If a plant

[36] If you are scratching your head, you are not alone. There are a lot of details in policy and law that are difficult to follow. You can read more discussions about definitions in the "Weed Seeds Order (WSO) Review - Proposal for Change" (CFIA, 2013b) and then look for definitions in the ISPM documents related to RNQP (ISPM-16, 2021e).
[37] For a more detailed discussion around species placement, see the "Weed Seeds Order Review Secondary Consultation Document" (CFIA, 2013g) and "Weed Seeds Order Regulatory Impact Analysis" (CFIA, 2016b).
[38] *Plant Protection Act* (S.C. 1990, c. 22).
[39] CFIA, "List of pests regulated by Canada," 2022 (last modified 2022-11-21).
[40] Described in detail in ISPM-11, "Pest risk analysis for quarantine pests," 2019. p. 8-26.
[41] A plant pest is "Any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products." Note: In the IPPC, "plant pest" is sometimes used for the term "pest" FAO, 1990; revised ISPM 2, 1995; IPPC, 1997; CPM, 2012] ISPM-5, 2023c, p.7; ISPM-5, 2022, p. 32.
[42] Pathways can include natural dispersal, intentional introduction, and or unintentional introduction.

meets the definition of a potential pest and endangers parts of Canada, the assessment can proceed. **The use of this narrow interpretation does not capture the full ecosystem impacts of invasive plant species in Canada and is a key indication of the need for legislative or regulatory change**.

In stage two, the risk for invasion is considered and the plant is **categorized** to determine whether the criteria in the definition for a quarantine pest are satisfied.[43] **Distribution, official control, and economic importance** are the three key factors considered.

- If a plant cannot establish or spread in Canada, the risk assessment process stops.
- If the plant is widely distributed, the risk assessment process stops.
- If there are no official control measures in place or plans to put controls in place, the risk assessment process stops.
- If there are no potential economic consequences (including environmental consequences), the risk assessment process stops.[44]

Plants that move forward in the assessment process are designated as a **Quarantine Pest** (QP) or a **Regulated Non-Quarantine Pest** (RNQP). As described under the seed legislation section, RNQPs are plants that specifically impact "plants for planting."[45] They are regulated as noxious weeds in Canada for the purposes of seed quality under the *Seeds Act*.[46] If an invasive plant poses risks of potential economic importance to other areas and is not yet present, or present, but not widely distributed and is being officially controlled,[47] it is classified as a quarantine pest and the process continues to stage three.

In stage three, risk management options are considered. International law requires that options proposed should be the **least trade restrictive** to achieve the level of risk determined acceptable. Options can include no action, surveillance, localized control options (e.g., physical removal, pesticides, biocontrol), with prohibitions on trade as a last resort.[48] Public consultations are part of the process. Once feedback is reviewed, a course of action is selected, and a final Risk Management Document (RMD) is prepared.

The CFIA completes few PRAs to the final stage. As of Feb. 2023, there were 30 regulated plant taxa of 412 potential pest plants listed in the federal *Weed Risk Analysis Documents*.[49] Only 26 had RMDs prepared. (Compare this to the thousands of assessments done for toxic substances under CEPA). Of the prohibited plant species, the majority are agricultural weeds. Only four of the prohibited plants are of some ornamental/horticultural interest.[50] Below are excerpts from RMD summaries for giant reed,

[43] Stage 2 is described in detail in ISPM-11, "Pest risk analysis for quarantine pests," 2019. p. 11-22.
[44] The emphasis on environmental consequences is new to the PRA process.
[45] "Plants for planting" includes seeds, bulbs and tubers, and various kinds of vegetative propagating material used for growing plants (e.g., fruits, cut flowers, wood, grain) (ISPM-16, 2021. p. 6.).
[46] In the U.S. Noxious Weeds plants may not be transported across state lines, this is not the case in Canada.
[47] Official Control is defined as "The active enforcement of mandatory phytosanitary regulations and the application of mandatory phytosanitary procedures with the objective of eradication or containment of quarantine pests or for the management of regulated non-quarantine pests [ICPM, 2001]" (ISPM – 5-15, 2022). The concept of "official control" is subject to interpretation. IPPC guidelines state that official control should include efforts to eradicate and/or contain plants in the infested area(s), efforts to monitor populations, as well as efforts to restrict the movement of plants (ISPM 5-24).
[48] ISPM-16, 2021. P. 25.
[49] CFIA, "Weed risk analysis documents," 2021b.
[50] *Arundo donax, Echium plantagineum, Nassella trichotoma, and Pueraria montana* have appeared in the trades in North America and some present risks of hybridizing with other plants in trade, e.g. *N. trichotoma* with *N. tenuissima* (CABI, "*Nassella trichotoma* (serrated tussock grass," 2019).

Paterson's curse, tussock grass, and kudzu highlighting some of the economic impact and environmental consequences provided as support for regulation.

Table 2: Justification for regulatory measures presented in the Risk Management Document for four plants prohibited under the Plant Protection Act

Prohibited plant	Primary justifications for regulatory measures
Giant Reed (*Arundo donax*) RMD 2017	Potential Economic and Environmental Consequences Risk Rating for Potential Economic and Environmental Consequences Potential economic and environmental consequences are rated "High" for *A. donax,* as it has the potential to cause major damage to the environment (i.e., changes to ecosystem processes, community structure and function, loss of biodiversity), it is difficult and costly to control, and it can negatively impact a variety of water-based industries.[51]
Paterson's curse (*Echium plantagineum*) RMD 2020	Potential economic impact: At least six potential negative economic impacts have been identified for *Echium plantagineum:* pasture degradation, livestock and crop yield losses, hay and seed contamination, and increased costs of control. Potential environmental impact: *Echium plantagineum* has the potential to have serious impacts on the environment. The most significant of these are considered to be the potential negative impacts on animal and human health due to the plant's toxic alkaloids and the potential consequences of herbicide resistance in this species.[52]
Tussock grass (*Nassella trichotoma*) RMD 2020	Potential economic consequences Potential economic impact is not significant. … Potential environmental and social consequences Potential environmental impact is high. . .. While this area is very limited . . . these meadows represent a critically endangered ecosystem within Canada.[53]
Kudzu (*Pueraria montana*) RMD 2010	Potential economic consequences The greatest impacts of *Pueraria montana* are felt by the forestry industry. . .. Control costs have been estimated at approximately $500 US per hectare per year for five years, which exceeds profits for average 25 year-old pine plantations (Britton et al. 2002; Forseth Jr. and Innis 2004) and results in land being taken out of production . . . Potential environmental and social consequences *Pueraria montana* shades and crushes its competitors, killing native vegetation and forming kudzu monocultures. . ..[54]

The PRAs are not written in a consistent fashion making comparisons difficult. This likely reflects different assessors and an evolving process over time. There is evidence that more attention is being given to environmental impacts in more recent assessments. The more recently evaluated Tussock grass was regulated primarily because of environmental impacts. The simultaneous statement in the RMD that "Potential economic impact is not significant," is inconsistent with the IPPC guidelines stating that environmental impacts should be recognized as economic impacts.[55] The structure of the PRAs could be improved. For example, the EU *Non-native species risk analysis – risk assessment template* provides a

[51] CFIA, "RMD-16-02: Pest Risk Management Document for *Arundo donax* (giant reed) in Canada," 2017.
[52] CFIA, "RMD-13-04: Consolidated Pest Risk Management Document for pest plants regulated by Canada Appendix 7A: Pest Risk Assessment Summary for *Echium plantagineum* (Paterson's curse)," 2020a.
[53] CFIA, "Appendix 9A: Pest Risk Assessment Summary for *Nassella trichotoma* (serrated tussock)," 2020b.
[54] 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.
[55] ISPM-5, 2023c, p.28.

more rigorous and detailed model. It could be used to develop a more consistent publicly accessible PRA format in Canada.[56]

The Pest Risk Analysis and Invasive Species Panels (PRA ISP) of the North American Plant Protection Organization (NAPPO) have also noted "There are NO AQUATIC PLANTS OR ALGAE regulated under the *Plant Protection Act* and regulations at present."[57] This is a significant oversight. A lack of resources, "lack of scientific capacity . . . lack of an interdepartmental policy"[58] are likely at the root of this problem. As will be described in the case studies, Fisheries and Oceans Canada (DFO) have identified many potential high-risk species, many of these already exist in Canada.

New legislation that explicitly protects Canada's biodiversity and protects human health or more generally animal health from invasive species is crucial. An Act more like the CEPA is needed that requires invasive plants be treated like toxic substance and mandates assessments. This kind of Act should require the screening of the over 1,200 non-native plants existing in Canada to determine if they are causing harm, just as CEPA required the screening of existing substances.[59]

If the CFIA remains the department responsible for invasive plants, the department should:

- correct any lingering misinterpretations of IPPC requirements.
- address the failure to consider invasive aquatic plants.
- ensure the natural environment is given the same attention as the agricultural and forestry sectors.
- develop a screening plan to evaluate existing non-native plants in Canada and prioritize them for assessment.
- coordinate with other departments (e.g., Environment and Climate Change Canada, Biodivcanada, Fisheries and Oceans Canada, Parks Canada).
- publish risk assessments in a public database.

While this will require increased funding, it should save millions in the long term and incalculable damages to the environment.

[56] See for example: Pergl, "EU Non-native organism risk assessment scheme *Ailanthus altissima* (Tree-of-heaven)," 2018.
[57] Pest Risk Analysis and Invasive Species Panels of the North American Plant Protection Organization (NAPPO): (PRA-ISP) "DD 02: DD 03: The Role of the NAPPO in Addressing Invasive Alien Species," 2011.
[58] Champion et al., "Border control for potential aquatic weeds," 2007, 36.
[59] In 2013, 1,295 introduced plant taxa were described in Canada (Desmet & Brouillet, "Database of Vascular Plants of Canada (VASCAN): a community contributed taxonomic checklist of all vascular plants of Canada," 2013).

PROVINCIAL AND TERRITORIAL REGULATIONS

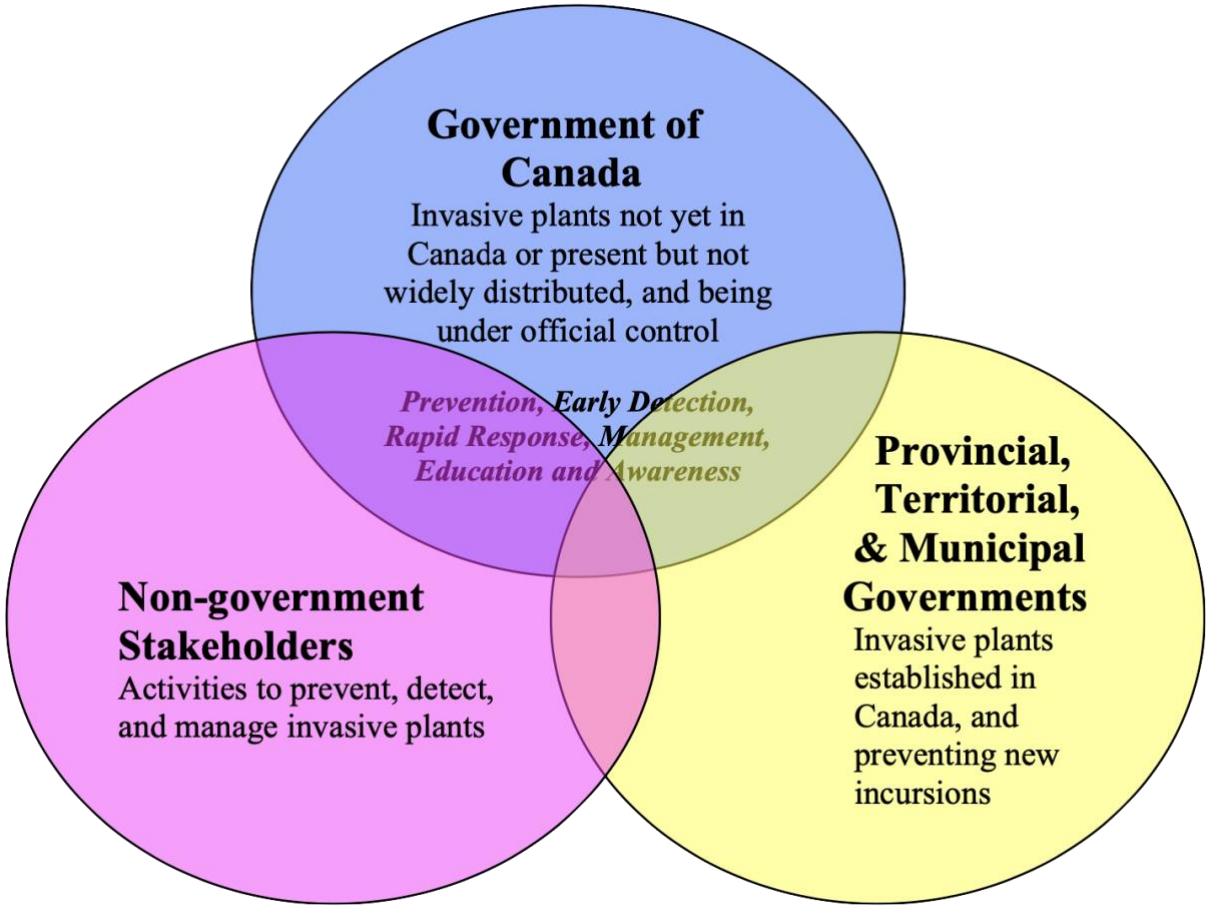

Figure 6. Responding to invasive plants is a shared responsibility. Source. CFIA, 2011.

The primary responsibility for managing established and widely distributed invasive plants in Canada falls to the provinces and territories (Figure 8).[60] In 2011, the CFIA advised provincial and territorial governments to revise noxious weed acts or other regulatory tools to provide them the authority for regulating invasive plants. Some provinces, like Alberta and Manitoba, did update their weed laws to improve their ability regulate plants that pose threats to the environment. Manitoba also updated its *Water Protection Act* to address invasive aquatic plants. Ontario enacted an *Invasive Species Act* (S.O. 2015, c. 22) that explicitly covers plants that may cause an "adverse effect to biodiversity."

[60] In 2011, a "Canadian Invasive Plant Framework" was developed based on a series of federal, provincial, and territorial workshops. At that time the Government of Canada was given the primary role of preventing the introduction of invasive plants into Canada. Once introduced to Canada, provincial, territorial, and municipal governments were given the responsibility of managing established invasive plants working in collaboration with non-governmental stakeholders, (Venn Diagram credit: Gov. of Canada "Canadian invasive plant framework: A collaborative approach to addressing invasive plants in Canada." 2011, p.15).

Five jurisdictions list no regulated plants (NB, NL, NT, NU, QB). Québec did have regulated plants but repealed its weed control act in 2018 and has not replaced it. Prince Edward Island regulates purple loosestrife alone and neighboring Nova Scotia regulates only ten weedy plants.

Table 3: Numbers of plants regulated by various jurisdictions in Canada.

Federal, provincial, or territorial legislation	Number of regulated plant taxa
CANADA (CAN) *Plant Protection Act* (SC 1990, c. 22) *Seeds Act* (R.S.C., 1985, c. S-8)	30 Federally Prohibited Taxa 96 Noxious Weeds: 26 Class 1 Prohibited, 36 Class 2 Primary, 29 Class 3 Secondary, 5 Class 4 Secondary, 43 Class 5 (this include Class 2 taxa)
ALBERTA (AB) *Weed Control Act* (SA 2008, c.W-5.1) *Fisheries (Alberta) Act,* RSA 2000, c F-16	80 Noxious Weeds: 44 prohibited, 29 noxious, 7 nuisances 16 invasive aquatic plants prohibited
BRITISH COLUMBIA (BC) *Weed Control Act* ([RSBC 1996] CHAPTER 487)	66 Noxious Weeds: 39 provincial, 27 regional
MANITOBA (MB) *Noxious Weeds Act* (S.M. 2015, c.38) *Water Protection Act* (C.C.S.M. c. W65) Aquatic *Invasive Species Regulation*	110 Noxious Weeds: 21 Tier 1 prohibited, 18 Tier 2 restricted, 50 Tier 3 (complaint controlled) 21 invasive aquatic plants prohibited
NEW BRUNSWICK (NB) *Weed Control Act* (SNB 1969, C.21	No lists
NEWFOUNDLAND AND LABRADOR (NL)	No lists
NORTHWEST TERRITORIES (NT) *Protected Areas Act* (SNWT 2019, c. 11)	No lists
NOVA SCOTIA (NS) *Agricultural Weed Control Act* (R.S.N.S. 1989, c. 501)	10 Noxious Weeds: 9 Class 1 threats to agricultural or cultivated land; 1 Class 2 threat to health
NUNAVUT (NU) *Wildlife Act* (S.Nu. 2020, c.15)	No lists
ONTARIO (ON) *Weed Control Act* (R.S.O. 1990, c. W.5 *Invasive Species Act* (S.O. 2015, c.22)	25 Noxious Weeds 15 Invasive alien plants: 5 prohibited; 10 restricted
PRINCE EDWARD ISLAND (PE) *Weed Control Act* (Chapter W-2-1) *Purple Loosestrife Control Regulations*	One taxa L*ythrum* spp.
QUÉBEC (QC) Agricultural Abuses Act (R.S.Q. c. A-2) repealed	List no longer regulated
SASKATCHEWAN (SK) Weed Control Act (Chapter W-11.1 2014, c.19)	60 Noxious Weeds: 23 prohibited, 37 noxious, and five nuisance weeds
YUKON (YT) Environmental Act (RSY 2002, c 76)	No lists

Regulatory actions are often reactive rather than proactive. For instance, *Phragmites australis* subsp. *australis* was well established in Ontario before it was regulated. After prompting from Fisheries and Oceans Canada, a few provinces are being more proactive regarding aquatic invasive plants. For instance, **Manitoba now prohibits over 22 aquatic invasive plants** under a recent update to the Manitoba *Water Protection Act.* Alberta regulates 17 plants (two distinct from Manitoba). Ontario regulates only nine on that list and Saskatchewan only three. (See Table 4).

Table 4: Ten regulated weeds in Canada illustrating inconsistencies.

Scientific name	Common name	Jurisdictions with regulations
Abutilon theophrasti Medik.	Velvetleaf	CAN (S2&5) BC (P) NS (C1)
Acroptilon repens (L.) DC. (=*Centaurea repens* L.)	Knapweed, Russian	BC MB (T1) SK (N)
Aegilops cylindrica Host (=*A. caudata* L.)	Jointed goatgrass	CAN (S1) CAN (PPA) AB (P) BC (P) ON (N) SK (P)
Agropyron repens [BC] (= *Elymus repens* (L.) Gould [CAN]) (=*Elytrigia repens* [SK])	Quackgrass; couchgrass	CAN (S2&5) BC SK (NW)
Ailanthus altissima (Mill.) Swingle	Tree-of-heaven	AB (P)
Alliaria petiolata (M. Bieb.) Cavara & Grande	Mustard, garlic	AB (P) MB (T1) SK (P)
Alopecurus myosuroides Huds.	Foxtail, slender	CAN (S1) CAN (PPA)
Amaranthus hybridus L.	Pigweed, smooth	MB (T1)
Amaranthus palmeri S. Watson	Amaranth, Palmer	MB (T1)
Amaranthus retroflexus L.	Pigweed, redroot	BC (N)
Amaranthus tuberculatus (Moq.) J.D.Sauer	Tall water-hemp	CAN (S2&5) MB (T1)

There are clear regulatory gaps and discrepancies across Canada. Very few plants used for landscaping purposes are regulated.

> Efforts aimed at managing plant health risks vary across the country—some provinces and territories have more robust systems of risk surveillance, monitoring, and management than others. This unevenness creates gaps. 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.[61]

A look at the weedy plants species regulated across Canada illustrates some of the inconsistencies in the current system. For instance, a quick look at the first ten terrestrial plant species (sorted alphabetically) illustrates some of the irregularities (Table 5). Only four provinces recognize the potential threat posed by jointed goatgrass (*Aegilops cylindrica*) and others may not be aware to look for its establishment. There is evident naming confusion. The plant called quackgrass or couchgrass is listed under three different scientific names (*Elymus repens* L. is the currently accepted name).[62] Only one province, Alberta, has recognized the threat posed by tree-of-heaven (*Ailanthus altissima)* sold through the plant trades.

Table 5: Invasive aquatic plants regulated in Canada.

Scientific name	Common name	Regulating jurisdictions
Butomus umbellatus	Flowering rush	AB, BC, MB(W), SK
Cabomba caroliniana	Fanwort, carolina fanwort	AB(F), MB(W), ON
Egeria densa	Brazilian waterweed	AB(F), MB(W), ON
Eichhornia crassipes	Water hyacinth	MB(W)

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

[62] Systematics is fundamental to ecosystem management and biodiversity conservation. The Integrated Taxonomic Information System (ITIS) was developed in the United States to provide access to standardized nomenclature. (ITIS.gov). The World Flora Online (WFO) Plant List is another comprehensive and authoritative source of accepted scientific names for species (WFO Plant List).

Hydrilla verticillata	Hydrilla, water thyme	AB(F), MB(W), ON
Hydrocharis morsus-ranae	European frogbit	AB, MB(W), ON
Impatiens glandulifera	Himalayan balsam	AB, BC, MB(W)
Iris pseudacorus	Yellow (flag) iris	AB, BC, MB(W)
Lagarosiphon major	African oxygenweed	MB(W)
Lythrum salicaria	Purple loosestrife	CAN, AB, BC, MB(W), PE, SK
Lythrum spp.	Loosestrifes any variety or species	PE
Myriophyllum aquaticum	Parrot feather, Brazilian watermilfoil	AB, MB(W), ON
Myriophyllum heterophyllum	Variable leaf watermilfoil	AB(F)
Myriophyllum spicatum	Eurasian watermilfoil	MB(W), SK
Najas minor	Brittle waternymph	MB(W)
Nitellopsis obtusa	Starry stonewort	MB(W)
Nymphoides peltata	Yellow floating heart	AB, MB(W), ON
Phragmites australis subsp. *australis*	European common reed	AB(F), MB(N) & MB(W)
Pistia stratiotes	Water lettuce	MB(W)
Potamogeton crispus	Curly-leaf pondweed	AB(F), MB(W), SK
Salvinia molesta	Giant salvinia	AB(F)
Stratiotes aloides	Water soldier	AB(F), MB(W), ON
Tamarisk ramosissima	Salt cedar	MB(N)
*Tamarisk ramosissima, T. chiniensis, T. parviflora**	Salt cedar	AB, MB(W), SK
Tamarisk spp.	Additional salt cedar species	SK
Trapa natans	Water chestnut	AB(F), MB(W), ON
CAN – plants regulated under Canada's *Seeds Act* AB – plants regulated under the Alberta *Weed Control Act*; AB(F) are plants regulated under the *Fisheries (Alberta) Act Revised Statutes of Alberta 2000* (AB FA) BC – plants regulated under British Columbia's *Weed Control Act* ON – plants regulated under Ontario's *Invasive Species Act* MB(N) – plants regulated under Manitoba's Noxious Weeds Act; MB(W) – plants regulated under Manitoba's *Water Protection Act* (*MB specifies cultivars, variety or hybrid) PE – plants regulated under Prince Edward Island's *Purple Loosestrife Control Regulations* SK – plants regulated under Saskatchewan's *Weed Control Act*		
Native aquatic weeds omitted from the list, (e.g., poison hemlock)		

A national risk assessment database could help to solve this problem by alerting all regions to potential threats from both weedy and invasive species.

In the summary of regulations that follows, a few plants are highlighted to illustrate the lack of consistency between jurisdictions. In particular, the knotweeds (e.g., bohemian, giant, Himalayan, and Japanese) and aquatic invasive plants are used to point out differences and disparities.

BRITISH COLUMBIA (BC):

British Columbia's *Weed Control Act* (RSBC 1996, c 487) requires that "an occupier must control noxious weeds growing or located on land and premises." There are 39 plants designated noxious weeds within all regions of the province and 27 more within specific regions specified on the BC Weed Control Regulation, (BC Reg 66/85). The Act does not mention invasive species or harm to the environment caused by plants.

The province-wide list includes the four highly invasive knotweeds:

- Japanese knotweed (*Fallopia japonica*)
- Giant knotweed (*Fallopia sachalinensis*)
- Bohemian knotweed (*Fallopia* x *bohemica*)
- Himalayan knotweed (*Polygonum polystachyum*).

Invasive aquatics on the province-wide noxious weed list include only four aquatic plants (see Table 4).

In 2014, the Inter-Ministry Invasive Species Working Group in British Columbia, encouraged "the **strengthening of federal import regulations and assessments** for the invasive potential of all proposed new imports e.g., agriculture, horticulture, fish and game stocking, pet and live food trades."[63] The need for a cohesive, comprehensive framework to clarify authority between federal, provincial, local, and Indigenous governments was reiterated in the *Invasive Species Strategy for British Columbia: 2018-2022*, facilitated by the Invasive Species Council of British Columbia.[64] The Federal Government has not yet responded with such a framework, nor is there publicly available information about federal-provincial-territorial working groups if they do currently exist.

New regulatory tools that clearly define jurisdictional responsibility, and improved capacity are required. The strategy document specifically recommends the creation of a harmonized provincial *Invasive Species Act* as current regulatory tools are not addressing the problem. They also identify the need for better collaboration with the Federal Government and "neighbouring jurisdictions to close the key pathways of invasive species."

ALBERTA (AB):

In Alberta, the *Weed Control Act* (SA 2008, c.W-5.1) enables the eradication and control of invasive plants. Alberta's *Weed Control Act* is administered by Agriculture, Forestry and Rural Economic Development and enables legislation for eradication and control of invasive plants. Regulated plants include 44 prohibited noxious weeds, which must be destroyed when found. There are another 29 noxious weeds that may be subject to a control program if a local authority feels they may have significant **ecological or economic impact** on lands within their municipality.[65]

Prohibited noxious weeds include the Japanese, giant and Bohemian knotweeds, but fails to recognize the threat posed by Himalayan knotweed.

The Weed Control Act includes six aquatic invasive plants: Eurasian watermilfoil, flowering rush, Himalayan balsam, purple loosestrife several tamarisk species, and yellow flag iris. In addition to those six, another 11 invasive aquatic plants are prohibited plants under the F*isheries (Alberta) Act Revised Statutes of Alberta 2000* (see Table 4). Having two lists presents some confusion and can make cross border comparisons difficult.

Alberta identified several issues regarding their 2008 legislation:

> In 2010 the Province of Alberta revised its *Weed Control Act*, which in turn required the revision of its list of regulated weeds. Issues that emerged . . . taxonomic and nomenclatural complexities;

[63] Inter-Ministry Invasive Species Working Group in British Columbia, "The BC Government Invasive Species Strategic Plan," 2014.
[64] Bergunder et al., "Invasive Species Strategy FOR BRITISH COLUMBIA 2018 – 2022," 2017.
[65] Alberta, "Provincially regulated weeds," 2023.

a lack of information on species distribution and impacts; the lack of legal jurisdiction over aquatic species; the need for education and training of those involved in enforcing the Act.[66]

It should be noted there is also a *Pest and Nuisance Control Regulation* (A -184/2001), under the *Agricultural Pests Act* (SA 1984, c A-8.1). The regulation prohibits the import, purchase, or sale of any animals, birds, insects, plants, and/or diseases identified as pests in Part 1 of Schedule 1. However, no plants are listed in the associated Schedule.

SASKATCHEWAN (SK):

Saskatchewan's *Weed Control Act* (SS 2010, c W-11.1) describes the requirements for the containment or control of prohibited, noxious, or nuisance weeds. There are currently 23 prohibited, 37 noxious and five nuisance weeds.[67] The Act does not discuss invasive plants that cause harm to the environment.

No knotweeds are regulated, even though the two bordering provinces have listed them. Prohibited aquatic invasive plants include flowering rush, Eurasian watermilfoil, yellow floating heart, curly-leaved pondweed, and **all salt cedar species**, not just the three specified by Alberta and Manitoba (see Table 4).

MANITOBA (MB):

Manitoba's Noxious Weeds Act (CCSM c N110) sets out requirements regarding control or destruction measures for different plants that may "negatively affect any aspect of Manitoba's **economy or environment** or the well-being of residents of the province." They are categorized in tiers, with 21 Tier 1, 18 Tier 2, and 50 Tier 3 plants. Tier 1 weeds must be eradicated without conditions. Tier 2 weeds must be managed according to the size of the infestation. Tier 3 weeds must be controlled if the spread would have a negative impact on the economy, the environment, or the well-being of residents nearby.[68]

Of the invasive knotweeds, only Japanese Knotweed (*Fallopia japonica*) is listed as a Tier 1 plant.

Of the invasive aquatic plants, only one species of salt cedar (*Tamarix* ramosissima) is listed as a Tier 1 weed under the *Noxious Weeds Act*. However, three salt cedar species are prohibited under Manitoba's updated *Water Protection Act* (*C.C.S.M. c. W65*). The Act states: "A person must not (a) possess a member of an aquatic invasive species in Manitoba." The associated *Aquatic Invasive Species Regulation* (*173/2015*) includes **the most extensive list of invasive aquatic species of any province** and currently includes 20 genera (Table 4). This list is also one of the more precise regarding nomenclature.

Missing from the list are plants like variable leaf watermilfoil and giant salvina prohibited in Alberta, as well as others assessed as high risk by DFO described in the Case of Aquatic Invasive Plants below.

ONTARIO (ON):

Ontario is the only province with an explicit statute to address invasive plant species. The *Invasive Species Act* (S.O. 2015, c.22) has specific provisions to regulate a species that is "harming or is likely to **harm the natural environment** of Ontario, regardless of whether it is present in Ontario or in a part of

[66] McClay, "Revising Alberta's Provincial Weeds List: Experiences and Lessons Learned," 2012, 25.
[67] Saskatchewan Minister of Agriculture, "Designation of prohibited noxious and nuisance weeds," 2010.
[68] Manitoba gov., "Controlling Noxious Weeds," 2017.

Ontario." "It is illegal to import, possess, deposit, release, transport, breed/grow, buy, sell, lease or trade prohibited invasive species."

Plant species are classified as invasive based on their biological characteristics, their potential for environmental harm, and their potential socio-economic impacts. Those not yet present in Ontario's natural environment are classified as prohibited and those present are restricted. Currently, there are five prohibited and ten restricted invasive plants (O Reg 354/16).

The five prohibited species are aquatic, not yet present:

- Brazilian elodea (*Egeria densa*)
- European water chestnut (*Trapa natans*)
- Hydrilla (*Hydrilla verticillata*)
- Parrotfeather (*Myriophyllum aquaticum*)
- Water soldier (*Stratiotes aloides*)

Three additional aquatic species are restricted and present in the province:

- Fanwort (*Cabomba caroliniana*)
- European frog-bit (*Hydrocharis morsus-ranae*)
- Yellow Floating Heart (*Nympoides pelata*)

The restricted list also includes two dog-strangling vines, phragmites, and four knotweeds (note the scientific names used are distinct from those being used by western provinces):

- Bohemian knotweed (*Reynoutria* × *bohemica*)
- Giant knotweed (*Reynoutria sachalinensis*)
- Himalayan knotweed (*Koenigia polystachya*)
- Japanese knotweed (*Reynoutria japonica*)

Ontario also maintains a *Weed Control Act* (R.S.O. 1990, c. W.5). This Act regulates plants that can negatively impact agriculture and horticulture lands. Currently there are 25 species designated as noxious weeds in Ontario (RRO 1990, Reg 1096). Action is complaint driven.

In the 2022 report entitled: "Value-for-Money Audit: Management of Invasive Species," the Ontario Auditor General notes that Ontario has not done enough to regulate the trade of invasive plants used for landscaping and ornamental purposes.[69] Recommendation 1 states:

> So that harmful terrestrial species and their pathways are promptly regulated, in line with the goals and objectives of Ontario's *Invasive Species Strategic Plan* (2012), we recommend that the Ministry of Natural Resources and Forestry:
>
> - develop and employ a standardized risk-assessment tool for terrestrial species;
> - collaborate with stakeholders to identify potential terrestrial plant invasive species for regulation; and
> - assess and address the need to regulate pathways for terrestrial invasive species.

In general, Ontario lacks expertise and financial resources necessary to perform risk assessments including analysis of ecosystem and related economic impacts. This results in inaction or long delays before action is taken. For example, the Ontario Auditor General found that Carolina fanwort—an invasive aquatic plant that crowds out native plants, clogs irrigation systems and interferes with aquatic

[69] Ontario Auditor General, 2022.

recreation— was regulated in 2022, almost five years after a complete risk assessment was provided to the Ministry by a contracted expert and eight years after Fisheries and Ocean's Canada had performed a Canada-wide risk assessment. [70] (See Case of Aquatic Invasive Plants below).

In addition to problems with aquatic plants, the Ontario Auditor General identified 30 terrestrial ornamental plant species that should be considered for regulation under the Act.

Table 6: Select unregulated invasive plant species in Ontario and their impacts (from Auditor General's report).

Invasive plant	Impact
Amur maple	Establishes dense shade that suppresses the growth of native shrubs, herbaceous plants and grasses.
Autumn Olive	Can outcompete and displace native plants by changing the chemistry of the soil around it.
Common buckthorn	Forms dense thickets that crowd and shade out native plants, alters nitrogen levels in the soil, and produces a large number of seeds that germinate quickly and prevent the natural growth of native plants. Can host the fungus oat crown rust.
Creeping jenny	Thrives in wet soil and creates dense mats that deter the establishment of native plant species.
Dame's rocket	Produces a large number of seeds and crowds out native vegetation.
Daylily	Poses a threat to native plants in fields, meadows, floodplains, moist woods and forest edges by forming dense patches that displace native plants.
English ivy	Threatens native species, including tree saplings, by outcompeting and impacting photosynthesis.
Garlic mustard	Actively displaces native spring ephemeral wildflowers, has chemicals produced in roots that prevent the growth of other plants, and changes the composition of the litter layer of the forest floor.
Glossy buckthorn	Produces a large number of seeds, preventing the growth of native plants.
Goutweed	An invasive groundcover that reproduces quickly and outcompetes native species by forming dense patches.
Italian honeysuckle	Can outcompete and smother small saplings and shrubs.
Japanese barberry	Forms dense thickets that reduce wildlife habitat, affect native plants, restrict recreational activities along trails, and shade out other native species. Can invade undisturbed forests and hybridize with the common barberry; and can impact agriculture by spreading black stem rust, a disease capable of causing major damage to grain crops.
Japanese honeysuckle	Twines around stems of shrubs, herbaceous plants and other vertical supports; forms large tangles that smother and kill vegetation; and kills shrubs and saplings by girdling.
Japanese spurge	Can spread by rhizomes in difficult growing conditions.
Lily of the valley	Outcompetes native species for resources by forming dense colonies. All parts of the plant are highly poisonous.
Manitoba maple	Quickly establishes itself along riverbeds and in disturbed areas, but can also grow rapidly in a variety of soil types where they create weak, hazardous and short-lived dense canopies that shade out native species.

[70] The threat from invasive aquatic species was recognized by the Canadian Council of Fisheries and Aquaculture, in a report: "A Canadian Action Plan to Address the Threat of Aquatic Invasive Species," in 2004. High risk invasive aquatic plants in the trades were identified in DFO reports by Marson et al., 2009a; 2009b and later formal risk assessments were again performed by Gantz et al., "Application of an Aquatic Plant Risk Assessment to Non-Indigenous Freshwater Plants in Trade in Canada,"2014." Some of these issues were identified in the "2019 Spring Reports of the Commissioner of the Environment and Sustainable Development," 2019.

Miscanthus	Forms thick bunches, displacing native plant communities and reducing light availability to other plants at the soil surface; creates fire hazards as dense, dry stands are highly flammable; and decomposes on the ground, limiting the amount of nutrients returned to the soil.
Multiflora rose	Overtakes the landscape, shading and outcompeting native species for light and nutrients; modifies the structure of the habitat it invades; and uses other trees and plants as scaffolding, overgrowing the plant and thereby suppressing its growth and/or killing it.
Norway maple	Creates dense shade, reducing the amount of light that reaches the forest floor, and replaces native tree species.
Oriental bittersweet	Chokes and girdles native woody plants. Can be spread long distances by birds as it can remain in the stomach for weeks.
Ornamental honeysuckle	Rapidly invades areas, outcompeting native plants by forming dense patches; affects light and nutrient availability of neighbouring plants; and produces toxic chemicals.
Periwinkle	Can escape cultivation and spread rapidly, quickly becoming a dominant plant in the forest understory, and outcompeting and displacing native plant species and tree seedlings.
Russian olive	Drinks more water than most plants in dry soil settings and can outgrow and compete with native species.
Sea buckthorn	Poses a threat to the native vegetation of sand dunes by forming dense thickets that shade out native dune plants and alter the nutrient status of the soil where it grows.
Spearmint	Can quickly sprawl into surrounding areas and suppress the growth of native plants.
Tree-of-heaven	Outcompetes native trees and is a preferred host for spotted lanternfly, an invasive insect not yet established in Canada.
White mulberry	Poses a threat to the endangered native red mulberry due to the hybridization of the invasive tree with the native tree.
Winged burning bush	Forms dense thickets, which can displace native woody and herbaceous plants.
Wintercreeper	Increases the rates of decomposition and nutrient cycling on the forest floor, altering the soil bacterial community in ways that benefit wintercreeper growth.
Yellow archangel	Can easily escape cultivation and establish in a variety of habitats, surviving robust and extreme conditions where it can reproduce through several means and dominate the forest floor.

QUÉBEC (QC):

Québec's *Environment Quality Act* (CQLR c Q-2) states that the Government may make regulations "to regulate or prohibit the growing, sale, use or transportation of specified invasive plant species whose establishment or propagation in the environment is likely to harm the environment or biodiversity" (95.1 -26), but the article has never been applied.

The regulation respecting noxious weeds, Agricultural Abuses Act (R.S.Q., c. A-2, s. 7) was repealed in 2018. La Fondation de la faune du Québec has developed the "Program for the Fight against Invasive Alien Plants" and the Ministère de l'Environnement has developed lists of priority invasive species, but no specific regulations are currently associated with this list.[71] In an article in La Tribune, Nicolas Bousquet from the COGESAF (Conseil de gouvernance de l'eau des bassins versants de la rivière Saint-François) is quoted:

> We often talk about it, but there is no solution. Who is going to legislate on this? The province does not want to get involved, it's complicated . . . Is it the MRCs [regional county municipalities]

[71] Fondation del la faune du Québec, "Programme pour la lutte contre les plantes exotiques envahissantes," 2023.

> who have to manage this or the municipalities? It's a bit on a case-by-case basis, who is going to apply that? It is complicated to implement regulations. We are like in a dead end where no one really wants to manage that.[72]

There is a *Plant Protection Regulation* (CQLR c P-42.1, r 2) that focuses on protecting commercial crops from harmful organisms but does not address invasive ornamental plants.

NEW BRUNSWICK (NB):

New Brunswick had a *Weed Control Act* (SNB 1969, C.21) but it was repealed and has been replaced by the *Plant Health Act* (RSNB 2011, c 204). Under the New Brunswick *Plant Health Act*, invasive weed species and weed seed could be designated as pests. No plants are listed as part of the legislation, though it refers to the federal *Seeds Act*.

NOVA SCOTIA (NS):

Nova Scotia regulates two classes of plants in their *Agricultural Weed Control Act* (R.S.N.S. 1989, c. 501). **Class Number One** plants are those that pose threats to cultivated or pasture lands. There are nine species listed in this category including the native common milkweed (*Asclepias syriaca*), which is essential to the native monarch butterfly. **Class Number Two** plants are those capable of inflicting ill health. The only plant listed is thornapple, *Datura* spp. (*Weed Control Regulations*, NS Reg 57/68). This likely presents a conundrum as certain *Datura* species, hybrids and cultivars are sold in the nursery trade in Canada.

NEWFOUNDLAND AND LABRADOR (NL):

Newfoundland and Labrador have a *Plant Protection Act* (RSNL1990 ch 16). It prohibits the exchange or sale of plants that are infected or infested with a pest. A pest is defined as something that causes "damage to a vegetable, a part, product or by-product of a vegetable or a plant material." No list of regulated invasive plants is apparent.

Newfoundland and Labrador hosted the two-day "Exotic and Invasive Alien Species Workshop" in 2008 including a review of legislation.[73] At the time, gaps in regulations, gaps in knowledge, lack of resource availability, and lack of standardized definitions were cited as problems. It was noted that:

- Most of the legislation reviewed federally and provincially was written before the IAS issue was elevated to what it is now.
- Many acts both nationally and provincially deal with substances, and organisms which could be interpreted as invasive alien species.
- Many of these acts were written to deal with specific issues as they relate to an industry or human health (e.g., *Plant Protection Act*).[74]

They called for better inter-agency cooperation and consideration of legislation.

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[72] Pion, "Des plantes envahissantes toujours en vente libre," 2022. (Quote translated from the original French).
[73] NL Fisheries, Forestry and Agriculture, "2008 Exotic and Invasive Alien Species Workshop," 2008.
[74] NL Wildlife Division, Department of Environment and Climate Change, "Legislation Review- Invasive Alien. Presentation," 2008.

PRINCE EDWARD ISLAND (PE):

Prince Edward Island's *Weed Control Act* (RSPEI 1988, c W-2.1) allows for the regulation of plants deemed noxious weeds. The Lieutenant Governor may designate a noxious weed as any plant that adversely affects or is likely to adversely affect any person, crop or other desirable plant, animal, or property. Loosestrife (*Lythrum* spp.) is the only taxa listed and there is a specific regulation that makes it an offence "to import, propagate or sell purple loosestrife or any variety or species of the genus *Lythrum*" (*Purple Loosestrife Control Regulations* PEI Reg EC629/91). There is also a *Plant Health Act* (RSPEI 1988, c P-9.1), but this legislation is largely aimed at the control of plant pathogens and does not reference weedy or invasive species.

NORTHWEST TERRITORIES (NT):

The Northwest Territories have no regulation specifically prohibiting invasive plants or noxious weeds. There is a *Protected Areas Act* (SNWT 2019, c. 11) to support and promote the protection, conservation and maintenance of biodiversity, ecological integrity, and cultural continuity of the Northwest Territories. It may be possible through this act to undertake protective measures, where there are threats of serious or irreparable harm to the ecological integrity of an area posed.[75]

NUNAVUT (NU):

In Nunavut, the purpose of the *Wildlife Act* (SNu 2003, c 26) is to "establish a comprehensive regime for the management of wildlife and habitat . . . including the conservation, protection, and recovery of species at risk." In specific reference to invasive species, it states that:

"No person shall release a member of a species into a habitat in which that species does not belong or never naturally occurred." Several guiding principles apply under this act including: *Avatimik Kamattiarniq/Amiginik Avatimik*. This essentially means that "people are stewards of the environment and must treat all of nature holistically and with respect, because humans, wildlife and habitat are inter-connected and each person's actions and intentions towards everything else have consequences, for good or ill."

In 2010, the Canadian Endangered Species Conservation Council (CESCC) identified 14 non-native plant species in Nunavut but stated: "there are currently no known species in Nunavut that can be classified as aquatic or terrestrial invasive species."[76] The CFIA technical report on Invasive Species Canada reported 16 invasive plant species in Nunavut,[77] While the interpretation of invasiveness can be debated, the discrepancy suggests a lack of information sharing between the Federal Government and territorial representatives.

[75] Gov. NWT, "Protected Areas Act," n.d..
[76] Environment Canada, "Non-native & invasive species in Nunavut," 2010.
[77] CFIA, 2008.

YUKON (YT):

The objectives of the *Environmental Act* (RSY 2002, c.76) are "to ensure the maintenance of essential ecological processes and the preservation of biological diversity". It does not explicitly mention IAPS but classifies "organisms prescribed by the Commissioner in Executive Council to be dangerous to life, health, property, or the natural environment" as Class 9 hazardous substances. It is unclear if this Act could be used to regulate IAPS.

SUMMARY:

The above provincial and territorial lists of regulated plants, or lack thereof, tell a story of inconsistency and lack of communication. Invasive plant species do not stop at borders. A national coordinating body is needed to facilitate cooperation between regions and to ensure information is broadly shared and resources are used efficiently and effectively.[78] Canada could use the Federal-Provincial-Territorial Invasive Alien Species National Committee established in 2018[79] or create a new biosecurity authority like that in Australia and New Zealand with a broader focus.[80] A coordinating body mandated to protect biological diversity along with the economy, food security, and public health is clearly needed.

In addition to national leadership, a national risk assessment database would go a long way to ensure that regions have access to science-based threat analysis. Many provinces identified lack of information and lack of expertise as obstacles to action. The Federal Government should remove these obstacles. Some plants should be regulated at the national level. As is the case with giant reed, federal regulation can avoid "a province-by-province approach to legislation, which could be less consistent.[81]

INVASIVE PLANT REGULATIONS IN THE U.S.

The regulation of invasive plants in the United States is a complex and evolving issue. The regulation of invasive plants is primarily handled at the state level, however, as in Canada there are federal acts to protect seed quality[82] and to protect plants. Unlike in Canada, there is a U.S. National Invasive Species Council (NISC) coordinating federal departments and agencies.

A National Invasive Species Information Center (NISIC) was developed to support the activities of the council.[83] It provides a wide range of invasive species information; covering federal, state, local, and

[78] Gov. of Canada, "Canadian Invasive Plant Framework: A Collaborative Approach to Addressing Invasive Plants in Canada, 2011.
[79] A 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 (ECCC, Personal Communication, April 2023); Report releases by FPT IAS "Recommendations of the Invasive Alien Species Task Force," 2017.
[80] Reid et al., "The state of Canada's biosecurity efforts to protect biodiversity from species invasions," 2021.
[81] CFIA, "RMD-16-02: Pest Risk Management Document for *Arundo donax* (giant reed)," 2017a.
[82] The U.S. Federal Seed Act Regulations (7 CFR § 201.28), first enacted in 1939, is used to regulate interstate and foreign commerce in seeds, to prevent "noxious weed seeds" that may be present in seed products.
[83] NISC [National Invasive Species Information Center], "About our site," 2023; NISC "Meeting the Invasive Species Challenge: National Invasive Species Management Plan," 2001.

international sources. Included in the database are up-to-date species lists and laws as well as resources for management and control. This kind of national database is needed in Canada.

At the federal level, the U.S. Department of Agriculture (USDA) is responsible for regulating invasive plants. APHIS (Animal and Plant Health Inspection Service) is a sub-agency of the USDA that like the CFIA is a National Plant Protection Organization under the IPPC. APHIS performs risk assessments in accordance with IPPC standards and maintains a list of plants considered noxious weeds (including invasive plant species). The importation, interstate movement, and release of noxious weeds are regulated under the U.S. *Plant Protection Act* of 2000 (PPA - 7 U.S.C. §7701).

The U.S. PPA consolidated and superseded several laws including the *Federal Noxious Weed Act* of 1974 (as amended).[84] The U.S. act has a broader scope than Canada's act of the same name. While Canada's PPA protects plant health and the agricultural and forestry sectors, the purpose of the U.S. PPA is to protect agriculture, environment, and economy.[85] In addition, in 2014, the U.S. act was amended to better regulate any plant that could potentially be a vector for a plant pest or disease.[86]

Changes to the U.S. PPA include complex import regulations. These are described in the APHIS "Plants for Planting Manual." This document contains an extensive list of regulated plants with specific restrictions. Importation and interstate movement without a permit of those plants designated Federal Noxious Weeds continues to be prohibited.

The Federal Noxious Weed List was last updated in 2010.[87] At that time, 87 terrestrial, 19 aquatic, and 5 parasitic taxa were on the list. The list includes some plants in the ornamental/horticultural trades. While ornamental noxious weeds, like Japanese bloodgrass (*Imperata cylindrica*), cannot be imported or moved from one state to another, vendors can still offer such plants for sale if they were propagated within the state.[88]

Each state can establish its own regulations and management strategies for invasive plants. Most states maintain a list of plants considered noxious weeds within the state. Plants identified may be prohibited or restricted, or control requirements may be prescribed.

Some states explicitly recognize invasive plants in the ornamental and landscaping trades and regulate their sale and or require labels to better inform the public of their harm. As in Canada, there are significant gaps and inconsistencies between states. However, some plants have been recognized in multiple states. (Examples are shown in Table 7 below.)

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[84] The U.S. *Plant Protection Act* consolidated and superseded several U.S. plant health laws, including *The Act of August 20*, 1912, The Federal *Plant Pest Act;* Section 102 (a)-(e) of the Department of Agriculture *Organic Act* of 1944; The Federal *Noxious Weed Act* of 1974 and several others (Corn & Johnson, "Invasive Species: Major Laws and the Role of Selected Federal Agencies," 2017).

[85] Congressional Research Service, "Invasive Species: Major Laws and the Role of Selected Federal Agencies," 2017, 15.

[86] "The Agriculture Act of 2014; H.R. 2642 / Pub. L. 113-79—became law in June 2014. It authorizes permanent funding for programs (USDA, "Plant Protection Act FY2020 (Annual) Implementation Plan for Section 7721: Plant Pest and Disease Management and Disaster Prevention Programs including the National Clean Plant Network," 2019.).

[87] USDA APHIS, "Noxious Weeds Program Home Page,"2022 list 2010; Gov.info. 7 CFR § 360.200 - Designation of noxious weeds. 2022.

[88] Beaury, Patrick & Bradley "Invaders for sale: the ongoing spread of invasive species by the plant trade industry,", 2021.

Table 7: Examples of ornamental plants regulated in three or more North American jurisdictions.

Scientific name	Common name	Jurisdictions regulated in U.S. Border States (additional states) and Canada	
Acer ginnala syn Acer tataricum subsp. *ginnala*	Amur maple	ME VT WI	
Acer platanoides	Norway maple	ME NH NY VT	
Acer pseudoplatanus	Sycamore maple	NY (CT MA)	
Aegopodium podagraria	Goutweed, Bishop's weed	ME OH VT WI	
Ailanthus altissima	Tree of heaven	ME MI NH, OH, PA VT WA WI (DE CT IN MA)	AB
Anthriscus sylvestris	Wild chervil, raven's wing	NY WA WI (MA)	CAN (2&5) ON
Berberis thunbergii	Japanese barberry	ME NH NY VT NY PA WI (DE IN MN)	CAN (PPA) 11 cultivars excluded
Celastrus orbiculatus	Asiatic bittersweet	ME MN NH NY OH PA VT WI (DE CT IL MA)	
Cytisus scoparius	Scotch broom	ID OH MT PA WA WI (MD)	BC
Elaeagnus angustifolia	Russian olive	OH MT WA WI (IL)	
Elaeagnus umbellata	Autumn olive	ME MI NH NY OH WI (CT DE MA)	AB
Euonymus alatus	Winged euonymus	ME NH NY VT WI (DE MD MA)	
Fallopia baldschuanica syn. *Polygonum …*	Silver lace vine	ME NH (IL)	
Frangula alnus syn. *Rhamnus frangula*	Buckthorn	ME NH NY OH PA VT WI (IL MA)	MB
Gensita spp.	Brooms	ID OH PA WA	
Gypsophila paniculata	Baby's breath	PA WA	AB BC MB SK
Iris pseudacorus	Yellow flag iris	ID ME MT NH NY OH, VT WA WI (MA MD OR)	AB BC MB
Leucanthemum vulgare syn. *Chrysanthemum leucanthemum*	Oxeye daisy	ID MT OH WA (AK PA)	CAN (3) AB BC MB SK BC
Ligustrum vulgare	Privet	ME NH NY	
Lonicera japonica *L. maackii* *L. morrowii* *L. tatarica* *L. x bella*	Honeysuckle, Japanese Amur or bush Morrow's Tatarian Bella*	ME MN NH NY OH VT WI (DE CT IL) *Bella is not regulated in ME or OH *L. xylosteum* is on ME list	
Lythrum virgatum	Wand loosestrife	OH WA WI	PE SK
Phellodendron amurense	Amur cork tree	ME NY WI (MA)	
Pyrus calleryana	Callery ("Bradford") pear	ME OH PA (MD SC)	
Rosa multiflora	Multiflora rose	ME NH, NY OH PA WI (IL MA)	
Ranunculus ficaria syn. *Ficaria verna*	Lesser celandine	NY OH WA WI (DE CT IL)	
Tamarisk ramosissima	Salt cedar	ND WA (IL)	AB MB SK

"The widespread availability of invasive plants in the U.S. is likely a symptom of disjointed state regulations that fail to protect ecosystems and economies."[89] Below is a quick summary of the approach taken by the 13 states bordering Canada: Maine, New Hampshire, Vermont, New York, Pennsylvania, Ohio, Michigan, Minnesota, North Dakota, Montana, Idaho, Washington, and Alaska.

MAINE (ME):

In the Maine code of rules, the Criteria for Listing Invasive Terrestrial Plants (01-001 C.M.R. Ch. 273) "describes the criteria a plant species must meet to be considered invasive and establishes three lists of plants that regulate the sale of invasive plants in the horticulture trade."[90] The invasive plant lists described in Maine's code are maintained by the Maine Department of Agriculture & Forestry under their Horticulture Program. Sixty-three (63) plants currently appear on the "Do Not Sell Plant List" (Table 8) with 29 more on a watch list.

Table 8: Maine Do Not Sell Plant List (2022).

Scientific name	Common name	Scientific name	Common name
Acer ginnala	Amur maple	*Iris pseudacorus*	Yellow Iris
Acer platanoides	Norway maple	*Ligustrum obtusifolium*	Border privet*
Aegopodium podagraria	Bishop's weed	*Ligustrum vulgare*	Common privet
Ailanthus altissima	Tree of heaven	*Lonicera japonica*	Japanese honeysuckle
Alliaria petiolata	Garlic mustard	*Lonicera maackii*	Amur or bush honeysuckle
Alnus glutinosa	European alder*	*Lonicera morrowii*	Morrow's honeysuckle
Amorpha fruticosa	False indigo	*Lonicera tatarica*	Tatarian honeysuckle
Ampelopsis glandulosa	Porcelainberry	*Lonicera xylosteum*	Dwarf honeysuckle*
Angelica sylvestris	Woodland angelica*	*Lythrum salicaria*	Purple Loosestrife
Anthriscus sylvestris	Wild chervil, raven's wing*	*Lythrum virgatum*	Wand loosestrife*
Aralia elata	Japanese angelica tree*	*Microstegium vimineum*	Stilt Grass
Artemisia vulgaris	Common mugwort	*Miscanthus sacchariflorus*	Amur silvergrass*
Berberis thunbergii	Japanese barberry	*Paulownia tomentosa*	Paulownia
Berberis vulgaris	Common barberry	*Persicaria perfoliata*	Mile-a-minute weed
Butomus umbellatus	Flowering rush*	*Petasites japonicus*	Fuki, butterbur *
Celastrus orbiculatus	Asiatic bittersweet	*Phalaris arundinacea*	Reed canary grass *
Elaeagnus angustifolia	Russian olive*	*Phellodendron amurense*	Amur cork tree
Elaeagnus umbellata	Autumn olive	*Photinia villosa*	Photinia, Christmas berry*
Euonymus alatus	Winged euonymus	*Phragmites australis*	Common reed*
Euonymus fortunei	Wintercreeper *	*Phyllostachys aurea*	Golden bamboo*
Euphorbia cyparissias	Cypress spurge	*Phyllostachys aureosulcata*	Yellow groove bamboo
Fallopia baldschuanica	Chinese bindweed	*Populus alba*	White cottonwood
Fallopia japonica	Japanese knotweed	*Pyrus calleryana*	Callery ("Bradford") pear*
Festuca filiformis	Fine-leaved sheep fescue*	*Ranunculus repens*	Creeping buttercup
Ficaria verna	Lesser celandine	*Robinia pseudoacacia*	Black locust
Frangula alnus	Glossy buckthorn	*Rosa multiflora*	Multiflora rose
Glaucium flavum	Yellow hornpoppy*	*Rubus phoenicolasius*	Wineberry*
Glechoma hederacea	Ground ivy *	*Silphium perfoliatum*	Cup plant*

[89] Beaury, "Invaders for sale: The ongoing spread of invasive species by the plant trade industry. ESA, 2020" [YouTube Presentation], 2020.
[90] Maine Dept. Agriculture, Conservation & Forestry, "Horticulture Program: Invasive plants," 2021.

Glyceria maxima	Great mannagrass*	*Sorbus aucuparia*	European mountain-ash*
Hesperis matronalis	Dame's Rocket	*Tussilago farfara*	Coltsfoot*
Hippophae rhamnoides	Sea buckthorn*	*Valeriana officinalis*	Common valerian*
Impatiens glandulifera	Ornamental jewelweed		
**To be phased out by January 2024*			

There is a separate regulatory code for the *Prevention of the spread of invasive aquatic plants* (38 MRSA 419-C which is under the authority of the Maine Dept. of Environmental Protection, "**A person may not: Possess, import, cultivate**, transport or distribute any invasive aquatic plant or parts of **any invasive aquatic plant**, including roots, rhizomes, stems, leaves or seeds, in a manner that could cause the plant to get into any state waters." **Water Gardeners and Aquarium Owners are informed that eleven aquatic plants are prohibited in the state**.[91]

NEW HAMPSHIRE (NH):

New Hampshire has enacted an Invasive Species rule (Ch. Agr 3802.1). "It is illegal in New Hampshire to collect, transport, sell, distribute, propagate or transplant any living or viable portion of any listed **prohibited invasive plant species** including all of their cultivars, varieties, and specified hybrids."[92] The NH Prohibited Invasive Species List includes popular landscaping plants like burning bush (*Euonymus alatus*), Norway maple (*Acer platanoides*), and yellow flag iris (*Iris pseudacorus*).[93]

New Hampshire Invasive Species Council adopted the nationally recognized invasive species evaluation protocol known as NatureServe Invasive Species Impact Rank (I-Rank).[94] It is used to determine which non-native plant species pose the most serious threats to native species and ecosystems. These are then evaluated for inclusion on the prohibited species list.

Aquatic invasive plants are addressed by a different regulation. "Since January 1, 1998, the sale, distribution, importation, propagation, transportation and introduction of key exotic aquatic plants has been prohibited (RSA 487:16-a)."[95] The extensive list includes all *Myriophyllum* species. Plants like yellow flag iris are included on both terrestrial and aquatic prohibited lists.

VERMONT (VT):

The state of Vermont "regulates the importation, movement, sale, possession, cultivation and/or distribution of certain plants known to adversely impact the economy, environment, or human or animal health" (VT *Quarantine #3 -Noxious Weeds*). The state Noxious Weed List includes Class A plants that are not yet in the state and Class B plants "that is not native to the state, is of limited distribution statewide, and poses a serious threat to the State, or any other designated noxious weed being managed to reduce its occurrence and impact in the State, including those on the Federal Noxious Weed List (7 C.F.R. 360.200)." The list prohibits the sale of several plants of ornamental interest, e.g., Norway maple (*Acer platanoides*), Japanese barberry (*Berberis thunbergii*), amur maple (*Acer ginnala*). The list also includes invasive aquatic plants like parrot feather (*Myriophyllum aquaticum*).

[91] ME Dept Environment Protection, "Water Gardeners and Aquarium Owners," 2019.
[92] NH Dept. of Agriculture, Markets & Food, "Invasive Plants," 2022.
[93] NH Dept. of Agriculture, Markets & Food, "Fact sheet: Prohibited Invasive Plant Species Rules, Agr 3800," 2017.
[94] NatureServe, "Data Types: Invasive Species Impact Rank," 2022.
[95] NH Dept of Environmental Services "Law Prohibits Exotic Aquatic Plants," 2019.

"**The impacts of these plant species on native ecosystems outweigh their value as ornamental plants** in the nursery and landscaping trades to the extent that the Agency of Agriculture has banned their sale in an effort to prevent their introduction into as yet uninfested areas or slow their further spread across the state through commerce."[96]

The Vermont Invasive Exotic Plant Committee (VIEPC) also maintains a "watch list" that has no regulatory force but is used to educate the public about potentially problematic plants. The plants are periodically reviewed for inclusion on the regulated list. "The VIEPC is composed of representatives from state and Federal Government, nonprofit organizations and private industry, as well as concerned individuals."[97]

NEW YORK (NY):

A regulation (6 CRR-NY V C 575 *Prohibited and Regulated Invasive Species*) was adopted in July 2014, that prohibits or regulates select invasive species. "The purpose of this regulation is to help control **invasive species, a form of biological pollution**, by reducing new infestations and spread of existing populations".[98]

Prohibited invasive species include plants of horticultural interest like amur cork tree (*Phellodendron amurense*), amur honeysuckle (*Lonicera maackii)* and Japanese bloodgrass (*Imperata cylindrica*). Prohibited species cannot be possessed with the intent to sell, import, purchase, transport or introduce. There are additional plants in the nursery trade classified as regulated invasive species. This list includes six species: black locust (*Robinia pseudoacacia*), burning bush (*Euonymus alatus*) Norway maple (*Acer platanoides),* Chinese silver grass (*Miscanthus sinensis*), Japanese virgin's bower (*Clematis ternifora*), winter creeper (*Euonymus fortunei*). These regulated species cannot be knowingly introduced into a free-living state.[99] Businesses selling any regulated species are required to label them with a 14-point font warning: **Invasive Species - Harmful to the Environment**.

This regulation was based upon a report prepared by the New York Invasive Species Council entitled "A Regulatory System for Non-Native Species" (2010). The "four-tier system proposed in this report includes:

- a list of prohibited species, which should be unlawful to possess, import, purchase, transport, or introduce except under a permit for disposal, control, research, or education;
- a list of regulated species, which should be legal to possess, sell, buy, and transport but not be introduced into a free-living state;
- a list of unregulated species which are non-native species that should not be subject to regulation; and
- a procedure for the review of a non-native species that is not on the prohibited, regulated, or unregulated lists before the use, distribution, or release of such non-native species."

[96] VT Agency of Agric., Food and Markets, "Quarantine #3 – Noxious Weeds (Noxious Weeds Rule) Frequently Asked Questions (FAQs)," 2012.
[97] Spinney, "Vermont's Invasive Exotic Plant Watch List Updated," 2022.
[98] NY Dept. of Environmental Conservation, "Invasive Species Regulations," 2022.
[99] Introduction in a free-living state means introducing the plant into an unconfined area outside the control of a person, and in particular public lands, lands connected to public lands, natural areas, public waters, waters connected to public waters or water-using facilities that provide access to public waters.

The *Invasiveness Ranking Form* is a possible assessment tool that could be useful in Canada.

In May 2016, a statewide *Aquatic Invasive Species (AIS) Spread Prevention Regulation* (6 NYCRR Part 576) was adopted to prevent the spread of aquatic invasive species.[100] It does not impact the sale of aquatic invasive plants.

PENNSYLVANIA (PA):

To protect agriculture and ecosystems, Pennsylvania enacted a *Controlled Plant and Noxious Weed Act.* (2017, PA C.S. 3). With those changes, a new Invasive Plant/Noxious Weed List (§ 317-103) was created that incorporates the PA Dept. of Agriculture's Noxious, Invasive and Poisonous Plant Program Class lists and the PA Dept. of Conservation and the Natural Resource's list of "Invasive Plants of Pennsylvania." Weeds are categorized in three classes based on spread and eradication potential. The list includes the Federal Noxious Weeds in Class C. **It is a violation to distribute, cultivate or propagate any noxious weed**. The list includes aquatic plants like European water chestnut (*Trapa natans*) and ornamental terrestrial plants like wild chervil (*Anthriscus sylvestris*) and chocolate vine (*Akebia quinata*).[101]

OHIO (OH):

In 2018, to protect native plant species, Ohio enacted an ***Invasive Plant Species Rule*** (901:5-30-01). Invasive plant species are defined as plant species that are not native to Ohio whose introduction causes or is likely to cause economic or environmental harm, or harm to human health as determined by scientific studies. Under this rule, "**no person shall sell, offer for sale**, propagate, distribute, import or intentionally cause the dissemination of any invasive plant." The list includes ornamental plants like tree-of-heaven (*Ailanthus altissima*), various Asian bush honeysuckle (e.g., *Lonicera japonica*), callery pear (*Pyrus calleryana*) and includes aquatics like water chestnut (*Trapa natans*) and water milfoils (*Myriophylum* spp.).

There are additional regulations for plants designated "noxious weeds" (901:5-37-01). Prohibited plants include several ornamental invasive plants such as purple loosestrife (*Lythrum salicaria*), kochia (*Bassia scoparia*), Japanese knotweed (*Polygonum cuspidatum*). Yellow groove bamboo (*Phyllostachys aureasculata)* is also prohibited "when the plant has spread from its original premise of planting and is not being maintained."

MICHIGAN (MI):

A limited number of invasive plant species are designated by the State of Michigan as either "prohibited" or "restricted." (*Natural Resources and Environmental Protection Act 451 of 1994* PART 413: *Transgenic and Nonnative Organisms*). The list of regulated species includes mostly aquatic invasive species and two terrestrial species: giant hogweed (*Heracleum mantegazzianum*) and Japanese knotweed (*Fallopia japonica*).[102] If a species is prohibited or restricted, it is unlawful to possess, introduce, import, sell or offer that species for sale.

[100] NY Dept. of Environmental Conservation, "Invasive Species Regulations," 2016.
[101] PA Dept. of Agric "Controlled Plant & Noxious Weeds," 2022.
[102] Michigan Agriculture & Rural Development, "Prohibited and Restricted Weeds," n.d..

Michigan also has "**rarely enforced**" noxious weed regulations.[103] Michigan's *Seeds Law* limits the percentage of noxious weed seed in "agricultural, vegetable, lawn, flower, and forest tree seeds" (MI *Seed Law 1995*, *Act 329*; and *Seed Law Implementation 1995*, *Regulation 715*). The MI Department of Agriculture maintains the Prohibited and Restricted Weeds Lists, though the official MI government website does not make it immediately clear which invasive species are regulated.[104]

MINNESOTA (MN):

Minnesota has several state laws intended to minimize the introduction and spread of invasive plant species. In addition to a *Noxious Weed Law* (Agric. Ch. 18), Minnesota has enacted additional statutes and rules to explicitly control invasive species (*Conservation Ch 89D; Natural Resources Department Ch 6216*). This state prohibits many aquatic invasive plants (28 species), including all but one on the federal noxious weed list, and regulates another seven.[105] Many ornamental terrestrial species are regulated as noxious weeds using a four-tiered system. "The Noxious Weed Law affects growing plants. Some plants are noxious because they can harm people, animals, the food we eat, and nature."[106]

There are currently 29 species on the prohibited noxious weed list, 16 on the eradicate list, and 13 on the control list. There are an additional 15 on a restricted list that cannot be sold, and four species that have special regulations. The various lists correspond to the establishment of the plants in the state and the requirements for control.

- Prohibited – Eradicate: not yet present. For instance, tree-of-heaven (*Ailanthus altissima*) is not yet present in the state, cannot be sold, and must be eradicated when found.
- Prohibited – Control: present and containable. - For example, giant knotweed (*Polygonum sachalinese*) is present in the state. It cannot be sold and must be controlled in a way that prevents its spread by seed or vegetative means where eradication is not possible.
- Restricted: widespread, eradication unlikely: These are widespread invasive plants, like the multiflora rose (*Rosa multiflora*) and eradication or control is "not feasible" statewide. These plants may not be sold or intentionally distributed.
- Regulated: eradication or control can be enforced under specific conditions: Four species fall under this regulation: amur maple, Norway maple, poison ivy, and burning bush.

For instance, amur maple and Norway maple may be sold, but as in New York, labelling is required.

> Sellers shall affix a label directly to the plant or container packaging that is being sold that advises buyers to only plant [these species and their] cultivars in landscapes where the seedlings will be controlled by mowing or other means. . .. [S]eed is wind dispersed and trees should be planted at least 100 yards from natural areas[107]

Burning bush is being phased out and will move to Restricted status in 2023. Plants like poison ivy (a native) must be controlled where it poses a public health hazard.

[103] Isleib,"Michigan noxious weed laws, though rarely enforced, define and regulate prohibited/restricted weeds," 2012.
[104] Michigan gov. "Invasive Species," 2022.
[105] MN Dept of Natural Resources, "Minnesota Weed Law," 2022.
[106] MN Dept. of Agric., "Minnesota invasive species laws," 2022b
[107] MN Dept. of Agric., "State Prohibited Noxious Weeds," 2022c.

NORTH DAKOTA (ND):

North Dakota prohibits the sale and intentional distribution of noxious weeds (ND CC § 4.1-47-02). They include ornamentals like purple loosestrife (*Lythrum salicaria* L., *L. virgatum* L. and all cultivars) as well as all salt cedar (*Tamarisk* spp.).

North Dakota prohibits the transport of any aquatic vegetation to or from any waters of the state.[108]

MONTANA (MT):

Montana maintains a noxious and regulated plant list under various agriculture regulations (Ch 4.5; Ch 7). Plants are classified as priority 1A, 1B, 2A, 2B or 3, based on their presence in the state and the management required.[109] As in Minnesota, those not yet present like common reed (*Phragmites australis* ssp. *australis*) require eradication. Those present like the knotweed complex (*Fallopia japonica, F. sachalinensis, F.* × *bohemica*) require eradication or containment.

More common invasive species like yellow flag iris (*Iris pseudacorus*) and Eurasian watermilfoil (*Myriophyllum spicatum, M. spicatum* x *M. sibiricum*) require containment and are prioritized over common species like oxeye daisy (*Leucanthemum vulgare*). There is a final category of regulated but not noxious plants that **cannot be intentionally spread or sold**, and this short list includes aquatic plants like parrot feather watermilfoil (*Myriophyllum aquaticum* or *M. brasiliense*) as well as terrestrials like Russian olive (*Elaeagnus angustifolia*).

IDAHO (ID):

Idaho has two statutes regulating invasive plants, a *Noxious Weeds regulation* (22 Ch 24) and a more recent *Invasive Species Act* (22 Ch19). Under the invasive species regulation, "**No person may** import, export, **purchase, sell, barter,** distribute, propagate, transport or introduce an **invasive species** into or within the state of Idaho." Invasive aquatic and terrestrial species are included with noxious weeds on state lists.[110]

Idaho has 71 weed species and 4 genera designated noxious by state law – 54 of these species are terrestrial.[111] Ornamental brooms and false brooms are all prohibited, from the genera: *Cytisus, Genista, Spartium,* and *Chameacytisus*. There are an additional 17 aquatic invasive species.[112] It is a tiered system requiring eradication, control, containment and or reporting, depending on how widespread the problem.

WASHINGTON (WA):

Washington State's *Noxious Weed Seed and Plant Quarantine* legislation (WAC 16-752-600) begins:

[108] ND, "Aquatic Nuisance Species." 2008, 30-03-06; ND Game and Fish, ANS Regulations," 2022.
[109] MT Gov., "Montana Noxious Weed List," 2019.
[110] ID, "Invasive species: Overview," 2022a.
[111] ID, "Invasive species: Terrestrial plants," 2022c.
[112] ID, "Invasive species: Aquatic plants,"2002b.

> Washington agriculture, environmental quality and natural resources, including waters and wetlands, are threatened by **non-native, aggressive species** of noxious weeds. A number of these noxious weeds are transported and sold within the state of Washington both as **nursery plants and as seeds in packets of flower seeds** or 'wildflower mixes.' Subsequent "escape" of these ornamentals has been a documented source of a number of infestations and has resulted in large public and private expenditures by landowners and land managers, weed boards, and weed districts and the department of agriculture to achieve the control mandated . . . regulation of the sale of these seed packets and plants as 'regulated articles' is necessary to protect Washington agriculture and natural resources and to prevent public and private costs of control.

Under state law establishing the *Noxious Weed Seed and Plant Quarantine rule*, "it is **prohibited to transport, buy, sell, offer for sale**, or to distribute plants or plant parts of the regulated species into or within the state of Washington" (WAC 16-752-620). Regulated species include certain noxious weed species,[113] but not all.

The WA noxious weeds are organized into three classes of weeds: Class A, B, and C. Class A are not widely distributed and must be eradicated where found. Class B are widespread, and containment or reduction is required. Class C weeds are often widespread or are of special interest to the agricultural industry. Control may be required if they pose a threat to agriculture or natural resources.[114] Additions of noxious weeds to the quarantine list within the last six years include: yellow archangel (*Lamiastrum galeobdolon*), butterfly bush (*Buddleja davidii*) except sterile cultivars, oriental clematis (*Clematis orientalis*), French broom (*Genista monspessulana*), giant reed (*Arundo donax*) (except variegated cultivars), and lesser celandine (*Ficaria verna*).[115]

ALASKA (AK):

Alaska's Department of Natural Resources manages *Prohibited and restricted noxious weeds* (Section 11 AAC 34.020). These are generally weedy species with little ornamental value. There is an *Aquatic Invasive Species regulation* (5 AAC 41.07), but no plants are identified on the list of regulated species.[116]

The Alaska Center for Conservation Science (ACCS) has been working to track all non-native species and has developed an invasive plant ranking system that evaluates the probability of species establishment in three eco-geographic regions of the state based on its worldwide range.[117] The list includes ornamental species like Siberian peashrub (*Caragana arborescens*) with high invasive potential. Hopefully such studies can be used to inform regulations to limit their spread.

SUMMARY

Bradley and colleagues recently summarized the status of the regulatory systems in the United States:

> [I]nvasive plant regulations are **inconsistent and reactive**. Of the 128 plants regulated by one or more states, 54 were regulated by a single state and only 16 were regulated by all six states; regulated species tended to be widespread across the region (not proactive). These outcomes are

[113] WA, "Prohibited plants and seeds in Washington State," 2021.
[114] WA Noxious Weed Control Board, "Washington's Noxious Weed Laws," n.d.a.
[115] WA Noxious Weed Control Board, "Noxious Weeds Index Quarantine List," n.d.b.
[116] AK Dept. of Fish and Game, "Invasive Species Legal Requirements," 2021
[117] ACCS, "Non-Native Plant Species List," 2021.

largely driven by different sets of evaluated species. For example, neighboring states Vermont and New Hampshire evaluated 92 species in total, but only 26 overlapped. In addition, states rarely evaluated species that were absent from the state. Risk assessment protocols varied considerably across states, but consistently included criteria related to ecological impact, potential to establish, dispersal mechanisms, and life history traits.[118]

SELECTED CASES STUDIES

The following are a few cases selected to illustrate problems with the current policies, processes, and regulations. They highlight gaps in regulations, inconsistencies, and serious risks posed by invasive plants that are not currently being addressed by any level of government. Many additional cases could be discussed.

AQUATIC INVASIVE SPECIES – FLOWING THROUGH A GAP

"Aquatic invasive species and their potential damage to Canadian aquatic ecosystems pose a multi-faceted problem with no easy solutions. The scope of the problem, combined with the fact that it will continue to grow if left unchecked, leaves no doubt that immediate steps must be taken."[119]

Fisheries and Oceans Canada (DFO) has identified the water-garden and aquarium trades as a primary source of non-native invasive plants in Canada.[120] Yellow flag iris, discussed above, was one of 88 taxa of 129 assessed considered potentially high risk, using an Aquatic Weed Risk Assessment protocol (AqWRA).[121] Several aquatic plants were of even higher concern than yellow flag iris.

Table 9: Risk assessments and regulations for invasive aquatic plants with volumes of sale in Canada.

Scientific name	Common name	Sales volume [122]	AqWRA score	USDA lowest hardiness zone[123]	Provinces Regulating	US Federal and States Regulating or Watching Taxa
Eichhornia crassipes	water hyacinth	32633	81	6	MB	Federal Noxious Weed, AL, AR, AZ, CA county, CO watch list, LA, MN, MS, NE, PR, SC, TX, Chicago, WI

[118] Bradley et al., "Breaking down barriers to consistent, climate-smart regulation of invasive plants: A case study of US Northeast states," 2022b.
[119] Canadian Council of Fisheries and Aquaculture, "A Canadian Action Plan to Address the Threat of Aquatic Invasive Species," 2004.
[120] 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.
[121] AqWRA is a 'questionnaire-style' risk assessment composed of 38 questions pertaining to the life history, ecology, climate tolerance, and invasion history of each species, (Gantz et al, 2014). 88 taxa of 129 assessed were considered potentially high risk. "*A priori* classification for test species based upon their status in the U.S. and predicted invasiveness risk level using the USAqWRA system" is available from Gordon et al., 2012.
[122] Marson et al., 2009a; 2009b.
[123] USDA Plant Hardiness Zone are a standard based on the average annual minimum winter temperature.

Pistia stratiotes	water lettuce	16374	72	7	MB	AL, CA county, CO watch list, FL, LA, MS, PR, SC, TX, WI
Cabomba caroliniana	cabomba, fanwort	6146	67	6	AB, MB, ON, SK	CA, CT, ID, MA, ME, MI, MN, NH, NY, PR, VT, WA, WI,
Egeria densa	Brazilian waterweed	5144	71	5	AB, MB, ON, SK	AL, CA, CO watch list, CT, ID, IL, IN, LA, MA, ME, MI, MN, MS, MT, NE, NH, NY, OH, OR, PR, SC, VT, WA, WI
Myriophyllum aquaticum	parrot feather	4107	75	5	MB, ON	AL, CA county, CO, CT, ID, IL, IN, MA, ME, MI, MN, MT, NE, NH, NY, OH, OR, VT, WA, WI
Iris pseudacorus	yellow flag iris, yellow water iris	2935	58	4	AB, MB, SK	CO watch list, CT, ID, IL, IN, MA, MD, MN, MT, NY, OR, VT, WA, WI
Trapa natans	European water chestnut	360	66	5 (3)[124]	AB, MB, ON	AL, ID, MA, ME, MI, NH, NY, OH, OR, SC, WI
Myriophyllum heterophyllum	Broadleaf watermilfoil	No data	72	5	AB	CT ID MA NH NY VT WA

As the table above indicates, many top-selling species in nurseries and in the aquarium-trade are considered high risk for invasion success. Popular plants like water hyacinth, water lettuce, fanwort, waterweed, and parrot feather all pose high risks to Canada's waterways.[125] As there are no labelling requirements, the public is unaware of the risks when purchasing such plants and are not informed that these plants should not be released into the environment. Of the above plants, only fanwort (*Cabomba*) appears in the Weed Risk Analysis documents maintained by the CFIA.[126]

Even though DFO had performed a risk analysis for many aquatic species in 2009, that information was not widely shared. It took EIGHT YEARS for the potential risk posed by fanwort to reach authorities in Ontario. The Office of the Ontario Auditor General reported:

> Carolina fanwort (an aquatic plant) was not regulated until almost five years after a Ministry consultant identified, in a draft risk assessment to the Ministry in 2017, that the species can cause significant harm to Ontario's natural environment (e.g., by out-competing native vegetation) and negatively impact recreational activities like boating, fishing, and swimming. We noted that this draft risk assessment is very similar (and in some sections identical) to the final risk assessment used to inform regulatory consideration for the species.[127]

[124] APHIS WRA for *Trapa natans* indicates hardiness zone 3 rather than those reported by Gantz et al, 2014.
[125] Adebayo et al., "Water hyacinth (*Eichhornia crassipes)* and water lettuce (*Pistia stratiotes*) in the Great Lakes: Playing with fire?" 2011.
[126] CFIA, "Weed risk analysis documents," 2021b.
[127] Office of the Auditor General of Ontario. 2019 Spring Reports of the Commissioner of the Environment and Sustainable Development, 2019.

Due to a lack of a shared information database for invasive plants, it took over a decade for regulation at the provincial level to occur. Other provinces and territories still lack the knowledge, resources and/or legislative tools to act. This will be explored further below.

The DFO risk assessments also did not appear to be transferred to the CFIA. In 2007, the CFIA informed the Pet Industry Joint Advisory Council of Canada (PIJAC) that the importation of 13 potentially invasive aquatic plants, in Table 8 below, would not be allowed entry into Canada until a risk assessment had been completed. "Once completed, the CFIA's aquatic plants policy will be finalized and posted on the CFIA website. Importers of aquatic plants will be notified accordingly."[128]

Of the 13 plants that appeared in the 2007 advisory, only two PRAs have been completed by the CFIA, one is pending, and the other ten are not listed among the plants being screened and subject to weed analysis documents. None are yet regulated under the *Plant Protection Act*.[129] Many of these plants were assessed by DFO as High-Risk plants.

Table 10: Aquatic plants identified by the CFIA as requiring risk assessment in 2007.

Species	CFIA Weed Risk Document (PRA)	AqWRA – U.S. Risk
Cardamine impatiens L. (narrowleaf bittercress)	not listed	
Crassula helmsii A. Berger (swamp stonecrop)	PRA pending	70 – High-Risk
Hydrilla verticillata (L. f.) Royle (water-thyme)	not listed**	79 – High-Risk
Limnophila indica (L.) Druce (Indian marshweed)	not listed	17 – Low-Risk
Limnophila sessiliflora (Vahl) Blume (Asian marshweed)	not listed	33 – Intermediate*
Ludwigia grandiflora (M. Micheli) Greuter & Burdet (large-flower primrose-willow)	not listed	
Ludwigia peruviana (L.) Hara (Peruvian primrose-willow)	not listed	61 – High-Risk
Marsilea quadrifolia L. (European waterclover)	not listed	65 – High-Risk
Myriophyllum aquaticum (Vell.) Verde. (parrot feather)	not listed**	66 – High-Risk
Najas minor All. (brittle waternymph)	not listed	67 – High-Risk
Nymphoides peltata (Gmel.) O. Kuntze (yellow floating-heart)	PRA / no regulations	A74 – High-Risk
Sagittaria sagittifolia L. (arrowhead)	not listed	30 – Low-Risk
Salvinia minima Baker (water fern)	not listed	70 – High-Risk *
Trapa natans L. (European water-chestnut)	PRA / no regulations	66 – High-Risk
* U.S. Fed. Noxious Weed; **Excluded from USGCP		

Both the U.S. and Canada have authority to regulate some aquatic invasive plants as pests under their respective PPAs, "but only the U.S. has an active program, with 19 aquatic plant species listed as Federal Noxious Weeds."[130] U.S. aquatic Federal Noxious Weeds:

- *Azolla pinnata* R. Brown (mosquito fern, water velvet)
- *Caulerpa taxifolia* (Vahl) C. Agardh, Mediterranean strain (killer algae)
- *Eichhornia azurea* (Swartz) Kunth (water hyacinth)
- *Hydrilla verticillata* (Linnaeus f.) Royle (hydrilla)

[128] Azan, "Invasive Aquatic Plants in the Aquarium and Ornamental Pond Industries," 2011.
[129] Three are listed as *Plants Excluded from the United States Greenhouse Certification Program*, a program that facilitates the trade of greenhouse-grown plants between the United States and Canada (CFIA, 2014).
[130] NAPPO, "DD 03: The Role of the North American Plant Protection Organization in Addressing Invasive Alien Species," 2011, 8.

- *Hygrophila polysperma* T. Anderson (Miramar weed)
- *Ipomoea aquatica* Forsskal (water-spinach, swamp morning-glory)
- *Lagarosiphon major* (Ridley) Moss; (frog's bit, tape-grass, waternymphs)
- *Limnophila sessiliflora* (Vahl) Blume (ambulia)
- *Melaleuca quinquenervia* (Cavanilles) S.T. Blake (punktree)
- *Monochoria hastata* (Linnaeus) Solms-Laubach (arrow-leaf pondweed)
- *Monochoria vaginalis* (Burman f.) C. Presl (heartshape false pickerelweed)
- *Ottelia alismoides* (L.) Pers. (duck lettuce)
- *Sagittaria sagittifolia* Linnaeus (arrowhead)
- *Salvinia auriculata* Aublet (eared watermoss, giant salvinia)
- *Salvinia biloba* Raddi (giant salvinia, watermoss)
- *Salvinia herzogii* de la Sota (giant salvinia, watermoss)
- *Salvinia molesta* D.S. Mitchell (giant salvinia, kariba weed)
- *Solanum tampicense* Dunal (wetland nightshade); and
- *Sparganium erectum* Linnaeus (exotic bur-reed).

It should be noted that in the early 1980s, all aquatic plants were subject to import requirements. Four taxa (*Elodea densa* -Brazilian waterweed, *Hydrilla verticillata* - water-thyme, *Myriophyllum* spp. - watermilfoil, and *Trapa* spp. - European water-chestnut) were prohibited for import into Canada. However, that changed in December 2001, when the CFIA stopped regulating aquatic plants. The decision was justified as follows:

> Some of the aquatic plants that are or may be imported into Canada do not fall under the definition of 'pest' under the *Plant Protection Act*;
>
> The lack of scientific capacity does not allow the Agency to adequately evaluate environmental and plant-pest risks associated with aquatic plants; and the lack of an interdepartmental policy.[131]

The 2007 notice to stop imports was a sober rethinking of the earlier 2001 decision to repeal prohibitions. Unfortunately, no substantial changes to legislation and policy were brought forward to fix the underlying problems. Fifteen years after the 2007 advisory, only two PRAs have been completed, and no aquatic invasive plants are regulated under the *Plant Protection Act*. The CFIA has failed to stem the importation and trade of potentially invasive aquatic plants.

> **As we enter the Anthropocene, humanity is reorganizing the biosphere, and it is alarming that native biota worldwide is also jeopardized by missing, incomplete, and improperly communicated legislation. The costs related with biological invasions are high and to safeguard aquatic ecosystems in the world, invasive aquatic pets [and plants] should be moved to the top, not the bottom, of the government's environmental priorities lists.[132]**

THE CASE OF BARBERRY (*BERBERIS* SPP.)

Barberry presents an interesting case that highlights the problem of the current regulatory system in Canada which focuses on food security and largely ignores the impacts of invasive plants on biodiversity

[131] Champion, Hofstra, & Clayton, "Border control for potential aquatic weeds. Stage 3. Weed risk management," 2007.
[132] Patoka, et al., "Invasive aquatic pets: failed policies increase risks of harmful invasions," 2018.

and/or public health.[133] Black stem rust (BSR - *Puccinia graminis*) is a fungal disease that can harm cereal crops and threaten food production. Because barberries (*Berberis* species) were known to carry BSR, legislative efforts toward barberry eradication began in Canada in 1917[134] and a quarantine regulation prohibiting entry of so-called rust barberry (*B. vulgaris*) into Canada followed.[135] A more general ban on all barberries was put in place between 1966 and 2001.[136]

During that period, the *Plant Protection Regulations* (SOR/95-212, 1990) were created and replaced earlier regulations. Plants that could host BSR or were susceptible to that fungal disease became regulated under the directive D-01-04. Both BSR and plants considered potential vectors for the disease became classified as Quarantine Pests.[137] The import, sale, and distribution of all barberries (*Berberis* species) and related genera (*Mahoberberis, Mahonia*) were banned in Canada.[138]

However, the Canadian Nursery Landscape Association (CNLA) argued that not all banned plants were host to BSR. After extensive lobbying from the CNLA, Canada decided to exempt plants thought to be resistant to the rust.[139] Eleven (11) Japanese barberry cultivars were exempted: '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®).[140]

In 2022, the CFIA learned that some exempted cultivars were potentially capable of producing rust susceptible offspring and some had been misidentified as *B. japonica* when they were hybrids with *B. vulgaris.* They issued a "Notice to industry: Recommendation to prevent movement of 'Concorde', 'Royal Cloak' and 'Tara' (Emerald Carousel®) barberry cultivars, into Alberta, Saskatchewan, and Manitoba." Based on a risk assessment and stakeholder feedback, those three cultivars are likely to "be removed from the list of exempt species and cultivars and their movement will be prohibited."[141]

In the accompanying pest management document, the CFIA notes barberry has escaped cultivation in several provinces and is invasive.

> Japanese barberry (*Berberis thunbergii*) has escaped or become naturalized locally in Ontario, Québec, New Brunswick, Prince Edward Island and Nova Scotia. . .. Japanese barberry (*Berberis thunbergii*) is considered invasive in most of the eastern Canadian provinces (Nova Scotia, Ontario, Prince Edward Island and Québec) (CABI, 2019), and is regulated as such by some U.S. states (for example, Massachusetts, New Hampshire, Vermont). The invasive nature of Japanese barberry is due to the combination of multiple and effective reproduction mechanisms, a low rate of plant

[133] E.g., Clark & Seewagen, "Invasive Japanese Bbrberry, *Berberis thunbergii* (*Ranunculales: Berberidaceae*) is associated with simplified branch-dwelling and leaf-litter arthropod communities in a New York forest," 2019; CABI 2019; Kulhanek & Smith, "Invasive species management: common and Japanese barberry," 2022.
[134] Fulling, "Plant Life and the Law of Man. IV. Barberry, Currant and Gooseberry, and Cedar Control," 1943.
[135] Britton, "Quarantine restrictions affecting shipments of Connecticut Plants," 1932.
[136] CFIA, "Regulations Amending the Plant Protection Regulations" 2001, In *Canada Gazette* 135(15) 1372-1380.
[137] CFIA, "Consolidation of regulated pests for Canada," 2016.
[138] Ornamental Mahonias continue to be sold across Canada.
[139] Landscape Trades, "CNLA News: Restrictions lifted on Japanese barberry," 2001.
[140] CFIA, "Technical reference R-004: Japanese Barberry Identification Manual," 2013a; CFIA, "Plant Protection Regulations," 2022d.
[141] CFIA, "Notice to industry: Recommendation to prevent movement of 'Concorde', 'Royal Cloak' and 'Tara' Emerald Carousel barberry cultivars, into Alberta, Saskatchewan and Manitoba," 2022a.

> mortality (Ehrenfeld 1999), and its capacity to tolerate a wide range of environmental conditions, such as full sun to full shade, severe drought and extreme winters (CABI 2020).[142]

Even though Japanese barberry is established in parts of Canada, it is classified as a quarantine pest.[143] The "endangered areas" were historically agricultural lands where barberry is considered under official control, i.e., it is monitored in those areas and there are active measures to eradicate it. Control of rust and not protection of the environment has been the primary reason for regulation.

In contrast, many states bordering Canada have enacted regulations prohibiting barberries. *Berberis thunbergii* and hybrids are regulated in seven of the 13 states that border Canada: Maine,[144] Minnesota,[145] New Hampshire,[146] New York,[147] Pennsylvania,[148] Vermont,[149] and Wisconsin,[150] as well as in Massachusetts,[151] Delaware,[152] and Indiana.[153] This is necessary to protect biodiversity and public health in addition to agriculture.

Several states, like Massachusetts, ban all cultivars, varieties, and hybrids. "Until such time that MDAR nursery inspectors are able to clearly recognize that a hybrid, variety, or cultivar of a species on the Prohibited Plant List is truly non-invasive or sterile (does not produce viable seed), these plants will be included in the list."[154]

The Minnesota Department of Agriculture sums up the health concerns:

> Japanese barberry infestations cause many detrimental ecological and economic impacts. It has the unique ability to change the chemistry of the soil beneath the plant, which in turn makes the site more favorable for additional Japanese barberry plants. Over time, the change in soil pH and the higher nutrient levels can contribute to changes in the whole ecosystem of the area, resulting in a decrease of native plant and animal biodiversity. . . . Dense stands of naturalized Japanese barberry could result in public health concerns as well. Research in Connecticut and Maine showed that **black-legged ticks** were twice as numerous in Japanese barberry infestations as in non-invaded areas.[155]

Public health concerns related to barberry infestations are growing. Researchers have found a strong correlation between Japanese barberry, tick populations, and tick-borne diseases (TBD). Deer tick also

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[142] CFIA, "RMD-21-02: Pest risk management document for barberry (*Berberis, Mahoberberis* and *Mahonia* spp.) as a biological obstacle to the control of black stem rust (*Puccinia graminis*)." 2022c.
[143] 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.**
[144] ME CMR 01-001 H Ch. 273 -Criteria for listing invasive terrestrial plants. Current through May 3, 2023.
[145] MN Ch-18-*Noxious Weed Act,* 2022.
[146] NH HB1258-FN-*Invasive Species Law*, 2000.
[147] NY 6 CRR-NY V C 575-*Prohibited and Regulated Invasive Species*, 2015.
[148] PA Ch-15-*Controlled Plants and Noxious Weeds*, n.d..
[149] VT R. 20-031-021-X-*Quarantine #3 -Noxious Weeds*, 2012.
[150] WI Ch NR 40 - *Invasive species rule - NR 40* Species Identification, Classification and Control, n.d..
[151] MA Ch 128 "Massachusetts Prohibited Plant List," 2023.
[152] DE 3 Ch.29 "Invasive and Potentially Invasive Plants," n.d.
[153] IN 312 IAC 18-3-25 *Terrestrial plant rule,* 2019.
[154] MA Gov., "Prohibited Plant List - FAQ," 2001. Other states like New York have exempted certain cultivars thought to be sterile, and therefore of reduced risk. Minnesota explicitly prohibits cultivars approved in Canada like: 'Bailgreen,' 'Bailone,' 'Monomb,' 'Rose Glow,' and 'Tara.' This is because of the environmental harm they cause and the indirect public health risk the plants pose.
[155] MN Dept. Ag. "Japanese barberry," 2022a.

called "blacklegged tick, *Ixodes scapularis*, is a vector of seven human pathogens, including those causing Lyme disease (LD), anaplasmosis, babesiosis, *Borrelia miyamotoi* disease, Powassan virus disease, and ehrlichiosis associated with *Ehrlichia muris eauclarensis*.[156] Research conducted by the Connecticut Agricultural Experiment Station reported higher populations of deer ticks in areas where Japanese barberry was present.[157] Williams, project director for Mitigating Lyme Disease Risk research, noted at Connecticut locations: "Ticks found in Japanese barberry infestations have been shown to have elevated infection prevalence with the Lyme disease-causing spirochete Borrelia burgdorferi."[158] Dense growth of barberry creates a microhabitat beneficial to all stages of tick development, protects ticks from predators, and increases[159] tick-to-host contact between the nymphal ticks and its primary, first stage host, the white-footed mouse.

> It is now widely acknowledged that the increase in temperature associated with climate change has contributed to a general increase in the number, types, level of activity and geographical distribution of ticks in North America . . . and has directly contributed to the northward spread of blacklegged ticks and LD into Canada. As a result, LD has emerged in Canada and the number of reported cases of Lyme disease continues to rise. . .. [T]here is an opportunity to work on other modifiable risk factors that affect TBDs in Canada, appreciating that this is a complex socio-ecological challenge.[160]

Continual introduction of barberries through the nursery trade adds to propagule pressure and invasion success. With invasion success comes an **increased public health risk**. Managing barberry sales is one way to reduce this risk factor.

To summarize, in Canada, barberries and plants that spread BSR are prohibited because they pose a threat to crop production. That is indeed a valid reason to prohibit them. However, the current process fails to prioritize threats to biodiversity and in this case an additional potential threat to public health from ticks and Lyme disease. The discovery that rust-resistant plants may produce progeny that spread rust highlights the need for a precautionary approach to approving cultivars. As of December 2022, barberry cultivars that pose a threat to crop production and continue to infest natural areas causing environmental harm can still legally be sold in Canada.

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[156] Eisen & Eisen, "The Blacklegged Tick, *Ixodes scapularis*: An Increasing Public Health Concern," 2018.
[157] E.g., Linske, Lyme disease ecology: effects of habitat and hosts on the density and distribution *of Borrelia burgdorferi*-infected *Ixodes scapularis* 2017; Ward, Comparing effectiveness and impacts of Japanese Barberry (*Berberis thunbergii*) control treatments and herbivory on plant communities 2017; 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.
[158] Williams, "Mitigating Lyme Disease Risk Through Control of an Invasive Plant Species," 2014.
[159] Kulhanek & Smith, "Invasive Species Management: Common and Japanese Barberry," 2022.
[160] Bouchard et al., "Increased risk of tick-borne diseases with climate and environmental changes," 2019.

THE CASE OF TREE-OF-HEAVEN (*AILANTHUS ALTISSIMA*)

Tree-of-heaven is recognized internationally as a tree with moderate to high invasion potential.[161] It has been established for some time in Canada and was discussed in the CFIA's 2008 technical report on "Invasive Alien Plants in Canada." While a risk assessment is pending, the CFIA has posted the following:

> Once established, tree-of-heaven is difficult to remove, and its powerful roots can damage infrastructure like sewers, foundations, and sidewalks. In some people, tree-of-heaven pollen causes allergic reactions and exposure to tree-of-heaven sap or plant parts can cause skin irritation.
>
> Tree-of-heaven is also the preferred host of the spotted lanternfly, an invasive insect that is regulated in Canada because of its threat to the Canadian grape, fruit tree, and forestry industries, as well as the environment.[162]

The web post states: "**Do not plant tree-of-heaven**," but it is only a recommendation.

The tree is hardy to USDA Zone 4,[163] which means the at-risk area in Canada is potentially large. Tree-of-heaven is recognized as an aggressive invader capable of modifying habitats, changing environmental conditions[164] and poses a potential threat to Canada's native biodiversity. Like barberry, it also serves as an important host for serious pests, like the Brown Marmorated Stink Bug (BMSB)[165] and the Spotted Lanternfly (SLF),[166] which threaten Canada's food security.

Based on risk assessments that predicted the tree would have a major impact on biodiversity and the environment, the European Union prohibited the sale of the tree across Europe. This tree should be a candidate for regulation in Canada. Canada currently appears to lack the policy and legislation needed to protect native ecosystems from species like tree-of-heaven.

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[161] E.g., U.S. Fish and Wildlife Service and Utah State University, 2015; Ma, Clemants, & Moore, "Invasive Plant Inventory and Early Detection Prioritization Tool," 2009; Jacquart, "Indiana non-native plant invasiveness ranking form: *Ailanthus altissima* (Miller) Swingle" 2012; Pergl, "EU Non-native organism risk assessment scheme Ailanthus altissima," 2018; EC, "Invasive alien species," 2022.

[162] CFIA "Tree-of-heaven – *Ailanthus altissima* (Mill.) Swingle," 2022e.

[163] E.g., Fryer, "*Ailanthus altissima*," 2010; Breen, "Landscape Plants: *Ailanthus altissima*," 2022.

[164] Khapugin, "A global systematic review of publications concerning the invasion biology of four tree species," 2019.

[165] BMSB (*Halyomorpha halys*) which originated in China, is a harmful invasive insect pest in North America and Europe. It poses a serious threat to fruit and vegetable crops worldwide (Haye et al., 2015). Initially, Canada made efforts to stop BMSB, but the CFIA decided not to regulate the pest. "As it is not possible to prevent the spread of *H. halys* to Canada, nor is there a reasonable possibility of sustained eradication if *H. halys* becomes established in Canada, the CFIA has taken the decision not to include *Halyomorpha halys* Stål in the List of Pests Regulated by Canada (CFIA, "RMD-12-02," 2012). BMSB is now established in Canada and spreading.

[166] SLF (*Lycorma delicatula*) is another harmful invasive pest with a preference for the tree-of-heaven. Unlike BMSB, it is not yet present in Canada and is included on the List of Pests Regulated by Canada. "Tree of heaven is the preferred host for SLF and SLF fitness (survival and fecundity) is maximized when feeding on tree of heaven" (Khapugin, "A global systematic review of publications concerning the invasion biology of four tree species," 2019). While SLF feeds on other species, females prefer to lay their eggs on tree-of-heaven and their young are more likely to survive.

THE CASE OF GIANT REED (*ARUNDO DONAX*)

Like Japanese barberry, giant reed is one of the plants federally regulated under the *Plant Protection Act*. Unlike barberry, it is not widespread and only small populations of this invasive species exist in southwestern Ontario. Therefore, it is considered domestically controllable. The species and associated ornamental cultivars are all prohibited for sale in Canada.

According to Canada's NAPPO partner, United States Department of Agriculture Animal and Plant Health Inspection Service (APHIS), giant reed (*A. donax*) is highly invasive.

> Limited mostly by cold temperatures, our analysis indicates that about 2 percent of Canada and 57 percent of the United States is suitable for the establishment of *A. donax*. In Canada, the areas at risk from *A. donax* are southwestern and south-central British Columbia, southern Ontario, and parts of the Maritime provinces. In the United States, much of the area is at risk with the exception of the coldest areas of central and extreme north-eastern United States (below Plant Hardiness Zone 6) and Alaska.[167]

The Canadian Weed Risk Assessment document identifies multiple serious risks:

> Values potentially at risk . . . include plant and animal diversity in riparian and wetland areas, water quality, water use for recreational activities (e.g., tourism, boating, fishing), irrigation, navigation or hydroelectric power generation, property values in infested areas, visibility along roadsides, flood control, and fire control.

The Impacts on Stakeholders section recommends regulation and identifies the need for a Canada-wide approach:

> The general public would be protected from the potential uncontrolled spread of this species. . .. Federal regulation would avoid a province-by-province approach to legislation, which could be less consistent across Canada and more difficult for Canadians to understand and comply with.[168]

While giant reed is prohibited in Canada, plants like tree-of-heaven (hardy to zone 4) and many other invasive plants in the ornamental plant trade with similar or worse risk profiles are not regulated. This inconsistency arises because, according to the CFIA, only plants which are not "widely distributed" and "under official control" can be regulated. This must be addressed.

THE CASE OF KNOTWEEDS – THREATS OF HYBRIDIZATION AND THE NEED FOR A NATIONAL DATABASE

It is clear from looking at the provincially regulated knotweeds that the provinces are not sharing information. Four provinces have recognized at least one knotweed as a high-risk invasive plant: Alberta (three), British Columbia (four), Manitoba (one) and Ontario (four).

Knotweeds are recognized as some of the most invasive plants in the world. "Japanese knotweed, giant knotweed, Himalayan knotweed, and Bohemian knotweed are perennial, rhizomatous plants resembling bamboo with their hollow stems and rapid, aggressive growth habits."[169] These plants were introduced

[167] APHIS (United States Department of Agriculture Animal and Plant Health Inspection Service), "Weed Risk Assessment for *Arundo donax* L. (*Poaceae*) – Giant reed," 2012a.
[168] CFIA, "RMD-16-02: Pest Risk Management Document for *Arundo donax* (giant reed) in Canada," 2017a.
[169] Parkinson & Mangold, "Knotweed complex," 2017.

to Canada as ornamentals in the late 1800s and reintroduced multiple times subsequently. Since then, hybridization has led to complex and complicated genetics.

Identifying the species and hybrids can be difficult. Misidentification can increase the likelihood of spread.[170] This is complicated by naming confusion. Real expertise is needed to sort this out. Misunderstandings and misuse of names can lead to confusing legislation and poor coordination across regions.

In the *Canadian Journal of Plant Science*, Japanese knotweed is described as follows:

> *Polygonum cuspidatum* (Japanese knotweed) is an introduced perennial geophyte in the buckwheat family (*Polygonaceae*). The phytogeographic distribution of *P. cuspidatum* in North America suggests a large number of intentional introductions via ornamental plantings from 1870 to 2000, followed by secondary spread from these foci.[171]

While Japanese knotweed in the cited article was identified under the scientific name *Polygonum cuspidatum,* that is no longer the accepted name. The plant is regulated in British Columbia, Alberta, and Manitoba under the name *Fallopia japonica* (Houtt.) Ronse Decr, while Ontario uses *Reynoutria japonica* Houtt. More problematic is inconsistent recognition of the threats posed by hybrids.

The Japanese knotweed invasion can be "viewed as a vast unintentional hybridisation experiment."[172] Arguably, the hybrids pose greater threats to biodiversity than the species. Japanese knotweed can hybridize with giant knotweed *Fallopia sachalinensis* (syn. *Reynoutria sachalinensis* F. Schmidt ex Maxim.). **The hybrid plant, *Fallopia* x *bohemica*, "appears more vigorous and troublesome in terms of invasiveness than either parent."[173]** Hybridization is not a single event. Crosses and back crosses with new introductions are part of a continuous process which can lead to novel threats.[174]

Himalayan knotweed is recognized as high-risk in two provinces, British Columbia, and Ontario. In Ontario, Himalayan knotweed is prohibited under the *Invasive Species Act* and is listed as *Koenigia polystachya* (a name not recognized by recognized nomenclature authorities like the Integrated Taxonomic Information System (ITIS or World Flora Online (WFO).[175.] British Columbia lists Himalayan knotweed as *Polygonum polystachyum*. It is likely both are referring to - *Persicaria wallichii* Greuter & Burdet. It is clear these provincial actions are not being coordinated. A central Canadian database, standardized with international databases, would minimize this kind of naming confusion, and allow provinces to better scan the horizon for potential threats in neighbouring regions and around the globe.

THE CASE OF PURPLE LOOSESTRIFE (*LYTHRUM SALICARIA*)

Purple loosestrife is a nationally recognized invasive plant that has spread to all provinces, although is not yet reported in the territories. In 2005, it was federally regulated as a Class 2 Primary Noxious Weed,

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[170] Vukovic, et al., "'Flying under the radar'-how misleading distributional data led to wrong appreciation of knotweeds invasion (Reynoutria spp.) in Croatia," 2019.
[171] Barney, et al., "The Biology of Invasive Alien Plants in Canada. 5. *Polygonum cuspidatum* Sieb. & Zucc. [= *Fallopia japonica* (Houtt.) Ronse Decr.]," 2006.
[172] Bailey, "The Japanese knotweed invasion viewed as a vast unintentional hybridisation experiment," 2013.
[173] *Fallopia* x *bohemica* Chrtek & Chrtková) J.P. Bailey syn *Reynoutria* x *bohemica* Chrtek & Chrtková (Bailey, 2013).
[174] One unexpected new hybrid that has emerged as a problem in Europe is *Fallopia* × *conollyana* (*F. japonica* × *F. baldschuanica*) and should be on a Canadian watch list (Bzdęga et al., "A survey of genetic variation and genome evolution within the invasive *Fallopia* complex," 2016).
[175] Integrated Taxonomic Information System, 2023; World Flora Online WFO, 2023.

under the Seeds Act,[176] which means it is regulated as a potential contaminant in seeds. It is not regulated under the *Plant Protection Act* because it is considered "widely distributed," as explained earlier.

While no official Pest Risk Assessment (PRA) was completed, the invasive nature of purple loosestrife is not in dispute.[177] There have been many efforts to control populations,[178] including the release of biocontrols. But it still has the capacity to spread and damage wetlands.

This history of purple loosestrife is important to consider as it highlights how horticultural practices can affect invasion success. The origin of purple loosestrife in North America is not known. The species may have been introduced intentionally as an ornamental plant, or accidentally, as a seed contaminant in the 1800s. However, after its first introduction, there were multiple re-introductions. Several species of loosestrife (e.g., *Lythrum salicaria, L. virgatum,* and *L. alatum*) were used to develop new varieties. Sales of these new cultivars led to the development of more robust populations that were better adapted for environmental conditions in North America.[179] This was recognized in Canada and presented in a Natural Resources Canada report in 2002.

> The greatest challenge to the control of purple loosestrife was, and still is in many parts of Canada, its horticultural sale. Numerous cultivars of the purple loosestrife have been developed for use in residential landscaping and gardens . . .. Some were advertised by Agriculture and Agri-Food Canada as ideal perennials for the home garden . . .. Subsequent research showed that all *Lythrum* garden cultivars produce viable pollen and seed and can spread. ... Manitoba added all loosestrifes to its noxious weed list in 1996. **Legally defining all varieties of purple loosestrife as noxious weeds was the biggest step towards implementing an effective purple loosestrife control program**. . ..[180]

Unfortunately, the Federal Government failed to prohibit the sale of the plant in 2005 when federal action was considered. In 2012, Canada's foremost expert on purple loosestrife, Cory Lindgren called upon "authorities to develop regulations to prohibit horticultural sales of Purple Loosestrife (to prevent human-mediated dispersal)."[181] Five provinces (British Columbia, Alberta, Manitoba, Saskatchewan[182] and Prince Edward Island) regulate loosestrife,[183] the remaining provinces and territories do not. The species, and in some cases hybrids and cultivars, are regulated in at least 40 U.S. states[184]

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[176] CFIA, "Weed Seed: *Lythrum salicaria* (Purple loosestrife)," 2017b.
[177] Michigan Dept. Ag. & Rural Development, "Weed Risk Assessment for *Lythrum salicaria* L. (*Lythraceae*) – Purple loosestrife," 2016; Pasiecznik, "*Lythrum salicaria* (purple loosestrife)," 2007, CABI.
[178] In 2006, it was estimated that $210,000 CDN per annum (Colautti et al., "Characterised and Projected Costs of Nonindigenous Species in Canada ," 2006, 51). There have been biocontrols released in several areas to try and control the population.
[179] Evidence of hybridization between *Lythrum salicaria* (purple loosestrife) and *L. alatum* (winged loosestrife) in North America. Houghton-Thompson et al., 2005; Anderson, "Throwing Out the Bathwater but Keeping the Baby: Lessons Learned from Purple Loosestrife and Reed Canarygrass," 2019.
[180] It has since been removed from the Noxious Weed list but is now regulated under the *Water Protection Act*.
[181] Lindgren & Walker, "Predicting the Spread of Purple Loosestrife (*Lythrum salicaria*) in the Prairies," 2012.
[182] Barnes, "Purple loosestrife: here to stay? 2021; Vadeboncoeur, "'A bad year for purple loosestrife': How the invasive plant species is being fought in Manitoba," 2022.
[183] AB: SA 2008, c W-5.1 - Alta Reg 19/2010; BC: RSBC 1996, c 487 - BC Reg 66/85: SK SS 2010, c W-11.1; PEI has a regulation just for purple loosestrife. Reg EC629/91.
[184] Invasive.org, "purple loosestrife *Lythrum salicaria* L.," 2018.

Given its hardiness (USDA Plant Hardiness Zones 3-12),[185] purple loosestrife is likely to impact much more of Canada than say giant reed (USDA Plant Hardiness Zones 6-13).[186] Policy, interpretation of the International Standards for Phytosanitary Measures, limitations of resources, and limitations of the law have meant that sales of giant reed can be halted, but plants like loosestrife can be left on the market.

During the sixth Conference of the Parties (COP) to the CBD, the following guidance was given.

> General Guiding Principle 7 that member states like Canada should not only implement controls for alien species that could become invasive, but also implement controls for alien species that are invasive.
>
> Guiding principle 10 states that '**No** . . . **subsequent introductions** of an alien species already invasive or potentially invasive within a country **should take place** without prior authorization from a competent authority.'[187]

Given the new guidance from the IPPC Canada should take a more proactive stance to stop the continued introductions of non-native invasive species in the horticultural trades. While nurseries recognize the threat of purple loosestrife, and it has disappeared from the marketplace, other similar species, like yellow flag iris, are emerging as threats. Canada needs to stop sales or label these at the national level as soon as the threat is recognized.

THE CASE OF YELLOW FLAG IRIS (*IRIS PSEUDACORUS*)

Yellow flag iris is a highly invasive plant that impacts wetlands. Like purple loosestrife, it is quite hardy (USDA zone 3), and like purple loosestrife, there is no official Pest Risk Assessment (PRA) listed in Canada's Weed Risk Analysis Documents.

The plant was brought to North America in the early 1900s as an ornamental plant. A Weed Risk Analysis (WRA) performed by APHIS in 2013 found it to be a high-risk invasive species, and it is predicted to be a major invader. "One hundred percent of the simulated risk scores were in the 'High-Risk'."[188]

In 2013, Fisheries and Oceans Canada (DFO) published an "Application of Aquatic Risk Assessment of Non-Indigenous Plants in the Trade in Canada" in which yellow flag iris was identified as a high-risk invasive species.[189] Yet, no federal regulatory actions were taken.

In 2015, the *Aquatic Invasive Species Regulations* (SOR/2015-121) under the *Fisheries Act* were developed to prohibit the possession, transportation, and release of aquatic invasive species, such as invasive carp.[190] However, no plants are included on the list of regulated species. "Fisheries and Oceans Canada was unclear on whether its responsibilities for regulating aquatic invasive species included

[185] "Based on three climatic variables, we estimate that about 92 percent of the United States is suitable for the establishment of *Lythrum salicaria*" (MI Dept. Ag, "Weed Risk Assessment for *Lythrum salicaria* L. (*Lythraceae*) – Purple loosestrife," 2016).
[186] Giant reed is projected to impact only 52 percent of the U.S. (APHIS, "Weed Risk Assessment for *Arundo donax* L. (Poaceae) – Giant reed," 2012).
[187] CBD COP-6, 2002.
[188] United States Department of Agriculture Animal and Plant Health Inspection Service (APHIS), 2013.
[189] DFO, "Application of an Aquatic Plant Risk Assessment to Non-Indigenous Freshwater Plants in Trade in Canada," 2013.
[190] Gov. of Canada. *Aquatic Invasive Species Regulations* (SOR/2015-121). 2015.

freshwater plants."[191] Even though DFO recognized invasive aquatic plants posed a threat to Canada's waterways, they took no immediate action.

There have been recent efforts to share the information with provinces and territories. However, as of the November 2022, *Iris pseudacorus* is regulated in only three provinces (British Columbia, Alberta, and Manitoba).

Sales of *Iris pseudacorus* are also prohibited in eight border states: Idaho, Maine, Montana, New Hampshire, New York, Vermont, Washington and Wisconsin (being phased out), and a growing number of other states: Colorado, Connecticut, Illinois, Maryland, and Massachusetts. This widespread recognition of the risk posed by this plant indicates that national action to halt the continued sales of yellow flag iris is warranted in Canada. If it cannot be regulated under the *Plant Protection Act* as it is now being administered, then something needs to change.

THE CASE OF EUROPEAN WATER-CHESTNUT (*TRAPA NATANS*)

European water-chestnut (*Trapa natans*) is one of the few aquatic plants with a listed PRA in Canada's Weed Risk Analysis Documents.[192] The Canadian assessment concluded that the likelihood of establishment and the potential for harmful economic and environmental impacts were HIGH. This plant is quite hardy (USDA zone 3) and has the potential to spread widely in receptive waterways.[193]

The plant was prohibited for import under *D-94-27 -The Plant Protection Import Requirements for True Aquatic Plants* (Sept. 8, 1994). As mentioned above, despite the risk the species poses, this regulation was repealed in 2001 due to lack of policy, lack of expertise, and lack of legislative tools.

According to the CFIA risk assessment, "Water-chestnut was considered absent from Canada until 1998, when a population was observed in Rivière du Sud, a tributary to the Richelieu River in southwestern Québec. The population has overwintered and continued to spread since 1998." It is now in Ontario waterways and is having a high socio-economic impact in the Great Lakes.[194] Impacts:

> Large infestations of *T. natans* can reduce water flow and even clog waterways and hinder commercial navigation. Infestations can limit or even prevent recreational activities such as boating, fishing, and hunting. The hard, spiny seeds can puncture leather and can cause painful wounds to humans and animals that step on them. These nuts can also wash up and accumulate along the shore, reducing the access to beaches.
>
> The major economic costs associated with water chestnut populations are mechanical or chemical control efforts. Millions of dollars have been spent on mechanical harvesting and manual removal of T*. natans* populations. . .. From 1982-2005 various state organizations spent over $5 million to control in Lake Champlain. [195]

From 1948 to 2019, it was a crime in the United States to transport water hyacinth, European water-chestnut, and alligator grass (*Transportation of water hyacinths - 18 U.S.C. § 46*). That section of code

[191] Office of the Auditor General, "Report 1—Aquatic Invasive Species," 2019.
[192] Available upon request from CFIA, not published on-line.
[193] APHIS, "Weed Risk Assessment for *Trapa natans* L. (*Lythraceae*) – Water chestnut," 2016b.
[194] E.g., Azan, 2011; EDDmapS, "European water chestnut *Trapa natans* L.," 2023; Pfingsten, "*Trapa natans* L.," 2022.
[195] Pfingsten et al., 2022.

was repealed in 2019 as it had never been used.[196] It is unfortunate that the U.S. did not make use of that law to reduce the sales of those species. Water-chestnut is listed as a noxious weed in 35 U.S. states.[197] Border states regulating the plant include: Idaho, Michigan, Minnesota, New York, New Hampshire, Ohio, and Wisconsin.[198]

European water-chestnut poses significant threats, and the plant has not reached its full ecological range in Canada. Yet it remains unregulated at the federal level by DFO and the CFIA. The Federal Government needs to clarify authority for regulation of aquatic plants. Policy needs to extend regulatory protections to plants that impact waterways. Risk assessment processes will need to analyze the direct and indirect impacts of non-native aquatic plants as well as terrestrial plants. Tools to do both monetary and non-monetary valuations need to be developed (e.g., "number of species affected, water quality"[199]). Currently, European water-chestnut is regulated in Alberta, Manitoba, and Ontario. Meanwhile, without Federal Government intervention, propagule pressure can continue to build in regions that do not recognize the impending danger.

THE CASE OF MILFOILS (*MYRIOPHYLLUM* SPP.) – A COMPLEX NATIONAL THREAT

As mentioned above, four provinces have taken action to regulate two milfoils, European watermilfoil (*Myriophyllum spicatum*) and parrot feather (*M. aquaticum*). These have likely arrived in Canada both unintentionally in ship ballasts and have been widely sold as oxygenating pond plants.[200] Alarms were sounded about the potential invasiveness of milfoils at the first International symposium on watermilfoil (*Myriophyllum spicatum)* and related *Haloragaceae* species held in Vancouver, British Columbia, back in 1985. Almost three decades later, using the aquatic invasive plant ranking system (aqWRA), Fisheries and Oceans Canada identified European watermilfoil and parrot feather as high risk.[201] It is possible other taxa are threats:[202]

Table 11: Milfoils (*Myriophyllum* spp.) risk assessment scores.

Species	AqWRA score	Hardiness Zone (USDA)	Presence in Canada
M. aquaticum:	75 High	5	established
M. heterophyllum:	72 High	5	established (native and introduced)
M. spicatum:	81 High	3	established
M. propinquum:	25 Low	7	not present
M. verrucosum:	34 Low	8	not present
M. spicatum x *M. sibiricum* (hybrid)			not assessed

[196] Section 46 relating to transportation of water hyacinths was repealed (U.S. Senate, "AN ACT To eliminate unused sections of the United States Code, and for other purposes," 2019).
[197] Naylor, "Water Chestnut (*Trapa natans*) in the Chesapeake Bay watershed: a regional management plan," 2003.
[198] Invasiveatlas.org, "European water chestnut *Trapa natans* L.," 2018b; Pfingsten, 2022.
[199] ISPM-11, 2021.
[200] Moody et al., "Unraveling the biogeographic origins of the Eurasian watermilfoil (*Myriophyllum spicatum*) invasion in North America," 2016.
[201] E.g., Gordon et al., 2012; Gantz et al., 2013.
[202] Introduced species such as *M. quitense* and *M. ussuriense* were reported as present in British Columbia, Ceska et al., "*Myriophyllum quitense* and *Myriophyllum ussuriense* (*Haloragaceae)* in British Columbia, Canada," 1986.

Like many other invasive aquatic plants, milfoils can have a wide range of negative impacts, they can:

- reduce native diversity.
- degrade water quality.
- change sediment chemistry.
- cause fish die offs from lack of oxygen.
- reduce waterfowl habitat.
- increase flooding risks.
- prevent use of waterways for navigation, fishing, and swimming.

The ability of European watermilfoil (EWM) to hybridize with the native Northern watermilfoil (NWM - *M. sibirica*) has produced plants with novel genetics and new hybrid invaders (HYB). "These results suggest that NWM has the potential for genetic assimilation by EWM and HYB, which if not managed could lead to further declines for this once common species in North America."[203]

Milfoils threaten waterways coast to coast and are arguably a national threat. The Federal Government is not regulating these milfoils and today leaves it to the provinces and territories to act.

> "A control program for *M. spicatum* was initiated in British Columbia in the 1970s; control measures used were primarily manual/mechanical and were initiated when plants had spread to eight lakes in the Okanagan Valley. The program cost over $6 million between 1972 and 1990 . . . and is still ongoing with additional operating costs of over US$4 million between 1990 and 2001."[204]

Despite the growing costs of milfoils in British Columbia, invasive milfoils are not regulated in that province.[205] In the U.S., European watermilfoil has caused considerable damage in lake systems and has driven property values down in some locations.[206] The provinces and territories not recognizing the real threat from these invasive aquatic plants are at risk for future harm and costs that could be avoided if federal action were taken sooner rather than later.

EU REGULATION 1143/2014 ON INVASIVE ALIEN SPECIES

As in North America, gardening and other horticultural activities are the primary introduction pathways of invasive plants into Europe.[207] The European and Mediterranean Plant Protection Organization (EPPO) estimated "80% of the invasive alien plants are voluntarily introduced for ornamental purposes, and international trade is increasing yearly."[208] In 2015, new legislation to address invasive alien species in

[203] Moody et al., "Unraveling the biogeographic origins of the Eurasian watermilfoil (*Myriophyllum spicatum*) invasion in North America," 2016, 716.
[204] Michigan Dept. of Agri. and Rural Development, "Weed Risk Assessment for *Myriophyllum spicatum* L. (*Haloragaceae*) – Eurasian watermilfoil," 2016.
[205] Invasive Species Council of Metro Vancouver, "Best Management Practices for Parrot's Feather in the Metro Vancouver Region," 2021, 4.
[206] Property values in Vermont and Wisconsin declined near lakes infested with milfoil (Zhang & Boyle, "The effect of an aquatic invasive species (Eurasian watermilfoil) on lakefront property values," 2010). Reducing the spread of milfoils provides net economic benefits (Hanley & Roberts, "The economic benefits of invasive species management," 2019).
[207] E.g., Niemiera & Holle, "Invasive Plant Species and the Ornamental Horticulture Industry," 2009; Arianoutsou et al., "Alien plants of Europe: introduction pathways, gateways and time trends," 2021.
[208] EPPO, "EPPO / Council of Europe Workshop 'Code of conduct on horticulture and invasive alien plants'," 2009.

the European Union (EU) came into force.[209] This legislation was necessary to help the EU Member States meet their obligations under the CBD.[210]

For the purposes of *EU regulation 1143/2014*, invasive alien species are defined as those "whose introduction or spread has been found to threaten or adversely impact upon biodiversity and related ecosystem services." Under the EU legislation, species identified as Invasive Alien Species of Union Concern are prohibited across all the Member States. Additionally, Member States may establish their own national lists of species of concern.[211]

Invasive Alien Species of Union Concern include plants that are widespread across European countries. For instance, a native Canadian plant, common milkweed (*Asclepias syriaca*) is on the list.[212] There is a cultivation and sales ban on this species, which has become established outside of cultivation in 13 Member States: Austria, the Czech Republic, Bulgaria, Denmark, France, Croatia, Hungary, Italy, Lithuania, the Netherlands, Poland, Romania, and Slovakia. There are similar cultivation and sales bans on other species that are considered a potential risk in Canada (e.g., tree-of-heaven - *Ailanthus altissima*, water hyacinth - *Eichhornia crassipes*, Carolina fanwort - *Cabomba caroliniana*, parrot's feather - *Myriophylum aquaticum*).

EU member states carry out comprehensive analyses. The information gathered is shared through the project Delivering Alien Species Inventories for Europe (DAISIE). Development of this shared database was key to the success of EU regulatory efforts.[213]

All EU Member States have signed the *International Plant Protection Convention* (IPPC) and follow IPPC standards[214] but they have followed the advice of the Standards and Trade Development Facility and enhanced their regulatory process to address the limitations of the *SPS Agreement* to meet their obligations under the CBD.[215] Canada must take similar action to reduce the harm and costs of IAPs.

AUSTRALIA'S APPROACH

Before 1996, plants proposed for importation into Australia were checked against a list of prohibited plants designated under the *Quarantine Act 1908*.[216] With the growing threat of invasive plants, the regulation was amended by a *Quarantine Proclamation 1998*, all plant species were prohibited from entering Australia unless they were on a Permitted Seeds List." To be permitted in Australia, new plant species have to be formally assessed as having a low potential to become weeds in Australia.

[209] 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.
[210] Target 5 of the EU 2020 Biodiversity Strategy, "By 2020, Invasive Alien Species (IAS) and their pathways are identified and prioritised, priority species are controlled or eradicated, and pathways are managed to prevent the introduction and establishment of new IAS" (European Commission (EC), 2011).
[211] Brundu et al., "Managing plant invasions using legislation tools: an analysis of the national and regional regulations for non-native plants in Italy," 2020.
[212] European Commission, "Invasive alien species," 2022.
[213] Arianoutsou et al., "Alien plants of Europe: introduction pathways, gateways and time trends," 2021.
[214] EC, "International Plant Protection Convention (IPPC)," n.d.
[215] Standards and Trade Development Facility (STDF), 2013.
[216] Australia Invasive Plant Council, "Stopping weed invasions: a 'white list' approach," 2009.

In 2015, Australia enacted a *Biosecurity Act*[217] and this absorbed the *Quarantine Proclamation*.[218] The Act provides for the management of biosecurity risks including invasive plants that can cause harm to human, animal, or plant health; harm to the environment; or economic consequences. Anyone proposing to introduce a new plant species must apply for permission and the plant requires a Weed Risk Assessment (WRA - paid for by the importer).[219]

This approach is consistent with guiding principle 10 for the prevention of intentional introductions of invasive alien species agreed to at the Fifth Ordinary Meeting of the Conference of the Parties to the CBD.[220]

> No intentional introduction should take place without proper authorization from the relevant national authority or agency. A risk assessment, including environmental impact assessment, should be carried out as part of the evaluation process before coming to a decision on whether or not to authorize a proposed introduction. States should authorize the introduction of only those alien species that, based on this prior assessment, are unlikely to cause unacceptable harm to ecosystems, habitats, or species, both within that State and in neighbouring States.[221]

While the pre-border assessment process is an important step toward reducing the introduction of potentially new invasive plants, it does not address the problem of invasive plants previously introduced through the ornamental plant trade.[222]

The problem of invasive plant species in Australia far exceeds that in Canada. There are now more foreign plant species in Australia than native species.[223] At least 66 percent of weed species were imported as garden plants.[224] Australia has only designated 32 Weeds of National Significance (WoNS).[225] These plants deemed to be national threats to biosecurity have now been banned across the country through State and Territory legislation. However, the roll out of the WoNS program took many years.[226] National action was required to ensure a coordinated regulatory approach was taken.[227]

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[217] Australia Biosecurity Act 2015, C2021C00355; Australia Dept. of Agric., Fisheries, & Forestry [DAFF], 2021.
[218] *The Biosecurity (Prohibited and Conditionally Non-prohibited Goods) Determination 2016* specifies prohibited plants and explains the conditions required to permit others for the purpose of the Biosecurity Act. It replaced provisions relating to conditions for importation of goods in the Quarantine Proclamation 1998 (DAFF, 2019a; WTO, 2016).
[219] Development of the Weed Risk Assessment (WRA) system, DAFF, 2019; Weed Assessment for Australia DAFF, 2019b. Importing live plants (nursery stock), Australia DAFF, 2022;
[220] CBD COP-5 Decision V/8, 2000.
[221] Beckie et al., "Agricultural weed assessment calculator: an Australian evaluation," 2020.
[222] Australia Invasive Species Council, "Stopping weed invasions: a 'white list' approach," 2009.
[223] There are approximately 15,800 native plant species (compared to under 4,000 native species in Canada). Close to 29,000 exotic species have been introduced to Australia. Of these introduced plants, over 3,000 species have naturalised and approximately 500 are now considered as noxious weeds under various state/territory legislation, including the 32 WONS (Williams et al, "Australia State of the Environment 2021," 2021).
[224] Groves et al., "Jumping the Garden Fence," 2005; Australian Government, "Reasons for the weed risk assessment system," 2022.
[225] A list of 20 WoNS was created in 1999 and a further 12 were added in 2012.
[226] Report on the regulation, control and management of invasive species and the Environment Protection and Biodiversity Conservation Amendment (Invasive Species) Bill 2002. Australia Senate Environment, Communications, Information Technology and the Arts References Committee, "Turning back the tide – the invasive species challenge," 2004.
[227] Wild Matters Pty. Ltd., "National established weed priorities - towards a national framework," 2020.

While the Australian regulatory system is distinct from Canada's, they have put in place some organizational processes worth emulating. The Australian Bureau of Agricultural and Resource Economics and Sciences conducts national surveys of weedy and invasive plants.[228] National surveillance enables early detection of new invasions and is used to track the spread and distribution of invasive plants. Plant lists have been created including the National Environmental Alert (NEA) list for invasive plants in the early stages of establishment and Agricultural Sleeper Weeds (ASW). This kind of national action is critical and was already recommended in 2017 in Canada by Federal-Provincial-Territorial Invasive Alien Species Task Force.[229]. National leadership is necessary to drive the development of consistent and coordinated approaches across the country and to provide clarity around priorities, roles, and responsibilities.[230]

DATABASE DEVELOPMENT AND PLANT RISK ASSESSMENTS

At the Sixth Ordinary Meeting of the Conference of the Parties to the CBD, Canada agreed to Guiding Principle 8 on the Exchange of information.[231] In accordance with this principle, Canada needs to develop a national database for the purpose of compiling and communicating information about non-native invasive plants. Database information should include:

- taxonomic information
- the history and ecology of invasion (e.g., pathways for introduction, distribution)
- the biological characteristics of the invasive alien species
- an assessment of impacts to the market economy (e.g., agricultural, forestry, horticultural sectors)
- an assessment of biodiversity impacts at the ecosystem, species, and genetic level
- an assessment of public health and socio-cultural impacts
- consideration of impacts to keystone species and endangered species or habitats, and
- the potential effects of future climate scenarios on distribution and impacts.[232]

The database requires the preparation of risk assessments. CFIA's current PRA process is primarily used for pre-border screening. Canada should place the burden for pre-border assessments on the importer.[233] This would allow the CFIA to focus on plants in circulation in the trades.

To make the risk assessment process efficient, it will be necessary to prioritize plant analysis. The European and Mediterranean Plant Protection Organization (EPPO) has developed a Prioritisation

[228] Ng, et al., "The state of weeds data collection in Australia,"2021.
[229] FPT IAS, "Recommendations of the Invasive Alien Species Task Force" 2017; Gordon, "FTP Task Force," 2017 – presentation downloads.
[230] Invasive Plants and Animals Committee, "Australian Weeds Strategy 2017–2027," 2017; The National Plant Biosecurity Status Report, Plant Health Australia, "The national plant biosecurity status report," 2018.
[231] Sixth Ordinary Meeting of the Conference of the Parties to the Convention on Biological Diversity, Canada - CBD COP-6, 2002.
[232] CBD COP-6, 2002; NAPPO, 2008; Bradley, 2022.
[233] This would be similar to the requirement placed on pesticide applicants who must "develop a comprehensive database of scientific information that demonstrates the product's value and its effects on the environment and human health." Health Canada, "Pesticides and pest management: Frequently asked questions," 2019.

Process compliant with the new EU regulation.[234] Canada could take the lead in the North American Plant Protection Organization (NAPPO) to help build North American capacity to share information on invasive ornamental plants. Experts from across borders could help share the burden and benefit of a North American database.[235]

As mentioned earlier, there are numerous tools and protocols that could be used to improve the Canadian assessment system.[236] Ecological impacts, native species interactions, hybridisation, impacts to society, culture, and human health should all be considered.[237] The history of plants like purple loosestrife, hybrid knotweeds, as well as invasive variants of Phragmites (*Phragmites australis*) indicate a need to recognize that small genetic changes can impact biological traits and invasion success.[238] "For horticultural species, unintentional field trials may already exist in the living collections of botanic gardens and data on the performance of introduced species might be a valuable indicator of behaviour outside the cultivated environment."[239] Therefore, Canada should develop special protocols for evaluating ornamental/horticultural varieties and cultivars.[240] There will be some uncertainty for

[234] Tanner et al., "The prioritisation of a short list of alien plants for risk analysis within the framework of the Regulation (EU) No. 1143/2014," 2017.

[235] "Qualitative expert assessment is usually undertaken by decision panels who use their experience to answer broad questions regarding likelihoods of introduction, establishment, impact and management on a qualitative scale (negligible, low, medium and high) and then summarise the overall risk based on these answers" (Hulme, "Weed risk assessment: a way forward or a waste of time?" 2011c).

[236] E.g., Morse et al., "An invasive species assessment protocol," 2001; Catling, "New 'Top of the list' Invasive plants of natural habitats in Canada," 2005; Carlson et al., "Invasiveness ranking system for non-native plants of Alaska," 2008; Nentwig et al., "Advancing impact assessments of non-native species: strategies for strengthening the evidence-base," 2016; Davidson et al., "Development of a risk assessment framework to predict invasive species establishment for multiple taxonomic groups and vectors of introduction," 2017; Hulme et al., "Integrating invasive species policies across ornamental horticulture supply chains to prevent plant invasions," 2017; Roy et al., "Developing a framework of minimum standards for the risk assessment of alien species," 2017; Strubb et al., "Advancing impact assessments of non-native species: strategies for strengthening the evidence-base," 2019; Brunel et al., "PM5/6(1) EPPO Prioritization process for invasive alien plants," 2010; Conser et al., "The Development of a Plant Risk Evaluation (PRE) Tool for Assessing the Invasive Potential of Ornamental Plants," 2015, Branquart et al., "A prioritization process for invasive alien plant species incorporating the requirements of EU Regulation no. 1143/2014," 2016; EPPO, "Guidelines on Pest Risk Analysis," 2017; EPPO, Bartz & Kowarik, "Assessing the environmental impacts of invasive alien plants: A review of assessment approaches," 2019; González-Moreno, "Consistency of impact assessment protocols for non-native species," 2019; Tayeh & Mannino, "Consistency of impact assessment protocols for non-native species," 2019; Vilà et al., 2019; Davidson et al., "Development of a risk assessment framework to predict invasive species establishment for multiple taxonomic groups and vectors of introduction," 2020; European Food Safety Authority et al., "A review of impact assessment protocols of non-native plants," 2021; Bernardo-Madrid et al., "Consistency in impact assessments of invasive species is generally high and depends on protocols and impact types," 2022.

[237] E.g., Roy et al., "Developing a framework of minimum standards for the risk assessment of alien species," 2017; Bernardo-Madrid, 2022; Bradley et al., 2022.

[238] E.g., Catling & Mitrow, "The recent spread and potential distribution of *Phragmites australis* subsp. *australis* in Canada," 2011; Wymore et al., "Genes to ecosystems: exploring the frontiers of ecology with one of the smallest biological units," 2011; Oh et al., "Novel genome characteristics contribute to the invasiveness of *Phragmites australis* (common reed)," 2022.

[239] Hulme, "Weed risk assessment: a way forward or a waste of time?" 2011b,c.

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

varieties that have limited history. In such cases, where there is lack of full scientific certainty, the precautionary principle should be followed.[241]

Despite the complexity and costs involved in evaluations, the process should not be avoided. Sound evidence-based policies and decisions require a knowledge base.[242] Some risk assessments have already been done in other jurisdictions and information will just need to be consolidated into a framework that can be shared.[243] Shared information can then guide management actions and regulatory measures nationally and regionally. Canada's national database will ensure that regions with fewer resources are not disadvantaged, and actions can be coordinated between provinces and territories. The goal is to reduce the costs and harm of invasive plants long into the future.

THE ORNAMENTAL HORTICULTURE SECTOR – COSTS AND OPPORTUNITIES

While restrictions on invasive plants may be disruptive in the short term, there are opportunities for innovation – including potential for expanding local markets. Innovative nursery growers can capitalize on regional botanical uniqueness. Importers and breeders should focus on non-invasive non-native plants that support environmental health and native plants.[244] As people look to reduce their impact on the environment, sustainable gardening is trending, and this is a segment that is expected to continue growing.[245] A new ecological approach to horticulture can be transformative for the industry and ultimately benefit all Canadians and global biodiversity.

Currently, the ornamental horticulture sector in Canada includes the floriculture (primarily cut flowers and potted plants), nursery (field-grown annuals, perennials, shrubs, trees, and vines), Christmas tree, and turf sod industries. In 2021, this sector generated sales of $2.54 billion.[246] The greenhouse production of flowers and plants was the largest revenue generating sub-sector, accounting for 66.2 percent of total sales with potted plant sales contributing most to the bottom line. Most potted plants sold are non-invasive as almost 40 percent are for indoor use, and at least another third are non-invasive bedding plants like geraniums and vegetable plants. The percentage of invasive plants produced by greenhouses is not known but likely low.

Nursery product sales and resales contributed an additional 27.2 percent to the Canadian ornamental industry revenue in 2021. 58 of field grown nursey plants were fruit bushes. It is not known what percentage of field grown or container grown plants are invasive plants like barberry 'Tara', but it is likely a small fraction of overall sales. For instance, in studies of the plant nurseries in the U.S. mid-

[241] CBD, 1992; CBD COP-6, 2002.
[242] Meyerson, et al., "Moving Toward Global Strategies for Managing Invasive Alien Species," 2022.
[243] For instance, 500 species assessments of North American introduced plants had been completed for NatureServe (Randall et al., 2008) and is available from the Invasive Plant Resource Guide, 2020.
[244] Care should be given to plants that could potentially hybridize with native plants like white mulberry (*Morus alba*), hybrid lupins (*Lupinus* spp.), and columbine (*Aquilegia* spp.).
[245] Ng, "Planet-friendly gardening: How small changes can make a huge difference," 2021; Gardiner, "Hottest gardening trends for summer 2022, According to Experts," 2022. Orentas, "Here are the top landscaping trends of 2023," 2022; Sons, "Gardening's hottest trend is here: The big shift to native plants and what it means for your business," 2022.
[246] Crops and Horticulture Division Agriculture and Agri-Food Canada, "Statistical overview of the Canadian ornamental industry 2019," 2021.

Atlantic region, only four percent of the taxa sold were considered invasive.[247]

Some have pondered: "If invasive species are pollutants, should polluters pay?"[248] Not surprisingly, the landscape industry has not responded favourably to the idea of taxing sellers.[249] However, the industry has responsibility to help solve this problem.

Regulation of sales has been the preferred course of action in many U.S. states. In states where sales bans have been put into effect, growers have been given transitional periods to phase out stock and develop alternatives. For instance, Ohio and South Carolina have announced that Callery pear (*Pyrus calleryana*), popular in the trades, will be prohibited for sale in 2023 and 2024 respectively.[250] Consultations with stakeholders needs to be part of the regulatory process to reduce the burden on specific actors in the horticultural sector. Gary Fish, responsible for the Maine Horticultural Program, reports the nursery industry has adapted to the new regulations without incident and they continue to work with sellers to phase-in changes responsibly.[251]

Would regulation and labelling requirements be bad for the nursery industry as a whole? The impacts should be relatively small and short term.[252]

> First, . . . **consumers increasingly wish to be informed** of invasive ability so that they can avoid purchasing invaders. If the nursery industry wants to continue to be perceived as a "green" industry, it will have to recognize this trend and respond appropriately to it.
>
> Second, invasive plants are a **small part of the sales** of most nurseries, so removing them from sale is unlikely to have a significant effect on the business's bottom line.
>
> Third, removing invasive plants from sale could **actually stimulate sales**, if handled correctly, because replacement plants would be promoted and sold.[253]

The industry can benefit by taking a proactive approach to slowing the flow of invasive plants. Breeders, growers, and sellers can each do their part. Breeders can focus on reducing the traits that make plants invasive: "reduced genetic variation in propagules, slowed growth rates, non-flowering, elimination of asexual propagules, lack of pollinator rewards, non-dehiscing fruits (to prevent seed dispersal), lack of edible fruit flesh, lack of seed germination, sterility and programmed death prior to seed production."[254] Growers can select non-invasive plants and give accolades to plants that support a healthy natural environment. Sellers can inform the public and market plants as better alternatives to older invasive varieties. In this way, the ornamental horticultural industry can embrace the problem as "our responsibility, our opportunity" and transform the industry so that they contribute to a healthy planet and therefore to human well-being.

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[247] Coombs & Gilchrist, "Nursery industry a baseline for future comparisons," 2018; George, Gilchrist & Watson, "An assessment of the native and invasive horticultural plants sold in the mid-Atlantic region," 2020.
[248] Simpson, "Chapter 7: If invasive species are 'pollutants', should polluters pay?," 2009; Barbier et al., "Implementing policies to control invasive plant species," 2013.
[249] Gagliardi, James & Brand, Mark, "Connecticut nursery and landscape industry preferences for solutions to the sale and use of invasive plants," 2007.
[250] Culley, "Invasive pears," 2022.
[251] Correspondence with Gary Fish, State Horticulturist Maine Department of Agriculture, Conservation and Forestry Horticulture, responsible for administering the Horticultural Program "Do Not Sell Plant List," 2022.
[252] Coats, Stack, & Rumpho, "Maine Nursery and Landscape Industry Perspectives on Invasive Plant Issues," 2011.
[253] 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.
[254] van Kleunen et al., "The changing role of ornamental horticulture in alien plant invasions," 2018.

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