Canadian Resilience, Grassroots Campaigns and Biosecurity Policy: Navigating Ecological and Economic Risks from New Invasive Species Through Soil-Focused Advocacy

By

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Abstract

Invasive species can create compounding risks to the resilience of Canadian ecosystems, agricultural productivity, and native biodiversity, introducing cascading impacts across forests, provincial parks, and the forestry sector that can complicate efforts regarding our national climate carbon commitments. Utilizing a mixed-methods approach that combines case study analysis of recent grassroots campaigns with a critical review of Canadian biosecurity legislation, this research explores the systemic barriers that impede rapid responses to new invasive species threats. Investigating whether citizen-led advocacy can successfully model a traction-gaining framework for future environmental campaigns, the emergence of invasive jumping worms in Canada becomes our primary case study. While biological invasions pose recognized threats to Canadian ecosystem services, agricultural productivity, and the resilience of natural habitats, governing bodies often experience delays in active response. Grassroots initiatives often serve as early-warning systems and vital educators for local populations, yet such agility is frequently undervalued. Conversely, formal policy frameworks are often constrained by administrative lag and structural silos that hinder rapid responsiveness—ultimately creating regulatory and policy gaps that allow high-risk invasive species to proliferate unchecked. To evaluate how grassroots initiatives can catalyze regulatory change, this study combines a literature-informed risk assessment of jumping worms—examining their taxonomy, locomotive traits, fecundity, and lack of natural predators—with an analysis of their potential impacts on urban agriculture, forestry, nature-based tourism, and northern boreal peatland carbon dynamics. By combining scientific evidence with strategic policy interventions, including targeted correspondence with decision-makers and custom graphic asset mobilization, the project demonstrates how a citizen-led campaign introduced an environmental issue to the policy agenda. These findings confirm that specific outreach tactics—in tandem with grassroots mobilization—provide a viable, replicable framework for future environmental advocacy and biosecurity policy development. Ultimately, the research highlights that safeguarding Canada's soil health and ecological integrity requires an adaptive policy framework that values public participation as a supportive component of national environmental security.

Keywords: Biosecurity, Invasive Species, Soil Stewardship, Grassroots Advocacy, Environmental Governance, Community-led, Campaign Design.

Foreword

This Major Research Paper (MRP) is submitted in partial fulfillment of the requirements for the Master of Environmental Studies (MES) degree at York University. Grounded in the MES program's interdisciplinary approach, this research investigates the friction between emerging ecological threats and traditional institutional management across natural systems, socio-cultural contexts, and policy structures.

MES framework champions a specific kind of scholarship: students are encouraged to analyze complex environmental problems but also to develop actionable, sustainable strategies for positive change. This project engages that call by examining how soil-borne threats like invasive jumping worms (*Amynthas* spp.) reveal the need for specific biosecurity protocols in Canada. By contrasting slow-moving government bureaucracy with the agility of citizen-led responses, this research explores how grassroots mobilization serves as an essential, yet frequently undervalued early-warning system, and a practical model for how Canadian communities can build real policy traction.

Rather than merely a critique, this work engages in applied environmental advocacy, acting as a practical experiment to see if a community-led model can actually apply certain tactics to influence policy. By integrating scientific literature review with hands-on tools for practical intervention, it proposes targeted biosecurity policy and regulation amendments to multijurisdictional political and Indigenous leadership. As well, a public awareness campaign helps ground the project as a working test case, exploring what it takes for Canadian communities to build real policy momentum and examine best practices for bridging grassroots action towards formal regulatory change.

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Introduction

My Masters research evolved suddenly when my exploration of urban agriculture through a 2025 green roof internship brought me to field observations that focused my inquiry. In my unpublished paper describing invasive plant and invertebrate species in three urban settings, I had noted that the green roof featured an “abundance of large robust vegetables that grow quickly and supply a sales station at a farmers market,” (Dyment, 2025) but there was another reason this was not a typical garden. A green roof is not like an earth-level garden and so is a bit of a laboratory, notable here as an instance of well-controlled invasive jumping worms, a species new to Canada which has been remodelling forests and alarming gardeners across North America since populations first surged in the 2010s (Chang et al., 2016; Reynolds, 2021). Unlike the invasive thistles and Norway maple on the green roof, wind transferral or ornithochory as with seed species was not a dispersal question with invasive jumping worm cocoons, as they are not designed like seeds to be picked up by the wind nor to survive the mechanical and chemical realities of avian digestion (Holyoak, 1972; Chang et al., 2021). As well, wild animals groom themselves frequently and, in comparison to the industrial quantities of materials involving soil moved by human activity, are simply not a vector. As renowned oligochaetologist and authority on earthworm taxonomy Gordon Enoch Gates once remarked, it is humans who are “the only agent known to be engaged in transporting earthworms on a large and continuous scale,” (Gates, 1976). As they are exclusively a human problem, with correct policy, their spread could be controlled.

When I first met a jumping worm, I had been working on my own with a campaign to stop their advance into provincial parks, but I had not encountered one in real life nor seen them in a garden. With my corresponding interest in urban agriculture, the two paths merged and I chose to make them a focus, as the much larger environmental implications of jumping worms had convinced me they strongly merited policy and the attention of a Masters Research Project in Environmental Studies (Thunberg, 2019; Klein, S, 2020). I determined that the presence of a new species that multiplies quickly and wreaks havoc in soil meant they were not only extracting a toll in agriculture in its various forms, but that urban agriculture was at special risk, and where found in gardens, they were likely in the forest soil nearby, with cocoons easily spreading by footwear from one source to another. I then concluded that arbourists in contaminated areas such as Windsor or Toronto with no biosecurity requirement (such as to clean their machines between jobs), could easily “free chip drop” urban wood waste to landscapers who then spread contaminated wood chips in their practice. This was a regulatory policy gap that could include woody waste debris spread as a stable walking surface on forest trails in urban and suburban areas (Lahkan, 2017; Keil, 2020). By extrapolation, with no regulatory control over even this one vector, lack of several other regulations implied that Canadian silviculture could surely also be impacted, as could Canada’s multimillion dollar tourism industry (Burman, 2005). This risk of an economic toll to Canada convinced me that I had a duty through my Masters Research Project to both alert multi-juridictional levels of government to the need for stronger biosecurity policy and make the public more informed and capable of coping with the advent of this new species into Canada.

So came about my voyage to learn everything about jumping worms, including perceived policy gaps in controlling their spread and all interconnected topics that I could.

While the CFIA was aware of them and Canada does have some good policy protecting it from soil-based invasives, at time of writing they had not been prohibited as an invasive species at all. As well, Canada has a problem with significant lag between being notified of a new invasive and actually taking appropriate action (Office of the Auditor General of Ontario, 2022). While the Auditor General had published about this in the widely-read 2022 report which wrought some change, the pattern of underfunding and slow responding still sustained (The Canadian Press, 2022; Morgan, 2023). However, there was another type of lag that I was more concerned about (Stohlgren & Schnase, 2005; Maine DACF, 2021; Robeck et al., 2024).The species itself had been in the United States for over a century, confined to botanical gardens with a more famous appearance as fodder at the Bronx Zoo in 1949 (Nichols, 1949; CBS/AP, 2022). Although known, jumping worms did not become a concern until very recently, when what appears to be a "lag period" of species adaptation ended, as jumping worms fine-tuned their ability to truly expand in regions far from their native soil (Gates,1958; Crooks, 2005; Burgman, 2005; Coutts et al., 2018).

I also observed that as researchers were beginning to track a sudden population explosion in the species, American support groups for gardeners had sprung up addressing eco-anxiety, while the term “Solastalgia” first coined by environmental philosopher Glenn Albrecht in 2003 and meaning distress from a changed environment, was being used (Albrect, 2003; Gupta, 2021; University of Minnesota Extension, 2025).

In forums I read testimony from gardeners in areas where the jumping worm invasion was in full swing, while in Canada it had not yet impacted:

“My strawberry plants are flat on the ground with no soil to hold on to. What are our farmers going to do? Crops will fail. Nutrient deficient and no earth to sustain them. What was soil around roots is now jumping worm castings,” (Hoyumpa, 2025).

“They are such a problem in the U.S., that support groups for gardeners have been formed and there is even recognition of the emotional toll that JWs have on gardeners,” (Harries, 2022).

And this one from the Master Gardeners of Ontario, who have done excellent outreach work from day one, “while they are regulated in several U.S. states, at present neither the Ontario nor the federal government has taken serious action to slow the spread. Preventing the spread NOW, early in the invasion, is critical,” (Kavassalis, 2023).

I quickly identified a series of regulatory gaps, that, despite Canada’s renowned biosecurity rules at the border, were still unaddressed, while clearly, jumping worms had gotten into Canada in 2014, and needed to be controlled from spreading.

To further assess the human dimension, I analyzed 75 posts under the hashtag #jumpingworms, which quantified this collective emotional response: 37 posts featured surprise or shocked emojis, 14 posts featured cry emojis, 7 posts received no direct emoji response, while the remainder received solidarity and supportive thumbs-ups. Posts exhibiting clinical or scientific detachment typically belonged to individuals who had already researched the species and explicitly acknowledged the underlying shock. This was further confirmed by a 2021 study in which a survey was given to Master Gardener coordinators for distribution to their volunteers. The Cooperative Extension

Master Gardener Program has “over 86,000 volunteers in all 50 US states, making it one of the largest volunteer organizations in the US,” (Johnson et al., 2021), the survey found that of 442 respondents, 61% had observed jumping worms, while over 85% of respondents viewed jumping worms unfavorably, and 42% indicated they had actively attempted some form of improvised control despite the lack of officially certified management protocols (Johnson et al., 2021).

If it was true that there was an emotional component to coping with the species, I felt that better preparing Canada’s urban gardeners, at the foundation of a resilient city, could help circumnavigate any sense of loss of agency over what was their essential contribution to a sustainable future. Extrapolating from studies such as the 2021 article by the Scientific Communications Team at National Resources Canada which indicated carbon stocks in boreal forests were being affected by earthworms, and that their activity was facilitated by climate change, I realized the impact of this much more “voracious” and high-metabolism detritivore was one quite different than the typical “earthworm” mentioned by the NRC (Bohlen et al., 2018; Chang et al, 2021; NRC, 2021; Zhang, 2026). The risk of jumping worms advancing north not only into the Boreal but to the Boreal Peatlands, the most massive carbon sequestration area on earth, holding twice as much carbon as forest, and one that is perhaps the definition of decaying organic matter, was the glaring issue the public and the Canadian government needed an actionable response to (International Mire Conservation Group, & International Peatland Society, 2021; World Economic Forum, 2025; Wikipedia, 2026; Zhang, 2026). While industrial activity such as drainage and a drop in the water table exposing peatbog to oxygen releases mass carbon into the atmosphere, it also risks creating a

setting where jumping worms can generate a second carbon stock loss on a scale that evokes the precautionary principle and not worth the risk (Muldoon et al., 2025; Waddington, & Price, 2000; Cameron, E.K., et al., 2015).

Studies such as “Ecological grief as a mental health response to climate change-related loss,” categorizes solastalgia into three main types: the loss of physical environments/ecosystems, the loss of cultural knowledge and identity tied to those landscapes, and the anticipated loss of future environmental stability, (Cunsolo & Ellis, 2018). Therefore, my outreach had to represent actionable knowledge mobilization that might support any community—from urban gardeners to those frontline communities, Indigenous groups, and individuals deeply connected to the natural world—in what eco-anxiety researchers like Ojala (2017) and Pihkala (2021) term "constructive hope." Such an approach in support of resilience-building mechanisms (Janssen et al., 2022) and collective action must foster community empowerment and agency, in this case, against invasive species, (McKinley, 2017; Klein, 2020; Environment and Climate Change Canada, 2024; Federation of Canadian Municipalities, 2026). I then created a Master's research project plan to determine if a citizen campaign model could protect Canadian ecosystems by raising awareness of a new invasive species to Canada that was, to my estimation, flying seriously under the radar.

I realized that I must also make communities in areas such as Northern Ontario, where mining and development might inadvertently spread jumping worms, aware of how easily biosecurity protocols already used by industry, such as clean equipment protocols, could be repurposed as closed loop systems before entering an area, (Ontario Invasive Plant Council, 2016). As this is something some industry is already

leaning towards, ensuring that mandatory protocols are put in place rather than industry self-compliance would be critical, (Ontario Ministry of the Environment, Conservation and Parks, 2014; Ontario Invasive Plant Council, 2016).

As a result of this early-stage exploration of the topic I have described, my project took on several different components in order to achieve a whole. I hope that the summary of my efforts may help move Canada towards strict biosecurity regulations regarding development in the north and a stronger appreciation of the serious risk to the Northern Boreal and Northern Peatlands. As well, it is my hope that better protections from this new invasive species to Canada to prevent economic harm to silviculture, agriculture, as well as Canada's multi-million dollar tourist industry may bring some very simple protocols into action. As well, my aim is to make everyday Canadians growing their own food aware of their essential role in the urban resilience framework of any nation while in command of the tools they need to divert Canada from the terrible toll the species has exacted in the US. Finally, I wanted to provide support not only for gardeners to wear “garden-friendly shoes,” but for municipalities and communities in the north to deploy a network of boot brush stations to protect their local trails, and to be informed of how simple biosecurity measures can be that protect the north. As these tools include materials to create preventative policy, this would include capacity for informed debate regarding pesticides, as they can be a reactive choice that in fact makes matters worse, and so I included information I learned explaining why they can cause a population explosion and should not be assumed to be answer, in support of knowledge mobilization, (Potter et al., 2010; Simon et al., 2025). While it is a species that may impact silviculture and agriculture—two sectors known to use pesticides

often—I also wanted to ensure that the message was out that reactively spraying chemicals was in this case potentially a counter-solution while efforts of prevention and regulation were what was urgently needed (Nouri-Aiin & Görres, 2021).
Combined, I hope this work fosters a positive shift toward soil stewardship. By moving past solastalgia, it empowers Canadians to take action against this new-to-Canada species, building on over a decade of recent data from researchers both at home and south of the border.

Jumping worms do not walk or fly, and it is humans and human actions alone that causes their spread, however, once informed, human inaction is a choice—and with the best science now at hand, we have a clear duty to implement inexpensive tactics of mitigation and control.

The Taxonomic Journey

Understanding the historical arrival of a new invasive soil-dwelling species to Canada first requires the assembly of a number of puzzle pieces. While the framework for these species was technically established via Pacific and California specimens by Swedish zoologist Johan Gustaf Hjalmar Kinberg in 1867, the true foundations of jumping worm classification and species descriptions belong to Seitaro Goto and Shinkichi Hatai (Kinberg, 1867; Goto & Hatai, 1898). At the turn of the last century, the race was on to identify and catalogue the pheretimoid earthworms of Japan. This resulted in several scientists unknowingly describing the exact same species at the same time, but the primary milestone still belongs to the pair's meticulous taxonomy. In their two-part zoological paper (1898–1899) titled, “New or Imperfectly Known Species

of Earthworms," carefully written descriptions appeared of twenty-eight species of earthworms, the majority of which, including jumping worms, were considered entirely new to science (Goto & Hatai, 1898; Blakemore, 2003). As it was still an age before Japan's famous optics brands had even emerged, these invertebrate studies would likely have been conducted using large brass microscopes imported from Europe (Evident, 2022).

Meanwhile, at laboratories in London and Hamburg, researchers Frank Evers Beddard and German oligochaetologist Wilhelm Michaelsen were racing to study separate collections of Japanese earthworms shipped to them by global collectors (Blakemore, 2012). During this same era, Seitaro Goto and Shinkichi Hatai performed foundational anatomical work, identifying the Pheretimoid group within the *Megascolecidae* family and formally introducing *Amynthas* and *Metaphire*—including the now-infamous *Amynthas agrestis* (1.5 – 5")—to the scientific world (Goto and Hatai, 1898). However, other jumping worms the pair had described were found—by rules of priority—to have been recorded in the 1892 work of European researcher Frank Evers Beddard—specifically *Amynthas tokioensis* (1.0 – 3") (Beddard, 1892), as Beddard had already described the species from a Tokyo specimen sent to his lab. Meanwhile, German oligochaetologist Wilhelm Michaelsen swept the credit away from Beddard for the taxonomic designation of *Metaphire hilgendorfi*, (2.0 – 8") having published a description (Michaelsen, 1892) a few short months before Beddard's work.

As a result of this strange competitive race in science, two of the three most common North American jumping worms are today credited to Beddard and Michaelson, and appear with an appended note to Goto and Hatai's work, as Goto and

Hatai also chronicled all of them in their series, and irrefutably “discovered” *Amynthas agrestis* in 1898 (Blakemore, 2012; Reynolds 2022). This at least secured some credit for research on their own soil, as Western taxonomy attempted to hastily categorize an ecosystem that Japanese scholars had already organized through centuries of their own sophisticated nature studies, including a history of elaborate documentation stretching back to publications from the Edo period such as found in the famous 1666 botanical encyclopedia, Kinmo zui (Tekisai, 1666; Marcon, 2015; National Diet Library, 2024). The Edo period, known for its refinement of horticulture, (Marcon, 2015) has a significance in the timeline of jumping worm invasion, as unregulated trade in Japanese plants later played a role in the spread of the organisms to North America (Görres, 2014; Del Tredici, 2017).

To the Japanese and neighbouring nations in which jumping worms are native, they are considered simply a sign of healthy soil as they do not multiply uncontrollably or cause havoc in plant nurseries, forests or field. The group Pheretimoid, with their specific behavioural and biological traits, are even celebrated as medicine in parts of China, where “Earth Dragon" (地龙 - Dì Lóng) is dried and used in Traditional Chinese Medicine (Cooper, Hirabayashi, & Balamurugan, 2012).

Assessing Traits in Establishing Risk

Traits of the Pheretimoid group were later described in a major 1972 study published in the Journal of the Linnean Society of London, Zoology, one which intended to better organize their classification, stating “the widely distributed earthworm genus *Pheretima* auct. containing 746 nominal species and subspecies, was last reviewed in 1900 when 167 species were listed,” and is a valuable twentieth-century update which

includes highly detailed taxonomic work (Sims, R. W., & Easton, E. G. 1972). Despite their proliferation and variety of services in their native soil, Pheretimoid worms fail to play a helpful role in North American soils but instead represent a destructive complex of invasive genera that rapidly dismantle the structural integrity of the forest floor and are invariably a disaster to these ecosystems (Chang et al., 2021; McCay et al., 2020). For the purpose of risk assessment in determining the need to enforce stricter regulations in Canada regarding their spread, let us examine their specific traits (Burgman, M. 2005; Lodge et al., 2016).

Identifying jumping worms

Jumping worms are distinct in colour with variations of a purple-brown hue and an iridescent metallic sheen in contrast to typical unpigmented earthworms known in Canada (McTavish, 2022; Niagara Master Gardeners, 2023). As jumping worms are not burrowers and spend their time close to the surface, their pigmentation can be assumed to be, “an indicator of the vertical location of earthworms,” as well as one which “provides visual protection from predators,” (Pham et al., 2023). Jumping worms also are identified, past juvenile stage, by a milky-white, highly-visible smooth band at the 14th segment, approximately the 15% point of their length, appearing not unlike a collar and closer to their head (McTavish, 2022). As well, jumping worms are distinguished by a larger mouth with an active prostomium (foraging lip), something not seen on the less mobile, recessed mouthparts of common *Lumbricus* spp. (Niagara, 2023). The 1972 study, “A numerical revision of the earthworm genus *Pheretima* auct.” points out that while species and subspecies of Pheretimoid worms have a high degree of morphology, there are persistent characteristics, importantly including that of “numerous setae

situated around the equator of all but the first and last segments," that are features only pheretimoid worms possess (Sims, R. W., & Easton, E. G. 1972).

Setae and locomotion

This trait of setae ringing each segment is helpful to us today in understanding why jumping worms possess serpentine locomotion, are difficult for much North American wildlife to capture past the juvenile stage and why gardeners and other observers describe their distinctive thrashing "jumping" movements as an identifier when handled, (Conservation Hamilton, 2022). They are in fact best found listed as "Snake worms" on iNaturalist app, which has maps showing their spread (iNaturalist, 2015). All earthworms have setae to assist in movement, which "give them a grip on the substrate around them," but jumping worms are unlike the (invasive) nightcrawler and other "friendly" earthworms known to North Americans with 8 setae at each segment, Pheretimoid worms have many more, documented since the early days of taxonomy (Bruner, 2015).

Public outreach material produced by both the State of Maine and by the University of Minnesota, places where jumping worms have been an issue a decade in advance of Canada and so of enormous research value to today's policy makers, also note the significance of setae, describing jumping worms as having "as many as 40 setae or more around each segment," (Fish and Peterson, Maine DACF, 2021; University of Minnesota, 2026).

While it seems strange to associate earthworms with anything other than a role as gentle soil aerators we have been taught, it is this number of setae that allows them the trait of "motions so violent, the worms appear to leap off of a surface, earning the

‘jumping’ part of their name” as described by researchers at Purdue University in 2015 and supported in other descriptions (Bruner, 2015; Frelich et al., 2026). How many setae? An archived Canadian government document, “The Earthworms (Lumbricidae, Megascolecidae and Sparganophilidae) in Canada” helpfully identifies the higher range of this setae count, stating “the pheretimoid earthworms have numerous setae (as many as 150) per segment,” Reynolds, J. (2022). A document intended to provide identification cues from the Connecticut Agricultural Experiment Station, also refers to “noticeably fast-moving, highly active worms with a strong, rigid, muscular body that can thrash violently when disturbed,” describing a “high hydrostatic body pressure, which makes them snake-like,” (Ridge, 2023). We find the term “thrashing” used by Ridge as an identifier that occurs throughout public-facing literature, including by Canada’s Invasive Species Centre (ISC, 2023).

Muscularity

The suggestion that they are muscular, however, requires qualification, and this can be found in the work Pham et al., also in 2023, which researched the burrowing behavior of various *Megascolecidae* family, (Phertetimoid) *Amynthas* species in Vietnam in order to assess their aeration merits in their native soil. Generally, burrowing species may be assumed to be more “muscular” as they must push through layers of soil, (Edwards & Arancon, 2022). Jumping worms are epi-endogeic (or simply epigeic) and do not burrow as they live very close to the surface, while endogeic or anecic species burrow further down (Bouché, 1972). Are jumping worms “muscular”? As they are smaller than many of the larger pheretimoid burrowers in Pham’s study, they were placed within Pham’s first ecological category (EC1) in a table assessing 16

morpho-anatomical traits of four ecological categories (EC). This data compiled from Pham et al. (2023) demonstrates that smaller epigeic pheretimoids (EC1) weighing only 540 mg., a ten percent fraction in size compared to larger endogeic or anecic species such as those represented by EC3 at 5456 mg in weight, do possess a disproportionately strong muscular power.

Specifically, Pham and researchers determined that the EC1 category actually carries in their body walls a longitudinal muscle thickness of 179 μm, in contrast to EC3 at 237 μm, or 75% the longitudinal muscle thickness of an EC3 earthworm. Listed as statistically indistinguishable (ns) from the 237 μm found in the much larger EC3 worms, this a very dense muscle structure for jumping worms, and also qualifies Ridge's description of a "high hydrostatic body pressure," as, unlike European earthworms, whose muscle fibres are designed for elasticity and slow, sustained movement, jumping worms are sinewy, strong and much more difficult for predators to grapple (Mill, P., & Knaff, M. 1970).

No Natural Predators

As we implied above, this "displaced" being/earth relative, benign in its native soil, adapting its best (very well) to a strange place, has no real predators, as other species cannot effectively hunt nor keep pace with its expansion, allowing it to recently emerge from "lag phase" as a significant ecological threat across North America. Jumping worms are also uniquely equipped with the trait of a voracious appetite for North American organic matter, including cellulose, soil and all leaf litter, demonstrated by the rapid stripping away of forest soil o-horizons wherever they are active (Qiu, & Turner, 2016). This feeding process quickly transforms invaded soil into granular,

pebble-like material much different from natural soil and with little capacity to retain moisture or allow roots to grip (Chang et al., 2021; Ferlian et al., 2024). The destructive capacity of pheretimoid earthworms represent therefor serious consequences for plant productivity and forest health; with research indicating that the resulting damage is directly linked to economic impacts in Canada such as the widespread dieback of sugar maples (Bal et al., 2018; Skinner et al. 2018) and a catastrophic decline in seedling recruitment (Frelich, 2006; Craven et al., 2016). While mechanical impacts of these earthworms on soil structure are well-documented (Chang et al., 2016; Chang et al., 2021; Qiu & Turner, 2017), meta-analyses have confirmed that those essential ecological functions that are eroded by their impact include soil's capacity in sequestering carbon, something we will discuss in further sections (Ferlian et al., 2018).

Urban Agricultural Risk

In agriculture, reports of infestations severely damaging "the roots of plants in nurseries, gardens, and turf," by the Colorado Department of Agriculture confirm their threat to farming, while the Vermont Agency of Agriculture Food and Markets reports, "nutrient loss through erosion and leaching," with "perennial landscapes and forests (including sugarbushes) " at risk, and warnings of "significant damage to high tunnel vegetable production," (VAAFM 2026). The reliance on intensive mulching and compost cycling within nursery systems—combined with the ability of jumping worms to cause moisture loss through the degradation of soil—has prompted California to implement strict quarantine regulations to mitigate their spread (California Department of Food and Agriculture [CDFA], 2024). Research indicates that urban green spaces are particularly

vulnerable to the disruptive impacts of invasive jumping worms, as these environments are perfect high-moisture, organic-rich soil conditions that the species requires to establish and proliferate (Buchholz et al., 2026; Ziter et al., 2021). As jumping worms survive well in high-moisture, organic-rich soil conditions, landscaping and gardens are also particularly vulnerable to these disruptive impacts (Buchholz et al., 2026; Ziter et al., 2021).

The food justice red flag here is that with no awareness of control methods, city community gardens, an unsung foundation of urban food security, and spaces where soil integrity and nutrient cycling are critical elements, are at risk of soil damage affecting production (Mount, 2012; Levkoe, 2014). While MacRae et al. (2010) established the productive potential of these spaces, the systemic undervaluation of urban self-provisioning leaves our cities uniquely exposed to disruptions in local food production (Gilbert, 2014; Hammelman, 2019; Heynan et al., 2012). Furthermore, this type of vulnerability disproportionately impacts those most reliant on city-grown produce, and risks becoming a harm that reinforces existing cycles of food insecurity (Alkon, 2014; Heynen et al., 2012).

In fact, jumping worm management protocols are remarkably accessible while regional best-practice guidelines (Dellinger, 2021; MGOI, 2023; MGHS, 2024; VAAFM, 2022), offer basic measures—such as preventing soil movement, adhering to strict cleaning biosecurity, manual extraction during peak activity, soil removal, solarization and rotation of sites and the generous addition of organic matter that are sufficient to maintain productive vegetable yields in invaded areas. Combining strict protocols with the addition of organic matter has been shown to enhance soil structural resilience and

the quality of produce (Simon et al., 2025; Mia et al., 2026), a method actively employed in urban projects like the Green Thumbs UP roof garden (Green Thumbs Growing Kids, 2025).

Besides their inherent contribution to just sustainability, the role of gardens as hubs for public education and ecological management skills is undeniable (Krasny & Tidball, 2009). By empowering stewards to effectively monitor and manage jumping worms, we ensure these sites are no longer points of vulnerability but a “sustainable cities defense system,” leveraging the power of community science to map and mitigate invasive populations and the shared skills of gardeners at the fore (Buchholz et al., 2026; Ziter et al., 2021). Ultimately, as Agyeman reminds us, we must see spaces such as community gardens for their function as 'autotopographies'—living landscapes that manifest the lived experiences and identities of their stewards (Agyeman, 2013; Levkoe et al., 2021).

While COVID and other challenges have disproportionally affected low income groups, the skillset of biosecurity is not that different from COVID-era skills, allowing for “clean in, clean out” gardening protocols to be purposed with ease (Stiegman, 2022). Besides being community spaces, urban gardens require us to acknowledge that both 'the local' and 'local food' come to exist through the complex inputs of translocalism and city culture (Agyeman, 2013; Hammelman, 2019). These new skills then must be shared among gardeners, as any valuing of “green aesthetics” over functioning neighbourhood and community gardens in expanding global cities is a failure to uphold those essential sustainability practices that actually make a city alive (Gilbert, 2014; MacRae et al., 2010). Urban gardens advance not only early detection and monitoring

of invasive jumping worms, but such spaces interact with many and diverse stakeholders, functioning as educational hubs in the management work involved for resilient garden health despite many invasives and pests, and can function even in the presence of an insatiable invasive soil species (Buchholz et al., 2026; Ziter et al., 2021).

Undervaluing gardeners and placing future food in the hands of soil-less, vertical, or "smart" agricultural models unequipped to supply calorie-dense staple crops is, sadly, a ludicrous and dangerous naivete disconnected from material reality (Heynen, 2006; Odame et al., 2020). By presuming these models might allow us to not be impacted by invasive soil-borne species we ignore a deeper, more fundamental loss: the erosion of the human and animal connection to earth itself—the ever-cycling, organic foundations of life (Heynen, 2006; Dyment, 2025). Despite the hype surrounding high-tech indoor food production, such systems are also notoriously poor at meeting economic requirements compared to traditional or agroecological methods (Benis & Ferrão, 2018; Alves & de Oliveira, 2022). When urban dwellers believe the false impression that their salad greens-in-a-box could as easily become an emerald okra, a calabaza squash or bread from an indoor field of wheat, they trade also the resilience of community-based stewardship for a bubble sustainability and a precarious future far more vulnerable than true understandings rooted in the wisdom of working with Mother Earth.

In conclusion, the trait of rapid consumption of organic matter and quick processing of the epigeic layer seen in *Amynthas* spp*.,* does present a risk to Canadian urban agriculture—a sector that is increasingly vital as more than 81% of the Canadian populace now resides in urban centers (StatCan, 2024). Activating fundamental soil-protective protocols in a cultural shift towards biosecurity awareness is perhaps the

“gift” that the “Earth Dragon” has brought us. Our shared mindfulness for the land (often including the gritty chore of handpicking of pests!) are ancient skills that increase urban resilience in an age of climate crisis. Gardeners growing local food on urban soil are at the front line of management techniques, and equipping ourselves to prove that we can produce bountiful harvests despite jumping worms creates hope as well for the future of our forests. With the support of policy change or without it, gardeners will spearhead a movement of resiliency and empowerment beyond fear.

Nomenclature in policy and in outreach

I would like to take this moment to address a concern of species clarification in public outreach. I feel this clarification is critical as a policy gap may occur if the term “*Amynthas* spp.,” enters into formal policy designations. I was able to find that in 2016, three eminent authorities in earthworm ecology, Chih-Han Chang, Bruce A Snyder, and Katalin Szlavecz, published a paper that also addresses this directly. In the paper the authors remarked, “many publications in the United States have used *Amynthas* spp. to represent the group without identifying the species.” They remind us that these are all pheretimoid earthworm species, as are the 16 have been recorded in North America north of Mexico, “including four genera: *Amynthas, Metaphire, Pithemera*, and *Polypheretima*,” (Chang et al., 2016). The paper also describes “widespread co-occurrence of three species- *A. agrestis*, *A. tokioensis*, and *M. hilgendorfi* – and point out that many recent claims of invasion of *A. agrestis* need to be re-evaluated for potential misidentification,” (Chang et al., 2016). Examples of the use of *Amynthas spp.*, as a “broad brush” are frequent in both public and scientific literature, and it is worth noting that *Amynthas* spp. usage if not entirely rigorous may even serve several larger

functions. The Wisconsin Department of Natural Resources (WDNR) alongside research partners such as the University of Wisconsin-Madison are a highly regarded environmental authority, and one that went to work fast in response to the jumping worm threat. They created public facing materials that were the models for other states and regions, and their work included state legislative briefings, forestry best practices, and community biosecurity protocols (WDNR, 2024; UW–Madison Arboretum, 2024). Because jumping worms were first sighted in 2013 UW–Madison Arboretum, 2014) and they were identified as A*mynthas* spp.*,* the designation was a scientific name that was quickly shared and appeared in much of their outreach. By providing the public with a scientific nomenclature, the WDNR also inadvertently supported what will be an eventual shift away from the use of “Asian jumping worms,” as a descriptive, which, like terms “Asian carp,” or “Gypsy moth,” link an invasive or destructive organism to a specific geographic region or ethnicity and can inadvertently foster prejudice (Friends of the Mississippi River, 2022; Entomological Society of America, 2026) This possible intention is evidenced in current public resources from connecting institutions such as this one from the University of Minnesota, which states, “common names that reference specific places, such as ‘Asian’ or ‘Japanese,’ can unintentionally reinforce negative associations, particularly when applied to invasive species that are targeted for control or eradication,” (Gupta, et al. for University of Minnesota Extension, 2022). “Asian jumping worms,” is a term that is also widely used including in scientific literature. The use of geographic descriptors in such names may later be reconsidered as science communication evolves or as concerns arise about unintended associations with places or people. However, their original purpose was primarily urgent and descriptive: to

communicate the invasive species' native origin and distinguish it from other earthworms during a period when public awareness was limited. We must keep in mind that using a place or ethnicity-based name for an invasive species has been challenged formally, an example being the US State of Minnesota, which passed a law prohibiting the use of the name “Asian Carp,” Great Lakes Commission. (2022). Researchers using the term represent a global community of respected scientists from diverse ethnic and cultural backgrounds. Any impression of insensitivity in science must understand the name has been part of a global effort to communicate clearly about an invasive organism, not an expression of cultural association or prejudice. The challenging, often underappreciated work of early detection, ecological investigation, and public awareness requires use of a shared identifier for a species that quickly distinguished it from those typically described as European earthworms in the same manner. While scientific terminology must evolve alongside broader discussions of inclusive communication, evaluating historical naming practices requires careful attention to context, intent, and the substantial conservation contributions made by scientists who first brought attention to the issue.

For gardeners horrified by the discovery of jumping worms in their spaces, the need to categorize them as Asian outside the scientific context however serves no function. Decolonialized language such as the term “displaced plant relations” might hopefully someday support discussions of invasive jumping worms as relatives and valued medicine in their original homes, empowering gardeners to move past fear (Friends of the Mississippi River, 2022, citing Maggie, Wakan Tipi Awanyankapi, 2021). Meanwhile, *Amynthas* spp.*,* is easily found on websites such as those offered by the

Wisconsin Department of Natural Resources, which are award-worthy sites of scientific rigour and some of the most comprehensive and accessible materials available, while the small detail of an eventual third species of *Metaphire hilgendolfi* becoming identified in the mix did not stop the WDND from both raising the alarm and changing their laws to protect Wisconsin.

Use of the "*Amynthas* spp.," umbrella term for that reason appears throughout community-focussed online resources and is likely to stick, such as this one from the Chicago Community Gardeners Association, which also shows how difficult it is to convey information using non-impactful word choices, "Jumping worms, (*Amynthas* spp.) were first identified in our region in 2015 in northern Illinois. These worms are native to East Asia, and they also have been called crazy worms, jumping worms, and snake worms because the worm thrashes wildly when handled or disturbed, and it can shed its tail in defense," (CCGA Communications Team, 2020).

A widely published paper, "Effects of Invasive Jumping Worms (*Amynthas* spp.) On Microhabitat and Trophic Interactions of Native Herpetofauna," explored which creatures were incorporating jumping worms as a food source using *Amynthas agrestis* as prey, also described the mechanism of caudal autotomy as defence from snakes and toads, further entrenching the image in the public mind (Crone et al., 2022). Consequently, despite "stealing the spotlight," we might actually see the famous tail-shedding anti-predation mechanism of *Amythas agrestis* as serving an enormous and effective public relations function for jumping worm awareness across North America.

In public outreach research, the continued use is here to stay, while hopefully the use of the “Asian” descriptive will soon be discarded as the work of language activists regarding invasive species descriptives becomes more appreciated and refined.

Is *Metaphire hilgendorfi* widespread? Moving our attention to only a few kilometres west of Chicago, The Morton Arboretum in Lisle, Illinois describes the encroachment of “Asian jumping worms—a complex of three common species, *Amynthas agrestis, A. tokioensis, and Metaphire hilgendorfi*” as a co-invasive trio, avoiding use of the *Amynthas spp.* generalization in a lean towards scientific accuracy (Midgely et al., 2021). Offering a photo of a jumping worm at their research station that is twice the size of *Amynthas agrestis* – at 8 inches – very likely evidence of *Metaphire hilgendorfi* in Chicago. As Chang et al., emphasized, these species rarely invade on their own, but with cocoons that are tumbled together in the soil, resource-share and co-invade with others.

For policy purposes, it is my choice to advance the use of the term “pheretimoid earthworms” as there are no pheretimoid earthworms that are not harming to North American soil (Chang et al., 2016). As well, highly individualized species classifications are not necessary for legislation in Ontario, or more federally to protect Canada. The 2015 Ontario Invasive Species Act has a very wide taxonomic scope within which “species or similar groups of species” are declared “illegal to import, possess, transport, or release” anywhere in Ontario. For such a purpose, pheretimoid earthworms would be considered a group.The Invasive Species Act (2015), explicitly regulates the prevention and management of invasive species in Ontario. Species or similar groups of species are prohibited under this Act, meaning it is illegal to import, possess, transport, or

release these species anywhere in Ontario. Conservation officers would then have the immediate tools to seize any suspect bait trafficking of all pheretimoid species, while other regulations could be properly enforced regarding the movement of contaminated material inter-provincially. In Ontario, "prohibited" status is a far more powerful management tool than “restricted,” although Ontario also restricts 16 additional species or similar groups of species, “meaning it is illegal to bring them into provincial parks or conservation reserves and illegal to import or release them anywhere in Ontario.” The curious emphasis on parks and conservation areas specified under “restricted status” in the Ontario Invasive Species Act functions as a clause to keep specified invasives out of high-value ecological areas. It is one that is not mentioned under the stronger prohibited status but those areas are also subject to enforcement under the more effective prohibited status.

For pheretimoid worms, I am seeking a complete prohibition, which will help protect northern areas such as the Ring of Fire from accidental spread during the inter-provincial transport of any bio-contaminated materials such as soil and aggregates, vehicles and footwear from contaminated areas, and bait. However, I have also petitioned the Canadian Federal Government, something I will detail in my policies section. The reason for this in simple terms is because I identified loop-holes in Canadian border policy that allow for jumping worms to slip through, and I believe the Canadian Food Inspection Agency (CFIA) can easily purpose their regulatory response to, for example, Golden nematode contamination in soil, to one that can stop jumping worms as well. This biosecurity structure template combined with other recommendations I have made including those which use infrastructure from things

such as Emerald leaf borer control make control of jumping worms in Canada imperative. I also believe that pheretimoid earthworms qualify under the Plant Protection Act (1990), not only as "pests injurious to plants" but as pests poised to cause economic harm to Canada over the next fifty years on a measurable and according to certain projections on a potentially vast scale.

As a note further on nomenclature, to petition using the terms *Amynthas agrestis, A. tokioensis,* and *Metaphire hilgendorfi* does not seem efficient to me, as these three species are not the only pheretimoid earthworms that have come to make an appearance on Canadian soil. On the topic of co-invasion, there are more pheretimoid earthworm species “on the horizon” and beginning to become noticeable in North America, including *Amynthas minimus* and *Pithemera bicincta*, both recently sighted in Canada, while *Amynthas gracilis, Amynthas hupeiensis* and *Amynthas corticis* are found close to the Canadian border. Of particular concern may be the pheretimoid green jumping worm or *Amynthas corticis*, which we will discuss shortly as we address fecundity in these species.

Risk assessment: Fecundity of jumping worms

It must be said here that many people new to jumping worms remark that surely the adaptation of predators such as snakes, toads, salamanders and birds is a “natural control” that will evolve in time and effectively reduce jumping worm numbers. It is important therefore for the public to understand that “Canadian” Nightcrawlers (*Lumbricus terrestris*) lay 1-3 cocoons per season with 1-2 eggs per cocoon, while jumping worms raise the issue of overcompetition for resources to an entirely different level (K. Butt, 1998). Jumping worms overwhelm ecosystems with extreme density,

laying cocoons which, like *Lumbricus terrestris,* may contain 1 to 2 eggs, while literature asserts that each adult jumping worm can produce up to 60 cocoons, not 1-3. Assuming those 60 cocoons all produce a hatchling, risk assessment can project the exponential impact of one viable stray cocoon falling from a hiker's boot tread in the pristine forest, as researchers often find cocoons and jumping worms at trailheads, (Schappach, 2025). So let us look with care in our risk assessment at fecundity studies, with numbers, but first, in public outreach. From Nancy Knauss, Horticulture Extension Educator with Penn State Extension, in a podcast: "They are so fertile and they don't need a partner to produce cocoons, so one adult worm can produce up to 60 cocoons. Each cocoon can have one to two eggs," (Knauss, 2022). A downloadable PowerPoint presentation from University of Massachusetts Amherst Agriculture and Food Environment website, titled *Invasive earthworms*, also offers the 60 cocoons claim on slide six (Kostromytska, 2021), and from the University of Connecticut (2022), "cocoons contain 1 to 2 eggs, and each adult may produce up to 60 cocoons."

Invasive jumping worms reproduce almost entirely through parthenogenesis, evidenced by "large populations of genetically identical clones and a widespread lack of male pores," and so each earthworm is capable of reproduction, "though a small subset retains the anatomy for what is thought to be episodic sexual reproduction preserving sufficient genetic diversity for adaption to new environments," (Nouri-Aiin 2022). "They don't need a partner" is therefore, accurate, as the 2022 study by Nouri-Aiin et al. confirms. While the 60 cocoon approximation also appears to be generally valid, there are large variations in hatching and climatic triggers to hatching. There also have been discrepancies around how many eggs are in each cocoon.

An online report by Virginia Cooperative Extension, 2025, states, each worm produces tiny cocoons at around 60 days of age, and each cocoon incubates “between 2 and 20 worms – which will again start producing more cocoons in about 60 days. This allows for about 2 generations per year,” (Virginia Cooperative Extension, 2025). This much higher fecundity claim has appeared before and is an error traceable to a 1957 study stating planarian egg capsules from “D. dorotocephala” will contain "usually from 2 to 20" eggs,” (Miller et al., 1957). This statistic in some circles became historically misattributed to earthworms in general. It is however not accurate for pheretimoid earthworms, which produce 1-2 (Nouri-Aiin 2022).

Interestingly, within this spectrum, a comprehensive 2025 study by Nouri-Aiin et al., describes *A. tokioensis* as “low fecundity” at ~10–50 cocoons per lifetime, as well as “slow development” with a “~100-day maturation, and sensitivity to environmental conditions,” as well as a delayed hatching strategy. "Given their slow production rate (one cocoon every two days), hatching timing is critical—April hatchlings may yield up to 60 cocoons, while July hatchlings might produce as few as seven. (Nouri-Aiin et al., 2025).

From the same paper, the researchers also remark, “as annual species, *A. agrestis*, *A. tokioensis*, and *A. hilgendorfi* …overwinter and hatch in spring—surviving desiccation and freezing. This seasonal rhythm makes temperature a key driver of their development and survival. Like other temperate earthworms, *Amynthas* species are most active at 10–20 °C. In *A. agrestis*, hatching success peaks around 10 °C, while viability declines above 40 °C (Blackmon et al., 2019; Johnston and Herrick, 2019)” (Nouri-Aiin et al., 2025). As we have seen, jumping worms are a mixed bag, and while

not all jumping worms types have the same rate of reproduction, the 60 cocoon claim is therefore appropriate.

As a result of their fecundity, jumping worms successfully overwhelm ecosystems causing collapse of the soil layer through density numbers that are at first difficult at first to grasp. In fact, the density of the familiar soil aerator earthworm *terrestris Lumbricus* (which, as an invasive species, is not benign) can also rise to a number per square metre of soil that at first appears to be very high. A 1993 document retrieved from Perdue Extension discusses the general benefits of earthworms to agriculture, listing densities at 20 *Lumbricus* earthworms per M2 in no-till corn and 340 per M2 in a dairy pasture, with much higher numbers achievable through techniques (Kladivko, 1993). We must also remind ourselves that North American soil has been hammered with *Lumbricus* spp. In European agricultural studies based in areas where they are a native species, this "good" earthworm was measured to populate to a documented *"*70 individuals per square meter," which the study claimed "is about 2 times higher than the natural average earthworm population density in soils of the region," (Maslov, 2022).

Jumping worms however dwell only in the top few inches of soil substrate, and not throughout a square metre cube of soil, and so are something researchers can literally count by hand, without need for excavation. A peer-reviewed study published in 2021 describing jumping worms population densities, recorded over 200 individuals per square meter [m2] as somewhat typical, attributable to "their large body size and resource consumption rate," as a factor compounding the effects of jumping worms on ecosystems, (Ziter et al., 2021). The Soil Nutrient Analysis Laboratory at the University of Connecticut has supported some very good policy action in the United States,

involving leading experts such as Dr. Gale E. Ridge at the Connecticut Agricultural Experiment Station (CAES) in New Haven. Dr. Gale Ridge confirms population densities with published claims of many as 330 worms/m² (Ridge, 2022). According to these formal accounts as well as informal accounts and videos on platforms such as Facebook, we therefore must assume that the top layer of Canadian soil can be impacted in a similar way and with similar densities, which indicates a complete catastrophe, but also something largely avoidable with fast implementation of correct biosecurity measures and the arguably "emergency" reassessment/addition of the pheretimoid earthworm group as a prohibited species in Ontario and more broadly in Canada.

In assessing numbers, if a viable cocoon produces one hatchling which then becomes mature and deposits 60 cocoons, this becomes 3600 by year two once the hatchlings have themselves produced 60 hatching cocoons. However, we are actually looking at more than 60 original hatchlings, as cocoons contain 1-2 eggs, not only one. This presses us to advance our estimates. Further, as the Soil Nutrient Analysis Laboratory at University of Connecticut helpfully explains, "typically, there are 2 generations each year," while "it takes approximately 60 to 90 days from egg to mature adult," (Pettinelli, 2023). The math in the case of two generations, assuming climate warming might make such a pattern much more viable in Canada, causes any risk assessment to be pushed back from our year two estimates to year one of >3600 mature jumping worms hatching from the 60 cocoons deposited by each of 60 mature first generation worms with all generations perishing by November, (Udicho et al., 2004). While there is variance between jumping worms types, *Agrestis tokeinsis*, for

example, (the earthworm described by Nouri-Aiin et al., as “low fecundity”) all jumping worms have a chill-susceptibility factor that required a small window of time for laying of cocoons.

From Chang et al., 2021, considered one of the most foundational papers on the “second wave” of earthworm invasion, *“*estimates of cocoon production in *A. tokioensis* and *A. agrestis* vary from 0.15 and 0.08 cocoons d-1 adult-1 , respectively, in laboratory cultures (Johnston and Herrick 2019) to 0.7 and 0.5 cocoons d-1 adult-1 , respectively, from field investigation (Nouri-Aiin and Görres 2019)*” (*Chang et al., 2021). This point-scale in reproduction is because cocoons are developed one at a time by earthworms, and so represents their continuous laying over their adult lifespan. Cumulatively, this can result in the extremely high per meter square density of ground-level populations described such as “at the Vermont site. By October the reproductively mature jumping worms are estimated to have produced about 1500 cocoons m-2 (Nouri-Aiin and Görres 2019)” (Chang et al., 2021).

While the idea of encountering a population of this density is perturbing, we must remember that jumping worms operate silently a few inches below our feet, and so researchers still must remove leaf litter and roll back logs to reveal them, rather than the horror movie scenario that we might extrapolate from photos by vermiculture farmers of red wigglers en masse devouring composting material.

An important study by Blackmon et al., also indicates that not all cocoons deposited are necessarily viable. Blackmon’s group found that in the challenging setting of controlled submergence in water in a laboratory, “14.4 % of cocoons hatched, and all of these hatched during week 8-21 of the assessment period.” As it was a temperature

experiment, 64% of these hatched at 10C, indicating a strong climatic restriction on incubation and ideal hatching. Blackmon also cites a 2015 study by Ikeda et al., which performed dissections on cocoons incubated for 16 weeks on Petri dishes with filtered paper, finding cocoon viability rates of up to 60% and no higher (Blackmon, 2019).

Of further interest to Canadian risk assessment, a comprehensive document found archived on *publications.gc.ca* mentions it among “species over the years which have been intercepted by regulatory agencies,” and sent to renowned oligochaetologist Dr. John Warren Reynolds (Research Director at the Oligochaetology Laboratory in Kitchener, Ontario) “for identification, but not released into the country, e.g. *Amynthas corticis” (*Reynolds, 2022). *Amynthas corticis*, aka, Green Jumping Worm (*Amynthas agrestis* is sometimes termed Rustic Jumping Worm) has a most recent iNaturalist Oct 2025 sighting in New York, (latitude 40.730610 degrees N) and is equipped with the same reproductive and overwintering strategies as the other earthworms in its genus (Latlong.net, 2026). However, “*A. corticis*, produced more cocoons under tropical conditions in a laboratory study, reaching 55–282 cocoons per individual per year, *(*García-Fragoso*,* 2002, Chang et al., 2021).

We may also add to risk assessment the pheretimoid research work of Pham et al., 2023, which quantified many species of pheretimoids similar to jumping worms that are not epigeic but capable of forming burrows and causing incalculable damage if ever allowed to invade soil that is not native to their region, (Pham et al., 2023).
Should climate variation in Canada created by warming fluctuations cause a second generation of cocoons from a single late April hatchling which has matured at 60 days in late June, all cocoons deposited in June could in fact mature as soon as late August

resulting in new cocoons every few days along a timeline concluding with autumn freezing. Of note, second generation mid-summer hatchlings are likely to be much lower in count as they are not stirring from incubation in ideal 10C weather (Nouri-Aiin and Görres, 2025). Were these to somehow mature into adult jumping worms depositing cocoons in October, then our numbers are for year one not two and could be much higher than >3600. However, it is well-documented that “it takes approximately 60 to 90 days from egg to mature adult,” (Qiu and Turner, 2016, Pettinelli, 2023). Nouri-Aiin et al., 2025, also finds that at least in *A. agrestis*, but likely for all the *Amythas* spp.*,* hatching success peaks around 10°C, while warmer weather does not always produce as robust a hatching cycle (Nouri-Aiin et al., 2025). As well, in Canada, days of 10C + weather are often interrupted by a sudden freeze, and such events, while harming the emergence of beneficial insects, are compatible with the assumption of a juvenile jumping worm die-off (Adams et al., 2024). Regardless of this, in Canadian climates, the thermal window required to support a two-generation lifecycle is presently quite constrained by latitude. If both generations require a full 90-day maturation span, any second cohort would not reach reproductive adulthood until late autumn. At this point, the ideal temperatures of 10C as described by Nouri-Aiin et al., and Blackmon et al. are not as likely, while sudden sub-freezing temperatures in October and November should still represent a strict limit on the season before a second cocoon cycle can be completed. Any quickened maturation phase under strong selective pressure, while not unheard-of in adaptation science, is not at this time reported. However, we must consider that if the cycle from cocoon to maturity is 60 days or less, a risk of increase to already exponentially massive numbers may be equated, presenting a most likely

scenario of a spring “surge" of accumulated overwintering cocoons and less so later in the season.

While the very long summers typical of the American climate seem distant, in Canada we are for risk assessment purposes not so far away. Connecticut, which spans between 40°58′ N and 42°03′ N latitude, directly intersects with the 42° N parallel at the northern portion, while Windsor, Ontario sits at exactly 42° 18′ 8″ N. This is a 28 kilometers gap between the northern tip of Connecticut and the city of Windsor, where jumping worms were first observed at the Ojibway Prairie Complex in 2014 (Government of Canada. 2021, Encyclopædia Britannica, 2026). Further north, The Guelph Turf Grass Institute at the University of Guelph states, “after hatching in late June, each worm begins reproducing; their life cycle lasts 60 days, so we can have two generations easily each year,” (GTI, 2022).

At 43° 32′ 9″ N, The GTI Institute, while still far from the present upper latitude range for jumping worms of 45° N, may also not be accounting for the phenomenon of cocoon banking. This factor could at any time give the impression of a second generation that is actually a “cocoon bank hatching” in opportune weather, (Qiu & Turner, 2017, Blackmon, 2019). While jumping worms perish at first frost, a reassuring vulnerability in their control, and are highly chill-susceptible throughout their lifetime, they deposit cocoons that are extraordinarily resilient (Udicho et al., 2004; Adams et al., 2024). The resiliency of jumping worm cocoons is a critical topic for control, as is the system of cocoon-banking which makes them next-to-impossible to eradicate from the ecosystem they invade (Nouri-Aiin et al., 2025). It is also the resilience of their leathery cocoons which causes what is termed “a wicked problem,” of invasive species

management, “where any management impact on the invasive species can lead to one or more additional problems,” Seastedt and Wong, (2025). Cocoon-banking is of course similar to seed-banking by plants, a well-studied survival strategy that allows plant seeds to wait for an extended number of years until ideal or improved conditions are available for their emergence (Yang et al., 2021). Because jumping worms also have an asynchronous hatching strategy, biologists find viable cocoons are overwintering in the soil matrix not only until spring but for a number of years (Nouri-Aiin,et al., 2025).

In the study “Earthworm cocoons: The cryptic side of invasive earthworm populations,” researchers Nouri-Aiin and Görres revealed that cocoons absolutely pause, particularly during drought, and can hatch not next year but several years later. The implications for control and for number estimates are significant. A “high abundance of cocoons with ready-to-hatch embryos found all year round,” was also revealed by the same study, suggesting the “interplay of moisture and temperature may explain the presence of all stages of embryo development,” and finding embryos that “may hatch even in the winter during warming episodes,” to of course perish during the next cold snap, making climate fluctuations a positive factor in their mitigation (Nouri-Aiin and Görres, 2025). In a Youtube public-facing research report, *Asian Jumping Worms: A Research Update* by Dr. Tim McCay of Colgate University, McCay discloses at 33:00 mins., “very reminiscent of a seed bank, there are cocoons that will…hatch the second year, and even the third year, and we know this goes out to at least four years,” (McCay, 2022). While McCay is a respected authority on pheretimoid ecology, his claim regarding the duration of embryonic diapause currently lacks supporting empirical evidence. While a study of *Lumbricus terrestris* cocoons (Lowe, C.,

& Butt, K. 2014) kept at ideal conditions demonstrated “total viability” after 2 years “from 88% (E) to 94%” all embryos do rely on finite reserves within a cocoon. Cocoons can withstand remarkable stressors, as seen in a 1960 study of a rare North American (native) earthworm, *Bimastos zeteki*, which survived “a weight loss of 54 percent,” due to desiccation; where “in many instances, shrunken and folded capsules were found to continue development when water was added,” (Murchie, W. 1960). Although topsoil level jumping worm cocoons with less access to below ground moisture are well-known to diapause in drought while Lumbricus cocoons are more permeable (Lowe, C., & Butt, K. 2014), and despite a very resilient material encasing embryonic jumping worm, the survival-past-year-three claim requires peer-reviewed evidence at this stage.

In conclusion, the 60 cocoons per jumping worm statement of fecundity is legitimated by peer-reviewed scientific studies. The calculation of >3600 hatchlings within a short period is only tempered by questions regarding the viability of cocoons, which also is balanced by the fact that many cocoons produce more than one hatchling. As a result, the risks posed to Canada by the spring hatching of these frost-hardy cocoons meets more than enough evidence to warrant the immediate prohibition of all pheretimoid species in Canada, including regulations for their accidental transfer within and between provinces. Exceptions may be made under strict conditions for research purposes and the application of enforcement immediate. As an environmental researcher, my systematic scrutiny of these biological traits—ranging from the anatomical studies of Pham et al. to the population density reports of Ridge and Ziter—has allowed me to move towards identifying critical regulatory gaps that require public awareness and action.

In my policy outreach section the CFIA explains clearly why they believe their current restrictions are sufficient, but I am hoping they will reassess this species as an urgent situation that calls for prohibited status.

This risk assessment through an evaluation of scientific literature is supported by an appraisal of key traits—including fecundity, parthenogenesis, muscularity, setae count, anti-predator defense mechanisms, appetite for organic matter and the resilience provided by 'cocoon banking'—which collectively have enabled rapid colonization in certain agricultural settings as well as in temperate forest environments. The timeline section below will further demonstrate why I believe jumping worms may threaten the northern boreal with possible serious harm. However, my synthesis of scientific literature in this section, particularly the evident ‘lag phenomenon’ and the resilience of overwintering cocoon banks, has convinced me that to err-on-the-side-of-caution and raise the alarm regarding prevention of a population boom was the correct course. If jumping worms were first seen in Canada a year after their first sighting in the upper Midwest, then Canadian biosecurity protocols, while impressive, have specific gaps that allow things to slip through. Biosecurity, both in the mid-twentieth-century and today, remains largely driven by economics, and the overlooked economic threat of jumping worms seems significant. Larger cultural assumptions about invasion phenomenon as “simply nature taking her course” or earth as an endless sponge that digests anything, are two lasting cultural disconnects that still reflect themselves in systems.

The Timeline of inaction

Soil ecologists have been studying the impact of invasive earthworm species of various types for many decades. As a result, policy inaction and the thin hope that

jumping worms would not expand north into Canada can be studied along a direct timeline.

In 1995, a foundational book, *Earthworm Ecology and Biogeography in North America,* brought together extensive earthworm data from researchers into one volume. In it, the author notes that Megascolecidae (the family of which jumping worms are part) do not seem to extend into Canada but that instead their distribution “stops very near the terminal moraines of the ice sheets,” (Hendrix et al., 1995). The author hypothesizes that it may be a “preference for fine-textured soils which are largely absent in glaciated areas,” (Hendrix et al., 1995). This sort of formal speculation certainly may have raised hopes regarding the possibility of a natural ecological barrier for those who were hoping they were a strictly American phenomenon. While the Canadian border is not a strict delineation between glacial till and the finer American soil of sandy loess leading to silt loam loess further south, it is an approximate border to the withdrawal of the Laurentide and Cordilleran ice sheets and their deposited till (Geological Survey of Canada, 2017). Glacial till is entirely different from loess soil and the soil above the moraines is thinner while often populated with dense stands of coniferous trees, making it also more acidic (Bendle, 2020). This pH threshold theory as a possible barrier will be discussed shortly. Regarding latitude, because the *Amynthas* spp., in its native habitat is found most prevalently in Japan and Korea, their original latitude boundaries do not really exceed above the 45th parallel. This native habitat of the 35-45th parallel may explain why they easily adapted to American soils, while their first sighting in Canada, having bypassed Canada’s soil regulations at the border, was at the 42nd parallel in Windsor (Bennett et al., 2024). This first sighting, in 2014, was as well in a Carolingian forest area, an area

that does not typify most of Canada, and has a specialized soil suited to broadleaf, deciduous hardwood forest (Lee, 1998). The Carolinian zone is a unique ecoregion in Canada starting in Windsor that stretches 550 kilometers northeast (Rowe, 1972). Making up less than 0.1% of Canada's landmass, it is an ecosystem that is highly invaded by jumping worms in the Northeast US, which is why alarm at the sighting has special relevance here (Görres, 2018). In Canada, the Carolingian harbours more rare species than any other ecosystem in the country, with over 70 tree and 400 bird species, many found nowhere else nationwide (Government of Canada, 2014). Because the area supports roughly one-quarter of Canada's human population, intensive agriculture and rapid urban sprawl have deeply fractured the landscape, which shelters a full third of the nation's at-risk plants and animals (NPCA, 2010). This theory of compatible latitudes, however, also does not protect Canada's North, while Ottawa and Montreal are both only a few kilometers north of the 45th parallel, and jumping worms have been confirmed at both locations. Further, on China's mainland, the same species have been documented as far north as Jilin Province and eastern Inner Mongolia (Liu, 2026). Still unspoken in early documentation of the species, and the factor that is today causing soil scientists to raise the alarm, is that of climate change. Warming global temperatures could quickly unlock Canada's higher latitudes to their requirements (Singh, 2019, Natural Resources Canada, 2021; Bennett, 2024). That this can be clearly extrapolated from Canada's own government website makes the need for appropriate policy all the more pressing. In Canada's favour, by 1995, while Hendrix was wondering at the absence of Megascolecidae in Canada, bulk soil imports from the United States were already restricted. Of note, the Plant Protection Regulations

(SOR/95-212) enacted in April of 1995 was a foundational document built upon the Plant Protection Act of 1990, and one which laid clear support for the enforcement of laws regarding plant pests, which included earthworms. However, in 1995 and at the time of writing, (although it is my dire hope that this paper along with concurrent efforts will resolve the issue) border agents had never heard of jumping worms, had no training to identify or stop them, and no idea how to identify their cold-hardy cocoons in soil, as it was never forwarded to them as a training. Although in 1995, and at the time of writing, stopping bait worms found by an angler to be packed in soil was within their jurisdiction, knowing the actual risk factors as a biosecurity measure was not. A year after the publication of *Earthworm Ecology and Biogeography in North America,* In 1996, a paper titled, *Physiology of cold hardiness in earthworms*, foreshadowed the exact adaptations invasive earthworms were going through as the lag phase for Amynthas spp. drew to a close (Holmstrup, M., & Zachariassen, K. E. 1996).

It is helpful here to explain lag phase as a phenomenon in invasion science, and one that also may have contributed to slow policy response regarding the species (Gates, 1958; Crooks; 2005; Coutts et al., 2018). One of the greatest crimes of horticulture is the lack of concern or even awareness of lag phase, the phase in which an introduced species can appear innocuous while it is adapting to a new climate and terrain (Stohlgren & Schnase, 2005; Robeck et al., 2024). Some lag phases are quite quick and noticeable, such as for invasive phragmites or the emerald ash borer. The infrastructure of heat treatment for slowing the spread of the emerald ash borer is actually not all that different from some of the heat treatment biosecurity measures required for jumping worms.

While earlier studies such as a much-cited 1972 work by researcher Gunnar Abrahamsen showed a correlation between acidic soils and reduced numbers of earthworms in Norwegian forests, the “pH threshold” concept should also never have been seen as a reliable or universal metre for all earthworm species. By 1997, a lodgepole pine forest study of another invasive epigeic species (meaning those earthworm species dwelling in leaf litter and the first few inches of soil, as do jumping worms) demonstrated the epigeic octagonal-tail worm had wrought considerable damage to the boreal over a span of several years (McLean, 1997). While the realization that *Amythas* spp. could do the same damage in a single season had not yet come to pass, the work – published in the Canadian journal of forest research – demonstrated that acidic soil and pine litter could not be considered a barrier for the octagonal-tail and so it is easy to infer from quite early along that another epigeic species would also not be deterred. This was soon followed by one of the earliest direct warnings of the advance of the species northward. Terms such as invasion were now acceptably used, while the use of the term “second wave” had not quite yet arrived, science was quickly aligning with this determination. In a 1998 study of the influence of exotic earthworm invasion on soil organic matter, environmental researcher Amy Burtelow remarked, “the genus *Amynthas*, common in many forests of the southeastern US, are invading new habitats north of their reported range in the northeastern US (Burtelow, 1998). It is of note that Patrick Bohlen was a collaborator in Burtelow’s 1998 paper. Bohlen, currently Director of University of Wisconsin-Madison Arboretum, has been a driver behind some of the highest calibre research and outreach regarding

Amynthas spp. and has been a consistent force in ensuring the issue became well-known.

In 1999, the Canadian senate had a Subcommittee on the Boreal Forest, titled, *Competing Realities: The Boreal Forest at Risk.* The document functions as an assessment of Canada's northern ecosystems, and alerts Canadians that the vast majority of boreal species—are soil species operating below ground—unknown and largely misunderstood. The 1999 report cautioned that maintaining Canada's ecological complexity was essential for managing a changing climate, and described Scandinavia's struggles following intensive industrial forestry as a cautionary tale. The paper is still highly readable and relevant today. In 2001, a highly-cited paper titled, "The evolutionary impact of invasive species" addressed not only the unprecedented "*rate of change* in the composition of the atmosphere today, and the consequent rate of climate change," but also "the extent of migration of species among continents," (Mooney & Cleland, 2001). The paper describes ways in which invasive species alter the evolutionary pathway of native species by "competitive exclusion, niche displacement, hybridization, introgression, predation, and ultimately extinction." The paper was a wise precursor to a collaboration between Bohlen and Hendrix in 2002, as the idea of a trophic cascade of displaced organisms that Mooney spoke of was something even more dire in soil, where everything from biota to ground-nesting birds were at risk. The 2002 paper also allowed Hendrix to clarify that he was very much onboard as an early scientist raising the alarm to slow the spread of Megascolecidae north. In advance of others, Bohlen and Hendrix's work offered clear policy support in the form of a document titled, "Exotic Earthworm Invasions in North America: Ecological and Policy

Implications," that gave policy makers tangible guidance on addressing the threat. In it, the authors argued that earthworms originating from northern latitudes (such as the "common earthworm and bait worm, European lumbricids, and Asian megascolecids such as *Amynthas* spp.) should be considered high-risk species that pose an immediate threat of invading unglaciated northern forest soils" (Hendrix and Bohlen, 2002). The work is intended for an American audience of policy-makers, and appears to have been somewhat unheeded. The authors clarified that "no native earthworms have been reported from Canada east of the Pacific Northwest or from Alaska or Hawaii, although exotic species now occur in all of these regions," and outlined a number of policy suggestions. They caution against "no action…the innocent-until-proven-guilty approach" and cite Canada's regulations: "In Canada, earthworms can be imported only from the Netherlands (only *L. terrestris*) and the United States (only species that are known to already occur in Canada) (see www.cfia-acia.agr.ca/english/plaveg/protect/dir/d-00-04e.shtml)." Bohlen and Hendrix have criticisms however, remarking, "this policy would most likely reduce ecological risks of invasion by species known to be successful invaders, but without research on other species, it could not guarantee that those approved for importation do not themselves become invaders. Also, this policy may not reduce the risks of pathogen introduction, which could occur through approved earthworms." Focusing further, the authors explore the approach of severe restrictions on imported earthworms. "A policy allowing importation only of approved earthworms and appropriately treated earthworm materials would require an approval system, as well as measures such as quarantine of all materials before entry, importation in pathogen-free packaging (as is required in Canada), and perhaps pest monitoring and

control during production in the exporting country.” They also examine the policy merits of a complete ban on imported earthworms, as that would greatly reduce the risks of introduction of earthworm-borne diseases and of new invasions by exotic species. A complete ban on imported earthworms would naturally force users to rely on established populations “while potentially stimulating native culturing enterprises,” (Henrix and Bohlen, 2002). With certain exceptions, “because so many exotic species are already established, this action may not be an excessive burden on those desiring earthworms for vermicomposting, fish bait, and so on; it might even stimulate development of native earthworm-based culturing and distribution enterprises and greater exploration of possible uses of native earthworm species,” (Henrix and Bohlen, 2002). That these two foundational figures in soil biology were able to provide comprehensive biosecurity policy support over a decade before the appearance of jumping worms in the Northeast and Canada is a testimony to projections regarding invasive earthworms. The paper was supported by grants from the USDA, Animal and Plant Health Inspection Service and it served to establish formal criteria for assessing the ecological risks of earthworms to non-governmental agencies, yet the USDA itself was slow (by over a decade) in officializing any much-needed changes. While the global outbreak of Foot-and-Mouth Disease in 2001–2002 created major public concern over soil-borne vectors (BBC, 2002), Canada had already established strict boundaries for earthworms under Directive D-00-04 to target high-risk soil contaminants. This laid the groundwork for later modernization, and updated regulations now mandate that before shipping, a mandatory 15-day "cleansing period" in a soil-free and pathogen-free substrate—such as shredded paper or pasteurized material—must be done to ensure worms have no

soil in their digestive tracts from potentially contaminated sources. Shipments must then be repacked in fresh, clean artificial bedding, allowing inspection agents to stop any shipment that had any natural materials mixed in, (CFIA, 2015). Layered onto the D-00-04 cited by Henrix and Bohlen was D-08-04, which established that regulated plant exports to Canada from all origins must be accompanied by a Phytosanitary Certificate issued by the exporting country's plant protection organization, unless a specific exemption applies. Under D-08-04, exemptions allowing the entry of plants with soil or growing media became more tightly controlled, and while imports are permitted from the continental United States under strict certification systems, they are fundamentally prohibited from off-continent origins. A notable exception exists for the Netherlands, where facilities approved under the Canadian Growing Media Program, (D-96-20) may export plants established in certified, soil-free growing media (CFIA, 2023). For most standard international pathways, plants are required to be entirely free of soil and growing media, reflecting Canada's risk-based phytosanitary approach which includes geographic origin to determine the strictness of physical and regulatory barriers (CFIA, 2025). The Canadian directive cited in the report, that of "Directive D-00-04: Plant protection import requirements for earthworms," stayed on the books until 2015. At that time, earthworms lost their official, "stand alone" designation and became consolidated alongside terrestrial snails, slugs, and microorganisms under a more modernized biosecurity framework. This transition introduced two companion policies: D-12-02, which governs international imports, and D-12-03: *Domestic Requirements for Potentially Injurious Organisms (Other than Plants) to Prevent the Spread of Plant Pests Within Canada* (CFIA, 2026).The addition of D-12-03 strengthened Canada's domestic

biosecurity by formalizing the movement, containment, and regulatory oversight of organisms within Canada, complementing existing enforcement tools that were previously distributed across broader compliance mechanisms (Jasper, 2015). Existing tools included the Plant Protection Act, which has been in effect since 1990, the Plant Protection Regulations, which were implemented in May 1995, and Directive D-95-26 which was introduced in October 1995 (CFIA, 2026). We will discuss the importance of Directive D-95-26 shortly.

Further in assessing scientific literature pointing to the risk factors involved in lack of strict regulations specifying jumping worms from the first part of the last decade are a series of three publications in 2004 that were driven by Bohlen and Hendrix's earlier work. While the US did not immediately respond to *Exotic Earthworm Invasions in North America: Ecological and Policy Implications,* it seems clear that the CFIA at least processed and tightened certain regulations with awareness following its publication. However, other events were occurring in the US in direct response to the jumping worm threat at a very early and important moment. In January of 2004, Bohler published *Influence of Earthworm Invasion on Redistribution and Retention of Soil Carbon and Nitrogen in Northern Temperate Forests* in the well-known scientific journal Ecosystems**,** resulting in wide distribution. The paper demonstrated that jumping worms can alter soil carbon storage, shift nitrogen cycling and availability, and cause radical loss of leaf litter horizons. For policymakers, this document would cleary support the recognition of earthworms as ecological engineers with high invasive risk concerns. It also would support the need for stronger restrictions on earthworm importation and

movement. However, except for some precautionary but inadequate tightening of rules in Canada that we already know about, there was still little formal response.

Another widely published paper released a month later in February 2004 by the journal Ecosystems and titled, *Ecosystem Consequences of Exotic Earthworm Invasion of North Temperate Forests*, presented a broader explanation of ecosystem transformation, emphasizing biodiversity and regeneration impacts and built considerably more scientific consensus regarding the issue. *Ecosystem Consequences of Exotic Earthworm Invasion of North Temperate Forest* did not translate into enforcement mechanisms but was easier for non-specialists to understand and sparked communication about the topic. A third paper was published by Bohlen in October of 2004 titled *Non-Native Invasive Earthworms as Agents of Change in Northern Temperate Forests*. This production was a collaboration with six other scientists including Dr. Cindy Hale. The paper documented the rapid elimination of the organic horizon by jumping worms, doing in a season what the common earthworm did over years. It providing the early proof that losing the O-horizon triggers a cascade of topsoil erosion, leaving northern forests highly vulnerable to invasive plants such as garlic mustard and buckthorn, and not allowing the regeneration of native species and forest soil that a trophic cascade of wildlife depended upon. The message that clearly a biosecurity directive limiting soil movement is the only way to stop this "agent of change" from entering pristine forests was loud and clear as a policy implication in the work. Meanwhile, Dr. Cindy Hale at the University of Minnesota Duluth had rolled out the Great Lakes Worm Watch program in 2004, an initiative by and one that was highly influential in shifting biosecurity policy from reactive management to active vector

control. The initiative's primary training workshops, public curriculum distribution, and citizen-science field operations beginning in the spring of 2004 (April and May) represented a continuum from her work *Minnesota Worm Watch* (founded in 2000) to a larger regional project. The impact of Hale's efforts was massive, in that it had created an open data collection using citizen and student volunteers to create early identification maps of spread for both US and Canadian resource managers to follow the expansion of the species and become fluent in the issue. By converting ecological data into actionable public science, the GLWW filled a massive information gap and directly shaped several regional biosecurity policies. Dr. Hale's research and the mapped data generated by GLWW volunteers provided concrete evidence that the "leading edge" of earthworm invasions radiated directly from boat launches, resorts, and campsites.

By 2006, the foundational document *Earthworm invasion into previously earthworm-free temperate and boreal forests* by a leading ecologists and soil scientists including Frelich and Hale created easy material for projections, noting that in "mature sugar maple dominated forests of northern Minnesota, earthworm invasion caused significant declines in the diversity and cover of herbaceous plants and abundance of tree seedlings," and measured thickness of forest floors while observing the reduction in native understory plants. It also predicted the increasing invasion of Buckthorn assisted by earthworm remodeling the soil in forests to a more depleted state, and examined the mixing of organic matter into mineral soil horizons, something jumping worms, which are epigeic, do not do. By 2009, Canadian coniferous forests, considered resistant to earthworms, were examined in contrast to deciduous forests in the paper, *Distribution and impacts of invasive earthworms in Canadian forest ecosystems* examined how

earthworm activity changes nitrogen dynamics, root structures, microbial communities, and understory vegetation, providing a clear framework for understanding earthworm invasions in northern latitudes. The same year, *Water Relations in Cutover Peatlands* investigated commercial peat harvesting in northern wetlands, and the exposing of decomposed subsurface peat to oxygen. The study details how artificial drainage and extraction drastically alter water table dynamics and create severe physical collapse of the ground surface while reducing flow and stability of water between the layers (Price, 2009). The capacity for remediation from this state is limited. In 2013, of extreme importance to the silvaculture industry, a paper titled *Effects of liming on survival and reproduction of two potentially invasive earthworm species in a northern forest Podzol* clarified that the use of liming was paving the way north for earthworms that otherwise would not have survived in the low pH conditions. Our last timeline year is 2014, or year zero when jumping worms were first sighted in Canada at the Ojibway Prairie Provincial Nature Reserve within Windsor, Ontario. While there were other papers and many more that continued past this cut off date of “early warning” publications, two papers of particular significance were published in 2014 one regarding ecotoxicity and one discussing climate change. Like many relevant works, *Glyphosate herbicide affects belowground interactions between earthworms and symbiotic mycorrhizal fungi in a model ecosystem* did not discuss jumping worms specifically but more broadly looked at earthworm interactions. The study showed that glyphosate-based herbicides destroy mycorrhizal fungi networks, stopping the biological interaction between roots and fungi. With the arrival of a voracious epigeic worm population, such ecosystems with fungal networks already failing cannot defend itself from such a pest and will collapse rather

than support those plants cultivated for agriculture or growing forests in a system because of unseen belowground herbicide damage. As well in 2014, “future warming is hypothesized to accelerate earthworm invasions into yet non-invaded regions,” in the study report *‘Warming shifts ‘worming’ : effects of experimental warming on invasive earthworms in northern North America.*The study concluded that climate barriers are dissolving as warming, at least in their experimental setting, significantly increased earthworm survival, and that unless warming causes severe soil drying, earthworms benefit from the increased temperatures on all the metrics of survival (Eisenhauer et al., 2014). Together these selected works create what should have been an early warning system before a recognized crisis in Canadian nurseries and forests, as they map out why and how Canadian ecosystems were seriously vulnerable—a risk alert before the zero hour that can strongly guide steps required now to contain rather than resign Canada to invasion by a belowground force.

POLICY INTERVENTION

Science has known for some time that non-native earthworms rival wildfires in terms of releasing carbon. The 2015 study by Cameron et al. *Modelling Interacting Effects of Invasive Earthworms and Wildfire on Forest Floor Carbon Storage in the Boreal Forest* demonstrated that (non-pheretimoid) earthworm activity reduces forest floor carbon stocks by 49.7% to 94.3% over 125 years (with the steepest drops occurring 35–40 years post-invasion) by speeding up the rate at which organic matter is consumed and released back to the atmosphere as CO2. Although earthworms strip away some of the fuel for combustion, the carbon is still lost to respiration, and as we see, wildfires are not actually decreasing in Canada, but on the rise. As earthworms can seriously dry soil, their presence makes wildfires more likely, not less (Frelich, et al.,

2019). A 2026 paper by three prominent soil ecologists (Zhang, Eisenhauer, & Chen), titled, *Earthworm Colonization Weakens Vertical Carbon Stratification in Alpine Peat Soils under Climate-Relevant Degradation Scenarios* clearly demonstrates that in areas where climate-driven drying have altered moisture in the soil, vulnerability to earthworm invasion is increased (Zhang et al., 2026). This includes traditionally waterlogged peat soils even before the harm of industrial draining, which are already at risk of drying and vulnerable to earthworms accessing carbon reserves that were previously locked away safely in stratified layers, accelerating carbon release as agents of global change (Zhang et al., 2026).

The first policy for limiting this harm is under the jurisdiction of the Canadian Food Inspection Agency, to which I sent a policy request. The CFIA is mandated to protect agricultural and forestry productivity and as a federal agency is aligned with the "ecologically modernist orientation," of Canada's current federal government (Winfield, 2022). As the provincial government in Ontario currently embraces the development of the Ring of Fire area in order to access "critical minerals," despite its location directly within the delicate muskeg ecosystem that stores billions of tonnes of carbon in the peat, the risk of development bringing invasive jumping worms into the mix must be addressed (Wilt, 2020; Wildlife Conservation Society, 2022; Scott, 2023; Natural Resources Canada, 2025). As the current Ontario government is driven by an underinformed market populism and the Premier is aggressively pushing an extractivist agenda, the provincial pathways for environmental policy proposals are challenging. However, in pursuing decisive administrative intervention regarding this portion of ecological protection, border biosecurity and import controls are exclusively federal

domains (Centre for Constitutional Studies, 2024). Against this difficult backdrop I chose two long-standing CFIA officials that I respected for their important work, Dr. Anthony Anyia, the Senior Director of the Plant Protection Division in the Policy and Programs Branch at the Canadian Food Inspection Agency (CFIA), and Wendy Absil, National Manager, Invasive Alien Species and Domestic Plant Health Programs @ CFIA. This approach was to essentially alert leadership and technical management with the best information about a concern they had no doubt heard of, but not prioritized in their busy day and to present them with a regulatory loophole (enforcement gap) that I felt was allowing jumping worms to potentially access Canada from the United States. As you can see, I specified Directive D-12-02 and formally requested to advance jumping worms to a prohibited status because I was not convinced they weren't accessing Canada through variations in nursery shipments.

The letter:

Urgent Regulatory Action Request: Jumping worms (*Amynthas spp.*)

I am writing to urgently request that the Canadian Food Inspection Agency (CFIA) amend its current directives to explicitly include jumping worms (*Amynthas* spp.) as a regulated pest and impose corresponding import restrictions on all plant, soil, and organic media shipments entering Canada from the Continental United States.

To bring to your closer attention the potential ecological and regulatory implications of these organisms, new research confirms they are capable of persisting in northern forest soils that Canada had previously hoped would limit their spread. Because Canada's boreal forests—particularly the peat-rich systems—store exceptionally large amounts of carbon below ground, the potential impact of this detritivorous species is a matter of special national concern and necessitates strict regulatory control.

Jumping worms as a high-risk invasive species show demonstrated capacity to:

- Rapidly degrade soil structure and nutrient cycling, reduce organic matter and nutrients, and fundamentally alter ecosystems
- Strip the forest floor substrate layer, causing erosion and loss of native plants
- Represent a high level threat to Canadian agriculture and forestry industries as well as to gardens and natural habitats through the destruction of soil organic matter, alteration of soil chemistry and microbial communities
- Reproduce parthenogenetically, (60+ cocoons a season) enabling rapid population establishment from a single individual or cocoon

Under Directive D-12-02 (Earthworm Imports) and the Greenhouse-Grown Plant Certification (GCP) Program (Directive D-16-02), CFIA's regulatory enforcement depends on whether the source U.S. state officially regulates a pest. Currently, a state such as Alabama, where the pest is widespread, do not regulate jumping worms, allowing shipments to Canada to potentially bypass stringent inspection, despite the organism being a prohibited species with serious fines for nursery owners in New York. This state-by-state enforcement is currently a patchwork undermining the pathway-focused protections of Directive D-95-26 (Soil and Soil-Related Matter), which prohibits importation of potentially contaminated soil.

Additionally, jumping worm cocoons are cryptic and survive in "soil-free" media, including peat, coir, and bedding, which can inadvertently bypass GCP inspections. At 1-3 mm the cocoons are not much bigger than golden nematode, yet inspectors are not trained to identify them, although many are now beginning to be aware of them and the scope of the problem. The current framework must provide a species-specific mechanism to prevent introduction. As a result, the situation does invite emergency action on your part, as it has the potential of unfolding into a much bigger issue for Canada if we do not act.

Requested Amendments

1. **Inclusion as a Regulated Pest**

- Explicit and immediate listing of jumping worms (*Amynthas* spp.) in Directive D-12-02 or a relevant CFIA directive.

- Include all life stages, including juveniles and cocoons, to prevent cryptic introductions that would bypass visible inspections.

2. **Mandatory Import Restrictions**

- Require bare-root shipping or certified heat-treated media for plant imports. Restrict imports to adult worms if applicable, enabling morphological verification. Juveniles may look quite similar to other species.
- Require a Facility Biosecurity Certificate for all U.S. exporters to verify off-ground, closed-loop growing systems.

3. **Contiguous U.S. "Infested Zone" Designation**

Treat the entire Continental U.S. as a single high-risk source region, irrespective of state-level regulation, to prevent interstate mixing of regulated and non-regulated stocks.

- Jumping worms have been identified by scientific studies as high-impact ecosystem invaders in North America.
- Current CFIA directives rely on state-level regulation, leaving significant gaps in protection.
- Implementing species-specific restrictions aligns with existing pathway protections and the CFIA's mandate to prevent the introduction and spread of invasive pests.

We urge the CFIA to take immediate administrative action to close this loophole, protect Canadian forests, gardens, and urban green spaces, and ensure internal consistency across directives D-12-02, D-16-02, and D-95-26.

Thank you so much for your attention to this critical biosecurity issue. I would welcome the opportunity to discuss this request and provide any supporting scientific documentation.

The CFIA officials passed the letter to a Senior Legislative Officer, who responded the very next day. His letter formally documented that *Amynthas* lack pre-approval, and so any shipment would face mandatory individual scrutiny. However, it is difficult to imagine anyone actually shipping *Amynthas* in a box to Canada, except

for the problem of novelty bait, in which case they would enter under a different legal designation. I was citing soil, as the CFIA's "**Import requirements for soil on imported plants"** strictly states that "you can import plants with soil from most parts of the continental United States, as long as they are accompanied by a Phytosanitary Certificate stating that they are free of certain quarantine soil-borne pests regulated by Canada," and I knew a phytosanitary certificate did not exist for jumping worms, certainly not in material originating from the vast majority of American states, and the absence of this check in Canada was a regulatory loophole (Canadian Food Inspection Agency, 2014). That was why I was requesting the amendments I presented in the letter. Here was the CFIA's response:

Thank you for your message regarding *Amynthas* spp., which was forwarded to me for response.

The Canadian Food Inspection Agency (CFIA) regulates a number of plant pests of quarantine significance under the *Plant Protection Act*, as identified in the *List of pests regulated by Canada*. For these pests, the CFIA maintains import and domestic regulatory programs. Regulatory decisions are informed by a number of factors, such as distribution, potential environmental and economic impacts, and the feasibility and cost-effectiveness of available measures needed to effectively manage such risks.

In response to your request, *Amynthas* spp. are not currently regulated by the CFIA as quarantine pests, nor do we have plans to regulate them as such at this time. That said, the CFIA does maintain requirements under the *Plant Protection Act* that help limit the further introduction of these worms into Canada. Our plant protection program governing the import and handling of invertebrates and micro-organisms applies to a broad range of organisms, including earthworms, that pose (or may pose) a risk to plant health in Canada. Requirements specific to earthworms were updated in 2020 following public consultations (see Notice to industry - Changes to the requirements for importing earthworms into Canada).

Although two species of *Amynthas* (*A. agrestis* and *A. hilgendorfi*) are considered established in Canada based on presence criteria, they were not included on the list of earthworms pre-approved for import, largely due to challenges associated with

taxonomy. As a result, species belonging to *Amynthas* spp. are subject to an additional level of scrutiny. Should a species of *Amynthas* be proposed for import under this program, an application would be required for CFIA review and determination of applicable conditions. This could lead to requirements restricting their import and handling to containment facilities and limiting activities to specific circumstances, such as for research or exhibition.

While we recognize that these measures do not fully prevent the potential further entry of *Amynthas* spp. into Canada, they do provide a level of prevention. This is further supported, albeit indirectly, by other plant protection programs that target pathways also associated with the introduction and spread of earthworms in Canada, such as soil.

Finally, I would note that CFIA requirements are not static and may evolve over time in response, for example, to changing priorities, circumstances, and the availability of new or updated information. We therefore appreciate you bringing this information to our attention.

Because the Senior Legislative Officer left open the door to “updated information,” I quickly responded with new information in the form of this letter and extensive support material with the following: “Thank you for your letter and for noting that CFIA requirements are not static and may evolve in response to new or updated information. Here are the necessary support materials and updated information to help those at the CFIA better grasp why New York, Wisconsin, and Minnesota designated jumping worms as a prohibited species in response to scientific evidence reflecting not only the need to safeguard ecosystems from harm, but in response to forecasts of substantial fiscal liability to forestry and agricultural sectors.” I then outlined (see Appendix A, Letter 1) updated and highly detailed evidence to build an argument that was essentially unequivocal, while maintaining a tone grounded firmly in knowledge mobilization.This support material featured seventeen peer-reviewed bibliographic references with active links, alongside documentary video footage of an invaded forest in the northeastern United States.

I did not receive a response from the Senior Official, and so this segment of outreach reporting is closed for the moment, lingering like a strange legal paper trail regarding regulatory loopholes and the CFIA. However, my March 27 response did successfully introduce intensive peer-reviewed material into their file (seventeen of them!)—linking *Amynthas* spp. directly to Canadian economic threats including the $1.53 billion maple products industry, forestry regeneration collapse, and agricultural soil carbon degradation. Even if policy wheels turn slowly, this is now officially part of their active regulatory correspondence file, creating a paper trail for future policy shifts or legal interest.

There were, fortunately, other policies to focus on that I felt were allowing the spread of jumping worms north. I had first started my campaign to have jumping worms prohibited in Canada by launching a public advocacy petition via Change.org targeting invasive species protection and the management of jumping worms in Ontario's ecosystems. The petition, "*Action: Put Jumping worms on Ontario Prohibited Invasive Species List immediately*," did get 120 signatures but I knew very little about how to advance the issue at that time and it was a side-project while I was studying full time. Around this time I also called the Ministry of Natural Resources and Forestry (MNRF) and had an extensive phone consultation with a staffer in Peterborough, provided educational info-links and outlined the newly emergent ecological threat to them. This was a friendly call sparking informal grassroots awareness, although I knew nothing about the impact of earthworms on carbon sequestration at that juncture. I then ordered stickers with the image of a boot tread on them, and the message "brush those treads," and contacted Patricia Lewis, program manager at the Sustainable Neighbourhoods

Project of the Toronto and Region Conservation Authority (TRCA). Because I had designed signage for the TRCA involving the Oakvale Tiny Forest, (where I was a steward), the SNAP programmers were familiar to me. I wrote to Lewis that there was an “Urgent Need for Boot Brush Stations at Provincial Park Entrances,” in particular Algonquin Park, with an explanation of the risk and asked for advice. Lewis responded that the information I had provided was being passed on to the internal Conservation Lands Management Team responsible for operations of local conservation areas, and offered to wrangle volunteers when/if required, if Algonquin truly wanted boot brush stations deployed at the park. As a result of this support, I contacted the Park superintendent, at the time John Swick, outlined the issue and included the offer from the TRCA. Swick wrote back warmly, thanking me for my interest and concern for Algonquin Park and its forest ecosystems. The letter outlined their “efforts to prevent the spread of invasive species and manage those that have arrived.” Algonquin Park enforces strict preventative protocols for staff, contractors, commercial filming crews, and commercial leases—including mandatory equipment sanitation, local aggregate sourcing, and limits on plant movement, described as “serious limitations on the movement of plants and nursery stock for commercial leases and cottages. The measures are “more specifically aimed at non-native plants, they will also help prevent the spread of other organisms.” However, the letter may have also conformed to a symbolic policy response as there was no commitment to material changes or hint at interest in resource allocation to build boot brush stations. This seemed administrative caution to an unanticipated and unbudgeted request, while the letter also remarked that “campers and day-users,” are a “much harder group to target.”

This was where I was hoping an engagement with my proposed solution might have been accepted. The letter pointed out that tourists travel to Algonquin Park from all sorts of locations, with “varying levels of awareness on invasive species,” and that “preventative actions would be voluntary.” It also helpfully explained that Algonquin is targeting anglers who may fish with live worms to ensure they do not release unused bait but dispose of it correctly. Algonquin Park management shared that while *Amynthas* aren’t typically used for angling, if somehow they were “in the carton,” management does not want fishing bait worms disposed of in the woods, prompting Algonquin’s education campaign regarding bait disposal. Concluding, the letter shared that “Ontario Parks ecologists are aware of *Amynthas* and other invasive species and are working to review operational policies and practices to prevent their spread.”

"Reviewing policies" however required no immediate action, set no timeline, and pushed the issue into internal administration in a way that made it difficult to interpret how soon the boot brush stations would become a feature at the park.

As Swick was retiring, he offered me an alternative contact, David Legros. I followed up, including this, “The TRCA thinks they may be able to help wrangle volunteers to support the installation of 30 boot-brush stations at the 30 park entry points. Does David Legros know any local carpenters? It would not take very long to knock together 30 but it would require a concerted community effort.”

This letter relied on the cc mechanism to fill Legros in on our previous exchange. As well, I sent along a new feature, a graphic. In developing the campaign, I realized that if the public was going to adapt to the idea of a species that had generated eco-anxiety and solastalgia in American gardeners, it required a positive mascot to support better acceptance of boot brushing before entering a trail. While an author like

Seth Klein might not see it as within the lineage of war-time mobilization such as cartoons by the National Film Board to encourage war bonds, as a strategy it was in the same spirit as I hoped the Bootbrush Bobcat might help guide public compliance. Legros replied by email, with appreciation for the “suggestions and the graphics,” which were shared with park ecologists. However, the friendly note also did not mention boot brush stations. I then sent a second follow-up letter (See Appendix A, Letter 2) that discussed pricing of boot brush stations and he did engage with more follow up (a video) but felt I was not going to further boot brush stations without more support. As a result I decided that creative grass-roots appeals with Algonquin Park must be backed by stronger policy pressure and higher-level political channels, as despite an administration change (Swick to Legros) which opened a window to potential dialogue, my early grassroots efforts at that time were not concerted enough or possibly informed enough to secure formal regulatory action. However, recommendations for a Spring biosecurity infrastructure (boot-brush installations) were still communicated to the park, establishing a documented record of agency awareness with offers of preventative risk management (volunteers from the TRCA) recorded by incoming administration but not instantly accepted.

On June 1, 2025, I set up an outreach table at the Pocket Eco Fun Fair, an event which was attended by Hon. Julie Dabrusin, MPP Peter Tabuns, and Toronto City Councillor Paula Fletcher. I was able to distribute fliers to all three politicians, while Hon. Julie DaBrusin dropped by my table, observed my display of the iNaturalst map showing the species advance north, and had a brief chat with me about the issue. Dabrusin directed me to also reach out to Steven Guilbeault about it, although he had left the

environment portfolio and she was no longer his Parliamentary Secretary but was at the time newly appointed as the Minister of Environment and Climate Change.

My next significant outreach therefore was to Minister Steven Guilbeault (July 1, 2025) in the form of a letter in response to a Julie Dabrusin's suggestion (see Appendix A Letter 3).

Dear Minister Guilbeault,

I am writing to you at the direction of the Honourable Julie Dabrusin, Minister of Environment and Climate Change, who advised me to connect as well with you following a discussion we had regarding the prevention of invasive jumping worms in Canada's northern forests.

The letter urged federal action to prevent the spread of invasive *Amynthas* and *Metaphire* jumping worms into Canada's northern forests, recommending a proactive, low-cost nationwide initiative to install boot-brush stations at trailheads—beginning with Algonquin Park—to safeguard critical soil ecosystems from irreversible disruption.

Submitting such a letter during a leadership transition was interesting strategically for a grassroots campaign, as it created a permanent federal record while the idea of inexpensive trailhead infrastructure that was able to travel across multiple desks, hopefully keeping the concept alive as the Federal administration shifted. Dabrusin in a new role was a shift that had created a transient political window, and her spoken interest in the idea sufficient that she directed me to send it to Guilbeault established problem recognition (Kingdon, J. W. 1995; Howlett, M. 2015).

That Dabrusin directed me to Guilbeault also served as a bridge across the political stream, as she leveraged her position to pass my policy design directly to a senior environmental authority before the window closed (Howlett, 2015). Suggesting an information-based instrument such as low-cost boot brush stations within a toolkit of

other changes that also included regulation (Pal, 2010; Howlett et al., 2015) combined mandates with voluntary, capacity-building behavioral changes. Having proposed an effective, efficient and fair implementation strategy" and toolkit of policy proposals (Winfield, 2014) I was honoured that it was promoted in this way and hopeful that Guilbeault will be a future supporter in the fight for biosecurity infrastructure. The July 1 letter also resulted in a Field Unit Executive Correspondence on July 22 from the desk of Terrie Dionne Field Unit Superintendent Eastern and Central Ontario (see Appendix A Letter 4). As this letter clearly originated from a direct suggestion by one of the Minister's offices, it validated that my policy recommendation was structurally sound and aligned with the Parks Canada operational toolkit (Pal, 2010). While not entirely confirming that implementation strategies were being considered, the letter did leave a door open to discussion by offering examples of what they are already doing, (rather than immediately engaging with my specific proposals) but also welcoming my contact for more dialogue. The letter also linked my proposal to Canada's 2030 Nature Strategy Target 6, which legally commits the federal government to reducing and mitigating the impacts of IAS on biodiversity. By anchoring my grassroots recommendation in such a way to a binding international and national biodiversity target, it transformed a localized request (Algonquin Park trailheads) into a scalable model for a *national* biodiversity strategy.

However, Dionne also drew a boundary line, sending me to the province by stating *"Algonquin Provincial Park is managed by the Government of Ontario. For inquiries specific to this park, we encourage you to contact Ontario Parks directly."*

While I spent the next few months doing various relevant activities, I first contacted the province indirectly by contacting the Invasive Species Action Fund (ISAF) which is financially supported and shaped directly in partnership with the Ontario Ministry of Natural Resources (MNR). Through it, I submitted a detailed grant request explaining the need to build boot brush stations at Provincial Park trailheads, something provincial officials and evaluators through the ISC review process would have to read during their evaluations. With slim chances and no real small-scale organization (this is what they were looking to fund), the tactic still allowed me to influence agenda setting within the ISC and the OMNR. I created an email, Operation Boot Brush Stations <operationbootbrushstations@gmail.com> and designed an otherwise very inspiring grant proposal forwarding why the issue needed to be prioritized by the ISC.

As I had noticed the Invasive Species Centre had celebrated 10 years by running a contest to give away ten boot brush stations (from my perspective formally rationing an essential and easy-to-build piece of trail infrastructure) inserting updated information to ISC evaluators was an internal agenda-setting tactic in direct response to the way the contest may have inadvertently trivialized their merits in stopping invasive species on trails.

My next two significant outreach letters were focussed on urban resilience as a citizen of Toronto, the first involving Rouge National Urban Park, which is under the jurisdiction of Parks Canada. However, the letter, like the park, is unusual, because I was able to cc the letter to The Honourable Gary Anandasangaree, Local MP for Scarborough—Guildwood—Rouge Park who is also the Minister of Public Safety. Usually, national parks are in the rural ridings of back bench MP's and not high-profile

senior cabinet ministers. Unlike most of Canada's national parks located in wilderness areas, Rouge National Urban Park—at 19,000 acres—is the country's first and only, and sits directly inside the Greater Toronto Area (Parks Canada, 2025). As a result, Anandasangaree is an ideal political ally to loop in and champion this issue to help secure vital biosecurity measures across the park's busiest trailheads.

While I did not receive a response from his office, and did not expect one as it was a cc, the December letter to Visitor Services, Rouge National Urban Park urging them to install boot brush stations/educational signage at high-use trailheads before peak tourist season (see Appendix A Letter 5) did receive a reply. The letter also proposed a cost-effective initiative backed by volunteers working with the Toronto and Region Conservation Authority to safeguard the park ecosystems from soil-borne vectors. In support of urban resilience in Toronto, I also built them this website:

https://www.operationbootbrushstationscanada.ca/

The reply:

Thank you for contacting Parks Canada and for your interest in Rouge National Urban Park. This is a very interesting topic – I have not heard of jumping worms before! I will be forwarding your email to our Resource Conservation team and have them look into this further.
I hope you had a wonderful holiday season and all the best for this winter term ahead!
Talk soon

From an infrastructure advocacy perspective, receiving that response was a strategic win for my campaign as my letter went directly to the Resource Conservation team, the field-level staff who manage the physical assets of the park. Because it pointed to a physical, proven model, it gave the infrastructure team a ready-to-implement tool (Howlett, 2024) that requires minimal initial design work on their end. The fact that park staff admitted they hadn't heard of jumping worms indicates an infestation has not taken

hold in Rouge and that hopefully my advocacy for preventative infrastructure might have a role in protecting the Rouge. By directly introducing the emerging threat of invasive jumping worms to Rouge National Urban Park staff, this campaign successfully initiated an outside-driven public feedback loop at the first stage of the policy cycle—agenda setting (Hessing, Howlett, & Summerville, 2005).

Given that Dabrusin had opened a direct inter-ministerial pathway when we had spoken which resulted in the July 1 letter to Minister Guilbeault, I then engaged an opportunity on January 12 to join a group meeting formally with Dabrusin to discuss concerns regarding the Memorandum of Understanding between Mark Carney and Danielle Smith signed November 27, 2025. While meeting with Dabrusin, I was able to hand-deliver a point-form brief written in English and in French (Appendix A Letter 6). Julie no doubt already knew that it was about biosecurity as we had met before, but she took the letter graciously and confirmed the language courtesy was a positive feature, joking that she “always look forward to a little French reading,” upon receipt. I am confident that she may have in fact scanned it, as she took it with her to her car rather than handing it immediately to a staffer, and I hope that a staffer later processed it correctly.

As campaign research, joining the group, creating the letter and bringing it along as a hand-delivery successfully bypassed passively waiting for a public consultation. As an active policy entrepreneur (Kingdon, 1995), I placed myself into the policy stream. As I respect Hon. Julie Dabrusin, and I felt the information was a bit doomsday, and potentially triggering to our courteous elected official, as the topic is hard even for me,

(Gupta, 2021; University of Minnesota Extension, 2025) I then followed up with a less declarative second letter on January 19th, also in English and French.

Dear Minister,

I am writing to follow up on my January 12 letter regarding the emerging threat of Asian jumping worms in Canada. I would like to share practical, evidence-based biosecurity measures that can be implemented immediately to prevent soil-borne invasives from spreading during housing and infrastructure projects. These measures are extremely low-cost, complimentary to the Liberal party, integrate seamlessly into existing construction workflows, and offer significant protection for Canadian soils, parks, and forests. In alignment with Prime Minister Carney's recent statements on accelerating construction and infrastructure development, these measures are designed not to slow down fast-tracked projects, but to ensure biosecurity and compliance.

I then listed and detailed the value of the following measures: Pressure-washing, Soil Solarization, Boot Brush Stations at Trails, Strictly Prohibit Bait Use (see Appendix A Letter 7). By tying my technical protocols directly to current federal priorities around fast-tracked infrastructure, economic efficiency, and low-cost execution, I used the follow up to reframe an ecological defense measure as an actual asset for executive policy implementation. Instead of presenting biosecurity as necessary red tape, I framed practices like pressure-washing, soil solarization, and trailhead boot brushes as solutions supporting Carney's accelerated construction priorities. This removed any excuse to dismiss environmental protections. Specifying that methods are practically free and locally sourced using Canadian lumber and plastic, as well as capable of engaging volunteers, youth or "green" training initiatives removed all friction. This shifted the biosecurity proposal to a shovel-ready initiative, and repositioned it as in support of existing government goals. On January the 19 Dabrusin was also dealing with releasing the Government of Canada's annual global mean temperature forecast. It is my hope

that the tactic of sending the first and the follow-up letter in French as well as in English as well as the deployable content supported it being internally forwarded, and I felt good that I had sent a fairly tangible series of suggestions for limiting the advance of jumping worms towards Canada's north.

In creating a model for a grassroots campaign that could also more directly help cities retain resiliency in encountering a new invasive species, I then reached out to Toronto City Council with Urgent Biosecurity Amendment to TS 211, TS 5.10, and TS 2.10 regarding *Amynthas spp.* (Jumping Worm) Neutralization. This was because I found regulatory gaps in Toronto's Topsoil Regulations. I encouraged the Committee to mandate strict thermal treatment protocols and digital time-temperature logs for topsoil, mulch, and imported organic materials, and to treat biocontamination in the same way as they already treated chemical and heavy metal pollutants. The technical appendix accompanying the letter included two detailed tables outlining the exact thermal criteria and operational municipal amendments for deployment by Engineering & Construction Services (see Appendix A Letter 8). The document proposed a city-wide invasive soil hygiene and landscaping protocol designed to protect Toronto's urban green spaces and was a policy intervention. It provided explicit text adjustments to existing municipal codes (TS 2.10, TS 211, and TS 5.10), and as a policy tool, it moved the issue past citizen-led environmental warnings by directly rewriting municipal procurement standards. Similar to the Federal document, it removed any bureaucratic excuse of cost or implementation delays. It also adapted an administrative framework built strictly for chemical contamination to be purposed for a biological threat that was new to Toronto (McTavish, 2021), requiring an accountability in the chain of custody for materials such

as mulch and soil. Although it has not been debated live by the committee, it introduced the new idea of mandatory biological biosecurity compliance for municipal soil and mulch procurement into the official administrative record of the City of Toronto, which is a stage in the agenda setting process (Hessing, Howlett, and Summerville, 2005; Kingdon, 1985).

As I had at this juncture built the knowledge mobilization website stopjumpingworms.ca it was shared with Francis Gallo & Rhonda Gagnon, of Anishinabek Nation, who worked in coordinating Land Resource organizers attending the Invasive Species and Climate Resilience Gathering in Sault Ste. Marie. On the first page of the website, I placed a dedicated land acknowledgement to make the knowledge mobilization purpose clear. Here I thank York University for clearing my research with the ethics department to ensure it was done correctly. As I was also discussing ideas with the Crown that were intended to be implemented on Northern territories, or to be an expectation in negotiations, the Duty to Share aspect was critical. As I was somewhat alumni of Trent University's Environmental Studies program, I deemed it fitting to reach out to the Chanie Wenjack School and their community leadership to establish a transparent record of ecological risks and low-cost solutions, in the spirit of reciprocal knowledge sharing rather than extractive research. In the letter I explained the impact of jumping worms and the need for biosecurity requirements for industry and travel as a condition of regional access to prevent the introduction of their cocoons into these sensitive landscapes. I also outline my recent connections in the campaign and in the interest of accountability and the "right to know," I shared that I had formally reached out to the Canadian Federal Minister of the Environment, Climate Change and Nature, regarding

inexpensive best practices to mitigate the spread of an environmentally damaging invasive species, including in the north. It also described the main points, and closed by welcoming any guidance (see full letter Appendix A Letter 9). By formally documenting my outreach, the letter established that the academic community and Indigenous institutions were notified of the biosecurity threat and equipped with actionable solutions (Goodfellow Craig, A. & Johnny, M., 2026). It also firmly established my KMb framework, stating "I hope this type of knowledge mobilization is helpful as Northern leadership frame their own protocol requirements for industry and expansion."

As Parks Canada had encouraged me to do, I reached out more directly at this point to the province in an email to the Honourable Minister of Natural Resources. It also had a distribution list, as I cc'd three Federal NDP Critics and three MPP Shadow Ministers, and also cc'd MP Julie Dabrusin and MP Health MacDonald (See Appendix A Letter 10). I submitted this as an economic brief to the Minister of Natural Resources, urging the immediate designation of jumping worms as a Prohibited Species under the Invasive Species Act (2015). The brief warned that unchecked soil degradation threatens Ontario's $5.5 billion forestry sector, $2.5 billion nursery industry, and provincial climate targets, and proposed mandatory heat-treatment standards and Northern biosecurity protocols to close regulatory gaps.

As a result of this outreach, I received a message from Stephen Casselman
Director, Fish and Wildlife Policy Branch, Ontario Ministry of Natural Resources.

Dear Mr. Dyment,

Thank you for your email about jumping worms. The Ministry of Natural Resources (MNR) shares your concern about invasive species and the negative impacts they can have on our environment and economy.

Jumping worms have been present in North America since the late 1800's and have recently been reported in Ontario. Early introductions are believed to have come from the transport of horticultural materials (e.g. potting soil from Asia).

Research is underway across North America to investigate potential integrated pest management techniques such as the use of pesticides, biological controls, and other techniques (like prescribed burns) to determine if these can provide effective means of control to curb their spread.

Information about the presence of jumping worms in Ontario is still relatively new, and the impacts of the establishment of jumping worms and potential spread are not well understood. Their natural mode of spread is relatively slow, so prevention measures can be effective at protecting our forests from further invasion.

MNR's current efforts are focused on outreach and providing funding to the Invasive Species Centre to communicate information to the public about invasive species including jumping worms, and how to identify and report them. This includes sharing resources like this fact sheet and web page.

I appreciate your well articulated and thoughtful points and have shared them with our team. MNR regularly conducts risk assessments on invasive species to inform additions to the list of restricted and prohibited species in Ontario. I encourage you to also share your research with the Canadian Food Inspection Agency, which regulates the movement of soil and soil-related matter for imports and domestic transfer. Thank you for your care and concern about conserving biodiversity in Ontario.

I was pleased that I had garnered a response, and through a certain lens, "shared with team" and "regularly conducts risk assessments on invasive species to inform additions" are wins in terms of moving the species closer to prohibited status provincially. The redirection to the CFIA when I am seeking prohibition regarding inter-provincial transfers of jumping worm contaminated material drew a jurisdictional boundary, however, that was not responsive to a provincial issue. While the letter asserts that jumping worms' "natural mode of spread is relatively slow," as a confirmation that "prevention measures can be effective at protecting our forests from further invasion," essentially aligned to action in words, it does not directly state that

when the species is dispersed through human vectors of nursery stock, mulch, compost, and topsoil transported by the landscaping and construction industries, the spread is very rapid. Further, the letter mentioned exploration of pesticides and controlled burns, which was alarming to me, as such “control” techniques absolutely can trigger a population increase, as the decaying material left by (for example Glyphosate) create a buffet for later hatchlings that easily survive a spray within resilient cocoons, while the thermoinsulating properties of soil also protects cocoons from controlled burns even a few inches beneath the soil. I used my follow up letter to challenge "Integrated Pest Management” very rigorously, dismantling the premise that IPM is an appropriate tool and is possibly counter-productive with soil science and ecological theory. It was a readable and highly detailed letter with sixteen integrated citations. I described healthy substrate as the “immune system” of our forest, and exposed the limitations of insecticides, noting that even *Beauveria bassiana* impacts non-target pollinators and beneficial soil invertebrates. I remarked that these invasions are predictably at trailheads, construction sites, and soil transport routes, and I urged immediate regulatory action (Appendix A Letter 11).

I then reached out to Ontario MPP Peter Tabuns, and connected in person with his constituency assistant, Robin Kaufman, who received a letter for Tabuns regarding the issue of jumping worms in Ontario. It was essentially the same economic brief I had sent to the Minister of Natural Resources, but with a cover letter and delivered by hand.

As I was certain his email had automated the earlier bulk cc mailing prioritizing the office of Provincial Minister of Natural Resources (Harris), I presented the issue afresh. I feel so fortunate that I am a constituent of Peter Tabuns, provincial electoral district of

Toronto—Danforth, which aligns with the same boundaries as the federal, the federal electoral district of Julie Dabrusin. As City Councillor Paula Fletcher (who represents Ward 14, Toronto—Danforth) serves as the Chair of the Infrastructure and Environment Committee (IEC) at Toronto City Council, I petition her as well as a constituent. In this capacity I felt it was my duty to do what I could to prepare Canada and Toronto for a new invasive species.

The following day, a Friday, I received a response from Tabuns. I had not expected such a timely response.

Dear Mr. Dyment,

Thank you for your email. In reviewing the material, I can see your concerns are grounded in a real threat.
My colleague, Guy Bourgouin, is the Shadow Minister for this ministry and will be back in touch with you. I will be supporting him in whatever measures he takes.
Thank you for bringing this matter to our attention.
Sincerely,
Peter Tabuns

I spent much of the weekend preparing two documents for MPP Guy Bourgouin. Bourgouin was also an office I had chosen as a cc destination for the earlier letter to Mike Harris Jr., but I considered it also likely that my bulk mailing had resulted in an automated sorting. To my surprise, although I was prepared, I received correspondence from Bourgioun’s office on Monday requesting more information. I immediately sent a letter which briefly explained the unique threat of jumping worms and the economic and trade arguments. I also outlined the carbon issue that Canada is compelled to uphold. I reviewed an "err on the side of caution" approach regarding the northern peatlands and

the risks involved in introducing the species through development. I also commented, “your office needs to know I have also refuted the MNR around their intention to explore chemical controls or controlled burns,” and described the issue of thermoinsulation by soil, remarking that this might also be a moment to support lessening the use of Glyphosate, because of the buffet of decaying vegetation it creates. The letter then reviewed in a series of sections Thermal Standardization for Imported Materials, Public Trailhead Protocols, Site-Specific Zoned Footwear Protocols, Angling and Bait Vector Management, Seasonal Crew Gear Hygiene, Northern Retail Nurseries, Northern Plant Swaps, Heavy Equipment and Transit Hygiene, Closed-Loop High-Pressure Truck Wash-Downs, a discussion of Civil Infrastructure, Road Construction, & Aggregates, Commercial Landscaping, Sod, & Bulk Mulch Shipping, and several other ideas that were designed to benefit northern Ontario. I had no idea if Bourgioun was going to support these ideas, but as they proposed accessing everything from soil and aggregates to labour from northern Ontario instead of importing, they were an economic argument in support of his jurisdiction that was a reasonable model of inexpensive biosecurity and economic opportunity.

Bourgioun’s office did see the risk of jumping worms to the boreal substrate that had been published in so many papers, and his office developed a beautifully written letter to Hon. Mike Harris, see Appendix A-14.

As an attachment, Biosecurity Measures Re: New invasive *Amynthas* spp. Northern Boreal and Peatlands prepared for the office of MPP Guy Bourgouin 2026_06_08 which I had created for Bourgouin was sent as well to *Hon. Kevin Holland, Associate Minister of Forestry and Forest Products, Hon. Trevor Jones, Minister of*

Agriculture, Food and Agribusiness, and Peter Tabuns, NDP Shadow Minister of Climate and Environment. As it was very similar to the information I sent Bourgouin before he dispatched the above letter, the Biosecurity Measures document is seen at Appendix A Letter 15.

Also sharing an element of the "hand-delivered" approach was a carefully crafted letter to the Federal Privy Council Office which has been reviewed by a specialized Executive Correspondence Unit and now has been logged with many other such letters but ideally flagged for review. Like the letters above, it contained economic details and was written in a tone to garner review (see Appendix A Letter 16).

In conclusion, although I pursued other advocacy, I feel with gratitude to the office of Peter Tabuns MPP and MPP Bourgoin, the issue advanced into the process of agenda setting. The only other document of serious note in the strict advancement of this agenda, (although I wrote to plant nurseries and their associations (see Appendix A Letter 17) the most significant was a request to Colin Cassin, Executive Director of the Invasive Species Centre, to support the immediate regulatory prohibition of jumping worms under the Invasive Species Act (Appendix 18). Additionally, I invited him to use his influence to urge the Ministry of Natural Resources and the Canadian Food Inspection Agency to adopt proactive biosecurity frameworks and address critical institutional data gaps. Together, these efforts I believe will ultimately result in a win for the prohibition of the species within Ontario and by the CFIA within Canada, which will allow the facilitation of enforcement. The grassroots strategy I used to forward the issue into public awareness and into the political agenda of Ontario and Canada is still a "work in progress," but my research evidenced the best practices of hand-delivered

documents, French translations, pragmatic and specific deployable infrastructure, and regulatory amendment requests/new measures were, it appears, effective methods. As well, the use of deeply researched citations, something I credit the MES department at York University in training me to do, are essential in validating a citizen concern to a Ministry. As John Kingdon described it, “The agenda…is the list of subjects or problems to which governmental officials, and people outside of government closely associated with those officials, are paying some serious attention at any given time ...So the agenda-setting process narrows this set of conceivable subjects to the set that actually becomes the focus of attention,” Kingdon,1985, as quoted by Canadian environmental policy expert Melody Hessing in Hessing, Howlett, and Summerville, 2005, *Canadian Natural Resource and Environmental Policy*).

Digital assets and knowledge mobilization (KMb) platforms 1 and 2

Although physical assets easily scaled and adopted such as brochures have been hand-distributed (see Appendix B Figure 1), including to community gardens (see B-Figure 2) while posters were distributed online to organizations such as Green Thumbs Growing Kids, Toronto Urban Gardeners, Toronto Regional and Conservation Authority and South Parkdale Community Pollinator Gardens (which also organized a public workshop on the topic) (see B-Figure 3) some of the most comprehensive (see B-Figure 4) of the many graphic assets I created appear on my websites, including as downloadable material. As key to the campaign, the first website for digital knowledge mobilization (KMb) purposes, www.stopjumpingworms.ca aims to counteract the narrative of "inevitability" and even fatalism surrounding the northward spread of the

species. The sites created a springboard for actionable community stewardship regarding the issue of *Amynthas* spp. invasion. This was a strategy point that this campaign and any environmental campaigns of this sort must not be without, an essential bridge of information to both government officials and the public. I chose a very simple graphic layout and, similar to investigative factfinding, using WHAT, HOW and WHY buttons to give control to the website visitors over their inquiry. By providing identification imagery, distribution maps, and biological facts regarding jumping worms, users could then shift from fear of the "ecological uncanny" (Albrect, 2005; Ghosh, 2016) to a more objective reality and a sense of informed agency. Hopefully the design to shift Canadians from feeling helplessly invaded to feeling practically equipped to take personal responsibility for prevention succeeded with these first three pages, the warm-ups for the action page. The LET'S STOP THEM page is the action page that moves awareness into citizen-led solutions. This page details accessible biosecurity and mitigation protocols, including links to information regarding DIY low-cost trailhead infrastructure such as regional boot-brush stations (see B Figure 5). The page also provides complete templates for municipal bylaws, for boot brush station requests, and for bait regulation, backed by downloadable links. It also has downloadable full colour brochures and posters for any gardeners and groups throughout Canada, as well as a template script for presenters and contacts for key decision-makers. The bait section addresses underregulated bait issues, instructions for creating a bait jar that carries used bait away from nature areas entirely, and a downloaded sticker for the bait jar to dignify it. Together the website moves visitors from helpless curiosity to frontline action to stop the spread. Were I to envision the future look of the website, it would be to

create assets translated into French, and to introduce multi-lingual assets as well. An example of a multilingual asset is seen on www.soilstewardshipresources.ca, the final digital outreach project, which we will be discussing next (B Figure 6). Soilstewardshipresources.ca has a lot of information on it, and I hope that visitors are able to truly appreciate the work that went into creating that platform, as each graphic is my own custom design, intended to diffuse the anxiety of a younger set of website visitors and transform them into empowered citizens. The challenge in this process was that any educational resource about the "underground world" is addressing an invisible world that kids, in particular urban kids, do not normally interact with compared to their suburban, exurban and rural counterparts (Louv, 2005; Harris et al., 2025). My effort to change this began with the banner I designed for Toronto's first Tiny Forest (see Figure B-7, Figure 8) as the banner included "underground world" imagery showing 18 root systems, 4 ground-nesting bee nests and invertebrate and other soil-dwelling fauna. Therefore, on the Exercises page, https://www.soilstewardshipresources.ca/exercises, a modification of the banner image appears as an activity (colouring) (see Figure B-9). This is followed by a detailed soil horizon for discussion. Next, a "Leave the Leaves" images and activity discusses the Swallowtail butterfly (*Papilio* spp.) and the Ground-Nesting Bumblebee (*Bombus* spp.), and an identification card of earthworm comparisons is beneath it (see Figure B-10, 11). Following the introduction through identification, a jumping worm colouring page for identification discussions supports the likelihood of stronger recognition should jumping worms be encountered (see Figure12). The jumping worm identification card has been used extensively in physical outreach, and hand-delivered to groups such as at TRCA invasive species workshops, placed at

gardening hubs such as Oakvale Green (see Figure 13) and given to gardeners including to program leadership in conversation.

Further on the website soilstewardship.ca, the necessity of iNaturalist identification support is introduced with a QR code for teachers to share, and an activity introducing this process. Finally, a pledge is presented and a badge strongly reinforcing the message of “forest friendly shoes” which is in the book narrative as well (see Figure 14, 12). All of these assets are fully downloadable/printable to teachers wishing to use any aspect in their classes. The last image of a membership card and then a collection of cool kids who are members is also intended to inspire engagement with the concept of guarding the health of the soil. The children’s literature piece “Soil Invaders and Forest-Friendly Shoes,” helps kids discover an implementable cultural shift that any age of child can do.

Conclusion

Together, these physical and digital knowledge mobilization platforms bridged the gap between complex academic research and everyday community action, ultimately serving the mission of my Master’s research: a model for a campaign that can transform ecological vulnerability into an organized and empowered defense of Canada's soils.

The best practices outlined in previous sections merged with the physical and digital KMb demonstrate that together, a new invasive species can enter the policy agenda, and that such campaigns can and must be replicated by everyday grassroots citizens as an essential component to supporting government awareness and response.

Bibliographic References

Abrahamsen, G. (1972). Ecological study of Lumbricidae (Oligochaeta) in Norwegian coniferous forest soils. *Pedobiologia*, *12*(4), 267–281. https://doi.org/10.1016/s0031-4056(23)02044-9

Adams, V. E., Chettiar, S. R., Clow, T. M., Gendron, E., Gough, A. L., Stewart, B. E. M., & Toxopeus, J. (2024). Invasive adult jumping worms in Atlantic Canada are chill-susceptible. *Biological Invasions*, *27*(1). https://doi.org/10.1007/s10530-024-03462-8

Addison, J. A. (2009). Distribution and impacts of invasive earthworms in Canadian forest ecosystems. *Biological Invasions*, *11*(1), 59–79. https://doi.org/10.1007/s10530-008-9320-4

Agyeman, J. (2013). *Introducing just sustainabilities: Policy, planning, and practice*. Zed Books.

Albrecht, G. (2005). Solastalgia: A new concept in human health and identity. *PAN: Philosophy Activism Nature*, *3*, 41–55.

Alkon, A. H., & Agyeman, J. (2014). *Cultivating Food Justice Race, class, and Sustainability*. MIT Press.

Alves, D. de, & Oliveira, L. (2022). Commercial Urban Agriculture: A review for Sustainable Development. *Sustainable Cities and Society*, *87*, 104185. https://doi.org/10.1016/j.scs.2022.104185

Arboretum, U. W. –Madison. (2014, May 15). *Jumping worm discovered in the Arboretum*. https://arboretum.wisc.edu/news/arboretum-news/jumping-worm-release/

ATV Clubs, O. F. (2025). *Clean equipment protocol*. https://ofatv.org/wp-content/uploads/2025/10/Clean-Equipment-Protocol.pdf

Badía, D., López-García, S., Martí, C., Ortiz-Perpiñá, O., Girona-García, A., & Casanova-Gascón, J. (2017). Burn effects on soil properties associated to heat transfer under contrasting moisture content. *Science of the Total Environment*, *601–602*, 1119–1128. https://doi.org/10.1016/j.scitotenv.2017.05.254

B.B.C. (2002). *BBC NEWS | UK | Foot-and-mouth: Crisis timeline from Bbc.co.uk website*. http://news.bbc.co.uk/2/hi/uk_news/1760785.stm

Beddard, F. E. (1892). On some Perichaetidae from Japan. Zoologische Jahrbücher: Abteilung für Systematik. *Geographie und Biologie der Tiere*, *6*, 755–766.

Benis, K., & Ferrão, P. (2018). Commercial farming within the urban built environment – taking stock of an evolving field in northern countries. *Global Food Security*, *17*, 30–37. https://doi.org/10.1016/j.gfs.2018.03.005

Bennett, S., Phillips, H. R. P., Dalziel, A. C., Manzer, L. R., & Cameron, E. K. (2024). Testing the impacts of invasive jumping worms at their northern range limit. *European Journal of Soil Biology*, *120*, 103590–103590. https://doi.org/10.1016/j.ejsobi.2023.103590

Bezrutczyk, A. (2021). *Invasive Species in a Nutshell Know the Worm Background*. https://ccetompkins.org/resources/jumping-worm-fact-sheet

Blakemore, R. J. (2003). Japanese earthworms (Annelida: Oligochaeta): A review and checklist of species. *Organisms Diversity & Evolution*, *3*(3), 241–244. https://doi.org/10.1078/1439-6092-00082

Blakemore, R. J. (2012). Japanese earthworms revisited a decade on. *Zoology in the Middle East*, *58*(sup4), 15–22. https://doi.org/10.1080/09397140.2012.10648981

Bohlen, P. J. (2004). Non-native invasive earthworms as agents of change in northern temperate forests. *Frontiers in Ecology and the Environment*, *2*(8), 427–435.

Bohlen, P. J., Groffman, P. M., Fahey, T. J., Fisk, M. C., Suarez, E., Pelletier, D. M., & Fahey, R. T. (2004). Ecosystem Consequences of Exotic Earthworm Invasion of North Temperate Forests. *Ecosystems*, *7*(1), 1–12. https://doi.org/10.1007/s10021-003-0126-z

Bouché, M. B. (1972). Lombriciens de France Écologie et Systématique. Station de recherches sur la faune du sol Centre de recherches de Dijon, Institut National de la Recherche Agronomique. *INRA*, 72–2.

Briones, M. J. I., & Schmidt, O. (2017). Conventional tillage decreases the abundance and biomass of earthworms and alters their community structure in a global meta-analysis. *Global Change Biology*, *23*(10), 4396–4419. https://doi.org/10.1111/gcb.13744

Buchholz, E., Lund, N., Frelich, L. E., & Yoo, K. (2026). Sentinel soil-plant continuum: How public gardens can advance early detection and monitoring of invasive jumping worms. *Frontiers in Forests and Global Change*, *9*. https://doi.org/10.3389/ffgc.2026.1824795

Burgman, M. (2005). *Risks and decisions for conservation and environmental management*. Cambridge University Press.

Burtelow, A. E., Bohlen, P. J., & Groffman, P. M. (1998). Influence of exotic earthworm invasion on soil organic matter, microbial biomass and denitrification potential in forest soils of the northeastern United States. *Applied Soil Ecology*, *9*(1–3), 197–202. https://doi.org/10.1016/s0929-1393(98)00075-4

Butcher, L., Loughman, Z., Ake, G., Wyer, A., Cecil, M., & Dann, J. (2026). A Study of Amynthas sp. Reactions to Climatic Variables. *Proceedings of the West Virginia Academy of Science*, *98*(1). https://doi.org/10.55632/pwvas.v98i1.1345

Cameron, E. K. (2015). Modelling interacting effects of invasive earthworms and wildfire on forest floor carbon storage in the boreal forest. *Soil Biology and Biochemistry*, *88*, 189–196. https://ostrnrcan-dostrncan.canada.ca/entities/publication/9a690986-25b1-40c1-b9b9-875db551d3b6

Government of Canada. (1910). *Destructive Insect and Pest Act (1910*. Justice Laws Website. https://laws-lois.justice.gc.ca/

Natural Resources Canada. (2025). *Peatland fires and carbon emissions*. Government of Canada. https://natural-resources.canada.ca/forests-forestry/wildland-fires/peatland-fires-carbon-emissions

Parks Canada. (2025). *Pickering lands - Rouge National Urban Park*. Government of Canada. https://parks.canada.ca/pn-np/on/rouge/info/gestion-management/biens-fonds-pickering-lands

Canadian Coalition for Invasive Plant Regulation. (2024). https://ccipr.ca/reducing-the-sales-of-invasive-plant-species-in-canada-to-safeguard-biodiversity/

Canadian Food Inspection Agency. (2014). *Requirements for soil. Government of Canada*. https://inspection.canada.ca/en/plant-health/soil/requirements-soil

Canadian Food Inspection Agency. (2023). *D- 96-20: Canadian Growing Media Program, Prior Approval Process and Import Requirements for Plants Rooted in Approved Media—Inspection.canada.ca*. https://inspection.canada.ca/en/plant-health/invasive-pests-and-plants/directives/imports/96-20

Canadian Food Inspection Agency. (2025). *D-08-04: Plant Protection Import Requirements for Plants and Plant Parts for Planting*. https://inspection.canada.ca/en/plant-health/invasive-pests-and-plants/directives/imports/08-04

Canadian Food Inspection Agency. (2026, January 15). *Canada and the Federation of Canadian Municipalities support 80 municipalities in building climate resilience*. Government of Canada. https://www.canada.ca/en/environment-climate-change/news/2026/01/canada-and-the-federation-of-canadian-municipalities-support-80-municipalities-in-building-climate-resilience.html

Castonguay, S. (2010). Creating an agricultural world order: Regional plant protection problems and international phytopathology, 1878–1939. *Agricultural History*, *84*(1), 46–73. https://doi.org/10.1215/00021482-84.1.46

C.B.S./A.P. (2022). *Invasive "jumping worms" threatening plants, forests and wildlife in dozens of states: "These are earthworms on steroids."* CBS News. https://www.cbsnews.com/news/jumping-worms-invasive-species-connecticut/

Centre for Constitutional Studies. (2024, October). https://www.constitutionalstudies.ca/2024/10/environmental-jurisdiction/

Chang, C.H, Snyder, B.A. and Szlávecz, K. (2016). Asian pheretimoid earthworms in North America north of Mexico: An illustrated key to the genera *Amynthas*, *Metaphire*, *Pithemera*, and *Polypheretima* (*Clitellata: Megascolecidae*. *Zootaxa*, *4179*(3), 495. https://doi.org/10.11646/zootaxa.4179.3.7

Chang, C.-H., Bartz, M. L. C., Brown, G., Callaham, M. A., Cameron, E. K., Dávalos, A., & Ransom, T. (2021). The second wave of earthworm invasions in North America: Biology, environmental impacts, management and control of invasive jumping worms. *Biological Invasions*, *23*(11), 3291–3322. https://doi.org/10.1007/s10530-021-02598-1

Chang, C.-H., Szlavecz, K., & Buyer, J. (2016). Review of Species-specific effects of earthworms on microbial communities and the fate of litter-derived carbon. *Soil Biology and Biochemistry*, *100*, 129–139. https://doi.org/10.1016/j.soilbio.2016.06.004

Colorado Department of Agriculture, (2026). *Asian jumping worm*. https://ag.colorado.gov/plants/pest-survey/asian-jumping-worm

Cook, G. M. (1998). Spray, spray, spray!": Insecticides and the making of applied entomology in Canada, 1871–1914. *Scientia Canadensis: Canadian Journal of the History of Science, Technology and Medicine*, *22–23*, 7–28. https://doi.org/10.7202/800406ar

Cooper, E. L., Hirabayashi, K., & Balamurugan, M. (2012). Dilong: Food for Thought and Medicine. *Journal of Traditional and Complementary Medicine*, *2*(4), 242–248. https://doi.org/10.1016/s2225-4110(16)30110-9

Cornell Cooperative Extension. (2017). Jumping worms threaten forest health. *New York Cornell Factsheet / Eastern Ontario Model Forest*.

Coutts, S. R., Helmstedt, K. J., & Bennett, J. R. (2018). Invasion lags: The stories we tell ourselves and our inability to infer process from pattern. *Diversity and Distributions*, *24*(2), 244–251. https://doi.org/10.1111/ddi.12669

Craven, D., Thakur, M. P., Cameron, E. K., Frelich, L. E., Beauséjour, R., Blair, R. B., Blossey, B., Burtis, J., Choi, A., Dávalos, A., Fahey, T. J., Fisichelli, N. A., Gibson, K., Handa, I. T., Hopfensperger, K., Loss, S. R., Nuzzo, V., Maerz, J. C., Sackett, T., & Eisenhauer, N. (2016). The unseen invaders: Introduced earthworms as drivers of change in plant communities in North American forests (a meta‐analysis. *Global Change Biology*, *23*(3), 1065–1074. https://doi.org/10.1111/gcb.13446

Crone, E. R., Sauer, E. L., Herrick, B. M., Drake, D., & Preston, D. L. (2021). *Review of Effects of Invasive Jumping Worms (Amynthas spp.) On Microhabitat and Trophic Interactions of Native Herpetofauna*. Research Square (Research Square. https://doi.org/10.21203/rs.3.rs-526527/v1

Crooks, J. A. (2002). Characterizing ecosystem-level consequences of biological invasions: The role of ecosystem engineers. *Oikos*, *97*(2), 153–166. https://doi.org/10.1034/j.1600-0706.2002.970201.x

Crooks, J. A. (2005). Lag times and exotic species: The ecology and management of biological invasions in slow-motion. *Écoscience*, *12*(3), 316–329. https://doi.org/10.2980/i1195-6860-12-3-316.1

Customs, U. S., & Protection, B. (2026). *Did you know... Insect infestation initially derailed Japan's cherry tree gift to nation?* https://www.cbp.gov/about/history/did-you-know/cherry-tree

Del Tredici, P. (2017). The Introduction of Japanese Plants Into North America. *The Botanical Review*, *83*(3), 215–252. https://doi.org/10.1007/s12229-017-9184-3

Dellinger, T. A. (2021). *Jumping Worms (Amynthas* spp. Virginia Cooperative Extension. https://vtechworks.lib.vt.edu/bitstreams/1a216333-d78a-4b68-9da2-2b2359ca696f/download

Dushkova, D., & Ivlieva, O. (2024). Empowering communities to act for a change: A review of the community empowerment programs towards sustainability and resilience. *Sustainability*, *16*(19), 8700. https://doi.org/10.3390/su1619870

Dyment, S. (2025). *Greenroofs, tiny forests and community gardens: Invasive plant and invertebrate species in three distinct urban settings* [[Unpublished manuscript].].

Edwards, C. A., & Arancon, N. Q. (2022). *Biology and Ecology of Earthworms*. Springer US. https://doi.org/10.1007/978-0-387-74943-3

Eisenhauer, N., Ferlian, O., Craven, D., Hines, J., & Jochum, M. (2019). Ecosystem responses to exotic earthworm invasion in northern North American forests. *Research Ideas and Outcomes*, *5*. https://doi.org/10.3897/rio.5.e34564

Eisenhauer, N., Stefanski, A., Fisichelli, N. A., Rice, K., Rich, R., & Reich, P. B. (2014). Warming shifts “worming”: Effects of experimental warming on invasive earthworms in northern North America. *Scientific Reports*, *4*(1). https://doi.org/10.1038/srep06890

Encyclopedia Britannica. (2026). Connecticut. In *Encyclopædia Britannica*. https://www.britannica.com/place/Connecticut

Entomological Society of America. (2021). Better common names project. https://entsoc.org/publications/common-names/better-common-names-project

Environment and Climate Change Canada. (2024). *Canada's 2030 nature strategy: Halting and reversing biodiversity loss in Canada*. Food and Agriculture Organization of the United Nations (FAO). https://faolex.fao.org/docs/pdf/can231326.pdf

Environment and Climate Change Canada. (2024). *Funding opportunities to support adaptation action*. Government of Canada. https://www.canada.ca/en/environment-climate-change/services/climate-change/adapting/funding.html

Environment and Climate Change Canada. (2026, January 19). *Canada forecasts 2026 to be among the hottest years on record* [News release]. Government of Canada. https://www.canada.ca/en/environment-climate-change/news/2026/01/canada-forecasts-2026-to-be-among-the-hottest-years-on-record.html

Epanchin-Niell, R. S., & Liebhold, A. M. (2015). Benefits of invasion prevention: Effect of time lags, spread rates, and damage persistence. *Ecological Economics*, *116*, 146–153. https://doi.org/10.1016/j.ecolecon.2015.04.020

Michigan State University Extension. (2023). *Invasive jumping worms: Background, identification and control*. https://www.canr.msu.edu/news/invasive-jumping-worms-background-identification-and-control

Ferlian, O., Goldmann, K., Bonkowski, M., Dumack, K., Wubet, T., & Eisenhauer, N. (2024). Invasive earthworms shift soil microbial community structure in northern

North American forest ecosystems. *IScience*, *27*(2), 108889. https://doi.org/10.1016/j.isci.2024.108889

Ferlian, O., Thakur, M. P., González, A. C., San Emeterio, L. M., Marr, S., Rocha, B. S., & Eisenhauer, N. (2019). Soil chemistry turned upside down: A meta-analysis of invasive earthworm effects on soil chemical properties. *Ecology*, *101*(3), 02936. https://doi.org/10.1002/ecy.2936

California Department of Food and Agriculture. (2024). *Pest rating for Amynthas* spp. *and Metaphire* spp. *(Jumping worms)*. Sacramento, CA: Plant Health and Pest Prevention Services. Retrieved from https://www.cdfa.ca.gov/plant/ppd/

Frelich, L. E., Blossey, B., Cameron, E. K., Dávalos, A., Eisenhauer, N., Fahey, T., Ferlian, O., Groffman, P. M., Larson, E., Loss, S. R., Maerz, J. C., Nuzzo, V., Yoo, K., & Reich, P. B. (2019). Side‐swiped: Ecological cascades emanating from earthworm invasions. *Frontiers in Ecology and the Environment*, *17*(9), 502–510. https://doi.org/10.1002/fee.2099

Frelich, L. E., Hale, C. M., Scheu, S., Holdsworth, A. R., Heneghan, L., Bohlen, P. J., & Reich, P. B. (2006). Earthworm invasion into previously earthworm-free temperate and boreal forests. *Biological Invasions*, *8*(6), 1235–1245. https://doi.org/10.1007/s10530-006-9019-3

Garden, M., & Society, H. (2024). *Plant sale best practices to stop the spread of jumping worms*. https://www.markhamgardenclub.ca/post/plant-sale-best-practices-to-stop-the-spread-of-jumping-worms

Gardeners, N. M. (2023). *Jumping worms*. https://mgniagara.com/wp-content/uploads/2023/10/Jumping-Worms-Poster.pdf

Gates, G. E. (1958). *On some species of the Oriental earthworm genus Pheretima Kinberg, 1867, with key to species reported from the Americas*. American Museum Novitates.

Gaudet, A., & Jernigan, A. (2026). Evaluating the environmental preferences and spread of the invasive Asian Jumping Worm (*Amynthas* spp.) in southwestern Virginia. *MicroPublication Biology*, 10 17912 002000. https://doi.org/10.17912/micropub.biology.002000

Geological Survey of Canada. (2017, March 2). *46. Ice Sheets (1890s)*. Science.gc.ca. https://science.gc.ca/site/science/en/educational-resources/history-geological-survey-canada-175-objects/46-ice-sheets-1890s

Ghosh, A. (2016). *The great derangement: Climate change and the unthinkable*. University of Chicago Press.

Gilbert, L. (2014). Social Justice and the “Green” city. *URBE - Revista Brasileira de Gestão Urbana*, *6*(541), 158–169. https://doi.org/10.7213/urbe.06.002.se01

Goodfellow Craig, A., & Johnny, M. (Eds.). (2026). *How York U turns research into actionable solutions for communities*. https://www.yorku.ca/yfile/2026/04/01/how-york-u-turns-research-into-actionable-solutions-for-communities/

Görres, J. H. (2014). The jumping worm invasion: Tracking a new threat to forest ecosystems and horticultural production. *Proceedings of the New England Horticultural Expo*, *14*, 22–25.

Goto, S., & Hatai, S. (1898). New or Imperfectly Known Species of Earthworms. *Annotationes Zoologicae Japonenses*, *2*(3), 65–78. https://www.biodiversitylibrary.org/item/151945?__cf_chl_f_tk=hn.ZJcSKXZ1lEfdwnjn3EN1gtU3h5irC_pUvs2uOve8-1782920291-1.0.1.1-5krBfAeeNyxzhoEwmrVwU5CNvNpHXe84lBGsM447cvM#page/4/mode/1up

Great Lakes Commission. (2022). *Guidance for the use of common names for invasive species*. https://www.glc.org/wp-content/uploads/GLP-Chan_IS-Common-Names-Chan-11_2_2022.pdf

Group, I. M. C., & Society, I. P. (2021). *What are peatlands? Peatlands.org*. https://peatlands.org/peatlands/what-are-peatlands/

Gupta, A. (2021). *Jumping worms have a surprising impact on human emotions*. Minnesota Woodlands and Waters Network. https://www.mnwwn.org/blog/2021/7/6/jumping-worms-have-a-surprising-impact-on-human-emotions

Gupta, A., Weber, M., & Minnesota Extension, U. (2022). *Improving plant and animal common names*. https://extension.umn.edu/identify-invasive-species/improving-plant-and-animal-common-names

Hale, C. M. (2007, August). Great Lakes Worm Watch: How citizen scientists have documented the distributions of exotic earthworms in the western Great Lakes Region. *92nd Ecological Society of America (ESA) Annual Meeting*. https://www.researchgate.net/publication/267358065_Great_Lakes_Worm_Wat

ch_How_citizen_scientists_have_documented_the_distributions_of_exotic_earthworms_in_the_western_Great_Lakes_Region

Hamilton Conservation Authority. (2022). *All about invasive jumping worms*. https://conservationhamilton.ca/blog/all-about-invasive-jumping-worms/

Hammelman, C. (2019). Challenges to supporting social justice through Food System Governance: Examples from two urban agriculture initiatives in Toronto. *Environment and Urbanization*, *31*(2), 481–496. https://doi.org/10.1177/0956247819860114

Harries, (2022). *"They are such a problem in the U.S., that support groups for gardeners have been formed…"* [Status update]. Facebook. Invasive jumping worms: Observation and Discussion.

Harris, N. R., & González, M. (2025). Neighborhood Conditions Profoundly Affect the Environmental Literacy of Urban Youth. *Cities*, *161*, 105470.

Hendrix, P. F. (1995). *Earthworm ecology and biogeography in North America*. Lewis Publishers.

Hendrix, P. F., & Bohlen, P. J. (2002). Exotic Earthworm Invasions in North America: Ecological and Policy Implications. *BioScience*, *52*(9), 801. https://doi.org/10.1641/0006-3568(2002)052

Hessing, M., Howlett, M., & Summerville, T. (2005). *Canadian natural resource and environmental policy: Political economy and public policy*. UBC Press.

Heynen, N. (2009). Bending the bars of empire from every ghetto for survival: The Black Panther Party's radical antihunger politics of social reproduction and scale. *Annals of the Association of American Geographers*, *99*(2), 406–422. https://doi.org/10.1080/00045600802683767

Heynen, N., Kaika, M., & Swyngedouw, E. (2006). Justice of eating in the city: The political ecology of urban hunger. In *In the nature of cities: Urban political ecology and the politics of urban metabolism*. Routledge.

Heynen, N., Kurtz, H. E., & Trauger, A. (2012). Food Justice, hunger and the city. *Geography Compass*, *6*(5), 304–311. https://doi.org/10.1111/j.1749-8198.2012.00486.x

Hines, J. (2026). *The use of fire in the control of invasive, epigeic earthworm species in the southeastern United States*. https://openscholar.uga.edu/record/20178?v=pdf

Hlava, J., & Kopecký, O. (2013). *Earthworm population responses to deciduous forest soil acidity and vegetation cover 44:133*. Jakub Hlava Czech University of Life Sciences Prague. https://doi.org/10.7160/sab.2013.440302

Holmstrup, M., & Zachariassen, K. E. (1996). Physiology of cold hardiness in earthworms. *Comparative Biochemistry and Physiology Part A: Physiology*, *115*(2), 91–101. https://doi.org/10.1016/0300-9629(96)00010-2

Holyoak, D. T. (1972). Food of the rook in Britain. *Bird Study*, *19*(1), 6–28. https://doi.org/10.1080/00063657209476327

Howlett, M. (2024). *Designing public policies: Principles and instruments* (3rd ed.). Routledge.

Howlett, M., Mukherjee, I., & Woo, J. J. (2015). From tools to toolkits in policy design studies: The new design orientation towards policy formulation research. *Policy & Politics*, *43*(2), 291–311. https://doi.org/10.1332/030557315X14255594054235

Hoyumpa, T. (2025, October). *My strawberry plants are flat on the ground with no soil to hold onto...* [Status update]. Facebook. Invasive jumping worms: Observation and Discussion.

Hudson, G. (2025). Rethinking Wood Chip Mulch - Northern Gardener. Retrieved June 23, 2026, from Northern Gardener website: https://northerngardener.org/rethinking-wood-chip-mulch/

Ikeda, H., Callaham Jr. , M. A., O'Brien, J. J., Hornsby, B. S., & Wenk, E. S. (2015). Can the invasive earthworm, *Amynthas agrestis*, be controlled with prescribed fire? *Soil Biology & Biochemistry 82 (2015) 21-27. 7 P.*, *82*(2015), 21–27. https://doi.org/10.1016/j.soilbio.2014.12.011

iNaturalist. (2015). *Observations for Amynthas (genus*. https://www.inaturalist.org/observations?subview=map&taxon_id=196397

Invasive Species Act, 2015. (2015). *S.O*, 22.

Invasive Species Centre. (2021). https://www.invasivespeciescentre.ca/isc-10/isc-10-ontario-boot-brush-station-contest/

Invasive Species Centre. (2022). https://www.invasivespeciescentre.ca/wp-content/uploads/2022/03/JumpingWormIDGuide_2022-02-17.pdf

Johnson, D. M., Gale, K. M., Dobson, A. M., & McCay, T. S. (2021). Public reporting and perception of invasive pheretimoid "jumping worms" in the Northeastern United States. *Northeastern Naturalist*, *28*(3), 383–396.

Johnston, M. R., & Herrick, B. M. (2019). Cocoon Heat Tolerance of Pheretimoid Earthworms *Amynthas tokioensis* and *Amynthas agrestis*. *The American Midland Naturalist*, *181*(2), 299. https://doi.org/10.1674/0003-0031-181.2.299

Kaiser, C., & Ernst, M. (2024). *Field nursery production (CCD-SP-06*. University of Kentucky Center for Crop Diversification. https://ccd.uky.edu/sites/default/files/2024-12/ccd-sp-06_field.pdf

Kaiser, C., & Olszynski, M. (2021). *Key characteristics of agile regulations: Stringency*. Smart Prosperity Institute. https://institute.smartprosperity.ca/AgileRegulationsStringency

Keil, R. (2020). An urban political ecology for a world of cities. *Urban Studies*, *57*(11), 2357–2370. https://doi.org/10.1177/0042098020919086

Kids, G. T. G. (2025). *Green Thumbs UP (Urban Produce*. https://greenthumbsto.org/green-thumbs-up

Kinberg, J. G. H. (1867). Annulata nova. Öfversigt af Kongl. *Vetenskaps-Akademiens Förhandlingar*, *23*(4), 97–103.

Kingdon, J. W. (1995). *Agendas, alternatives, and public policies* (2nd ed.). HarperCollins College Publishers.

Kladivko, E. (1993). Earthworms: Their intensive culture and use as demonstration. https://www.extension.purdue.edu/extmedia/ay/ay-279.html

Klein, A., Eisenhauer, N., & Schaefer, I. (2019). Invasive lumbricid earthworms in North America—Different life histories but common dispersal? *Journal of Biogeography*, *47*(3), 674–685. https://doi.org/10.1111/jbi.13744

Klein, S. (2020). *A good war: Mobilizing Canada for the climate emergency*. ECW Press.

Krasny, M. E., & Tidball, K. G. (2009). Community gardens as contexts for science, stewardship, and civic action learning. *Cities and the Environment (CATE*, *2*(1). https://doi.org/10.15365/1932-7048.1037

Lakhan, C. (2015). North of the 46th parallel: Obstacles and challenges to recycling in Ontario's rural and northern communities. *Waste Management*, *44*, 216–226.

Lakhan, C., & Winfield, M. (2017). *Waste Wiki: The Waste Library*. York University. https://wastewiki.info.yorku.ca/

Laushman, K. (2020, October 9). *See how wildly a jumping earthworm wriggles*. YouTube. https://www.youtube.com/watch?v=qiRwyLbPv5w

Lejoly, J., Quideau, S., Laganière, J., Karst, J., Martineau, C., Swallow, M., & Samad, A. (2023). Earthworm-invaded boreal forest soils harbour distinct microbial communities. *SOIL*, *9*(2), 461–478. https://doi.org/10.5194/soil-9-461-2023

Levkoe, C. Z. (2014). The food movement in Canada: A social movement network perspective. *The Journal of Peasant Studies*, *41*(3), 385–403. https://doi.org/10.1080/03066150.2014.910766

Liebhold, A. M., Brockerhoff, E. G., Garrett, L. J., Parke, J. L., & Britton, K. O. (2012). Live plant imports: The major pathway for forest insect and pathogen invasions of the US. *Frontiers in Ecology and the Environment*, *10*(3), 135–143. https://doi.org/10.1890/110198

Literary Latitude. (2025). *Ecological uncanny*. https://literarylatitude.com/2025/06/21/ecological-uncanny/

Liu, Y., Qin, X., Ren, G., Zhao, S., Han, X., & Qiu, J. (2026). Survey of earthworm diversity and genetic diversity analysis of dominant earthworms in urban green spaces in Northeast China. *Subterranean Biology*, *56*, 161–178. https://doi.org/doi.org

Lodge, D. M., Simonin, P. W., Burgiel, S. W., Keller, R. P., Bossenbroek, J. M., Jerde, C. L., & Rutherford, E. S. (2016). Risk Analysis and Bioeconomics of Invasive Species to Inform Policy and Management. *Annual Review of Environment and Resources*, *41*(1), 453–488. https://doi.org/10.1146/annurev-environ-110615-085532

Louv, R. (2005). *Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder*. Algonquin Books.

Lowe, C., & Butt, K. (2014). *Cocoon viability and evidence for delayed hatching by the Earthworm Lumbricus Terrestris in a Laboratory-based study*. Earthworm Research Group of Central Lancashire. https://knowledge.lancashire.ac.uk/id/eprint/11153/2/11153_butt.pdf

MacRae, R., Gallant, E., Patel, S., Michalak, M., Bunch, M., & Schaffner, S. (2010). Could Toronto provide 10% of its fresh vegetable requirements from within its own boundaries? Matching consumption requirements with growing spaces. *Journal of Agriculture, Food Systems, and Community Development*, *1*(2), 105–127.

Maggie. (2021, May 11). *Wakan Tipi Awanyankapi*. https://www.wakantipi.org/wta-blog/2021/5/7/planting-moon-in-a-warming-climate-pzhkr-cfs8j-yeyez

Marcon, F. (2015). *The knowledge of nature and the nature of knowledge in early modern Japan*. University of Chicago Press.

McAlpine, D. F., Reynolds, J. W., Manzer, L., & Elton, K. (2022). First reports of invasive pheretimoid earthworms (Oligochaeta: Megascolecidae) of Asian origin in Atlantic Canada. *BioInvasions Records*, *11*(4), 830–838. https://doi.org/10.3391/bir.2022.11.4.02

McClintock, N. (2013). Radical, reformist, and garden-variety neoliberal: Coming to terms with urban agriculture's contradictions. *Local Environment*, *19*(2), 147–171. https://doi.org/10.1080/13549839.2012.752797

McKinley, D. C., Miller-Rushing, A. J., Ballard, H. L., Bonney, R., Brown, H., Cook-Patton, S. C., & Soukup, M. A. (2017). Citizen science can improve conservation science, natural resource management, and environmental protection. *Biological Conservation*, *208*, 15–28. https://doi.org/10.1016/j.biocon.2016.05.015

McLean, A., & Parkinson, D. (1997). Soil impacts of the epigeic earthworm Dendrobaena octaedra on organic matter and microbial activity in lodgepole pine forest. *Canadian Journal of Forest Research*. https://agris.fao.org/search/en/providers/122535/records/65e01cc7b766d82b18041dc8

Messier, C., Bauhus, J., Sousa-Silva, R., Auge, H., Baeten, L., Barsoum, N., & Zemp, D. C. (2021). For the sake of resilience and multifunctionality, let's diversify planted forests! *Conservation Letters*, *15*(1). https://doi.org/10.1111/conl.12829

Mia, M. S. (2026). Food waste–derived organic fertilizers: Critical insights, agronomic impacts, and pathways for sustainable adoption. *Frontiers in Sustainable Food Systems*. https://pmc.ncbi.nlm.nih.gov/articles/PMC12604025/

Michaelsen, W. (1892). Terricolen der Berliner Zoologischen Sammlung. II. *Archiv für Naturgeschichte*, *58*(1), 209–261.

Miller, C. A., Johnson, W. H., & Millis, S. C. (1957). The sterilization and preliminary attempts in the axenic cultivation of the black planarian, Dugesia dorotocephala. *Proceedings of the Indiana Academy of Science*, *67*, 270–274. https://journals.indianapolis.iu.edu/index.php/ias/article/view/6361

Minnesota Extension, U. (2025). *Eco-anxiety*. University of Minnesota. https://extension.umn.edu/mental-wellbeing/eco-anxiety

Mississippi River, F. (2022). *Is it good or bad? Rethinking language around invasive species*.https://fmr.org/updates/conservation/it-good-or-bad-rethinking-language-around-invasive-species

Mooney, H. A., & Cleland, E. E. (2001). The evolutionary impact of invasive species. *Proceedings of the National Academy of Sciences*, *98*(10), 5446–5451. https://doi.org/10.1073/pnas.091093398

Moore, J.-D., Görres, J. H., & Reynolds, J. W. (2018). Exotic Asian pheretimoid earthworms (*Amynthas* spp., *Metaphire* spp.): Potential for colonisation of south-eastern Canada and effects on forest ecosystems. *Environmental Reviews*, *26*(2), 113–120. https://doi.org/10.1139/er-2017-0066

Moore, J.-D., Ouimet, R., & Bohlen, P. J. (2013). Effects of liming on survival and reproduction of two potentially invasive earthworm species in a northern forest Podzol. *Soil Biology and Biochemistry*, *64*, 174–180. https://doi.org/10.1016/j.soilbio.2013.04.013

Moore, J.-D., & Reynolds, J. (2024). First record of the invasive Asian earthworm *Amynthas tokioensis* (Beddard, 1892) in the province of Québec, Canada. *BioInvasions Records*, *13*(1), 1–8. https://doi.org/10.3391/bir.2024.13.1.01

Morgan, R. (2023). *Ontario is failing to control invasive species*. The Narwhal. https://thenarwhal.ca/invasive-species-ontario-response/

Mount, P. (2012). Growing local food: Scale and local food systems governance. *Agriculture and Human Values*, *29*(1), 107–121. https://doi.org/10.1007/s10460-011-9331-0

Murchie, W. R. (1960). Biology of the Oligochaete Bimastos zeteki Smith and Gittins (Lumbricidae) in Northern Michigan. *The American Midland Naturalist*, *64*(1), 194–215.

Nichols, W. H. (1949). February). Biggest worm farm caters to platypuses. *The National Geographic Magazine*, *95*(2), 269–279.

Nouri-Aiin, M., Connolly, S., Keough, C., Smigelsky, A. J., Wen, Y., Howland, J., Schall, J. J., & Görres, J. H. (2022). Review of Genetic population structure and reproductive system of two invasive Asian earthworms. *Amynthas Tokioensis and Amynthas Agrestis]. PeerJ*, *10*, 13622. https://doi.org/10.7717/peerj.13622

Nouri-Aiin, M., & Görres, J. H. (2019). Earthworm cocoons: The cryptic side of invasive earthworm populations. *Applied Soil Ecology*, *141*, 54–60. https://doi.org/10.1016/j.apsoil.2019.05.004

Nouri-Aiin, M., & Görres, J. H. (2021). Biocontrol of invasive pheretimoid earthworms using Beauveria bassiana. *PeerJ*, *9*, 11101. https://doi.org/10.7717/peerj.11101

Nouri-Aiin, M., Schall, J. J., Leibovich, O., Hoover, E., Eller, K., Izzo, V., & Görres, J. (2025). Annual endogenous cycle and thermal drivers of cocoon hatching in the earthworm *Amynthas tokioensis*. *Applied Soil Ecology*, *213*, 106300. https://doi.org/10.1016/j.apsoil.2025.106300

N.P.C.A. (2010). *NPCA Watershed Plan Lake Erie North Shore*. https://npca.ca/images/uploads/common/NPCA-Watershed-Plan-Lake_Erie_North_Shore.pdf

Nuutinen, V., Hagner, M., Jalli, H., Jauhiainen, L., Rämö, S., Sarikka, I., & Uusi-Kämppä, J. (2020). Glyphosate spraying and earthworm Lumbricus terrestris L. activity: Evaluating short-term impact in a glasshouse experiment simulating cereal post-harvest. *European Journal of Soil Biology*, *96*, 103148. https://doi.org/10.1016/j.ejsobi.2019.103148

Odame, H. S., Okeyo-Owuor, J. B., Changeh, J. G., & Otieno, J. O. (2020). The role of technology in inclusive innovation of urban agriculture. *Current Opinion in Environmental Sustainability*, *43*, 106–111. https://doi.org/10.1016/j.cosust.2019.12.007

Office of the Auditor General of Ontario. (2022). Government of Ontario. https://www.auditor.on.ca/en/content/annualreports/arreports/en22/ENV_ProvMgmtInvasiveSpecies_en22.pdf

Office of the Auditor General of Ontario. (2024). Author. https://www.auditor.on.ca/en/content/annualreports/arreports/en24/1-11FU_mgmtinvasive_en24.pdf

Ontario Invasive Plant Council. (2016). *Clean equipment protocol for industry: Managing invasive plants in the natural and urban environment* (One-page summary). https://www.ontarioinvasiveplants.ca/wp-content/uploads/2016/07/CEP-One-Page-Summary_FINAL.pdf

Ontario, Master Gardeners. (2023). *Invasive jumping worms: Information for home gardeners*. https://mgoi.ca/wp-content/uploads/2023/01/JWS-Information-for-Gardeners.pdf

Ontario Ministry of the Environment, Conservation and Parks. (2014). Government of Ontario. https://www.ontario.ca/page/management-excess-soil-guide-best-management-practices

Pal, L. A. (2010). *Beyond policy analysis: Public issue management in turbulent times*. Nelson Education.

Pham, Q. V., Nguyen, T. T., Lam, D. H., Capowiez, Y., Nguyen, A. D., Jouquet, P., & Bottinelli, N. (2023). Review of Using morpho-anatomical traits to predict the effect of earthworms on soil water infiltration. *Geoderma*, *429*, 116245. https://doi.org/10.1016/j.geoderma.2022.116245

Plant Protection Act, S. C. (1990). https://laws-lois.justice.gc.ca/eng/acts/P-14.8/page-5

Plant Quarantine Act of 1912, 7 U.S.C. §§ 151 et seq. (1912).

Potter, D. A., Redmond, C. T., Meepagala, K. M., & Williams, D. W. (2010). Managing earthworm casts (Oligochaeta: Lumbricidae) in turfgrass using a natural byproduct of tea oil (Camellia sp.) manufacture. *Pest Management Science*, *66*(4), 439–446. https://doi.org/10.1002/ps.1896

Potter, D. A., Redmond, C., & Williams, D. W. (2013). Managing excessive earthworm casting on golf courses and sport fields. *ResearchGate*, *12*, 347–355. https://www.researchgate.net/publication/292794830_Managing_excessive_earthworm_casting_on_golf_courses_and_sport_fields

Press, T. C. (2022). Ontario spends 4 million fighting invasive species, a 3.6 billion problem: AG. *Global News*. https://globalnews.ca/news/9314863/ontario-spends-little-to-fight-invasive-species-despite-economic-impact-ag/

Price, J. S., & Ketcheson, S. J. (2009). Water Relations in Cutover Peatlands. University of Waterloo Wetlands Hydrology / AGU Frameworks. *Geophysical Monograph*, *184*, 277–287. https://doi.org/10.1029/2008gm000827

Puettmann, K. J., Wilson, S. M., Baker, S. C., Donoso, P. J., Drössler, L., Amente, G., & Bauhus, J. (2015). Silvicultural alternatives to conventional even-aged forest management—What limits global adoption? *Forest Ecosystems*, *2*(1). https://doi.org/10.1186/s40663-015-0031-x

Puhlick, J. J., Fernandez, I. J., & Wason, J. W. (2021). Non-native earthworms invade forest soils in northern Maine, USA. *Forests*, *12*(1), 80. https://doi.org/10.3390/f12010080

Qiu, J., & Turner, M. G. (2016). Effects of non-native Asian earthworm invasion on temperate forest and prairie soils in the Midwestern US. *Biological Invasions*, *19*(1), 73–88. https://doi.org/10.1007/s10530-016-1264-5

Reynandez, R. (2024). *9 edible recipes to introduce students to soil. Project Learning Tree*. https://www.plt.org/educator-tips/edible-recipes-teach-students-soil/

Reynolds, J. W. (2024). Asian “jumping worm” records (Oligochaeta: Megascolecidae) in Ontario, Canada. *International Journal of Advanced Multidisciplinary Research and Studies*, *4*(4), 1050–1053. https://doi.org/10.62225/2583049X.2024.4.4.3148

Ridge, G. (2023). *Jumping Worms (Megascolecidae: Pheretima) in Connecticut. The Connecticut Agricultural Experiment Station (Https://Portal.Ct.Gov/Caes*. https://portal.ct.gov/-/media/CAES/DOCUMENTS/Publications/Fact_Sheets/Entomology/Jumping-worms-in-Connecticut.pdf

Robeck, P., Essl, F., Kleunen, M., Pyšek, P., Pergl, J., Weigelt, P., & Mesgaran, M. B. (2024). Invading plants remain undetected in a lag phase while they explore suitable climates. *Nature Ecology & Evolution*, *8*(3), 477–488. https://doi.org/10.1038/s41559-023-02313-4

Rowe, J. S. (1972). Forest Regions of Canada. Department of the Environment, Canadian Forestry Service. *Publication*, (1300).

Scott, D. N. (2023). *Impact assessment in the Ring of Fire: Contested authorities, competing visions and a clash of legal orders* [[Commissioned report].]. Osgoode Digital Commons, York University. https://digitalcommons.osgoode.yorku.ca/reports/229/

Seastedt, T., & Wong, M. (2025). *Introduction: Managing Invasive Species: Problems, Panaceas, and Realities for the 21st Century*.

Senate, C. P. (1999). Subcommittee on the Boreal Forest. *Standing Senate Committee on Agriculture and Forestry*. https://sencanada.ca/en/content/sen/committee/361/bore/rep/rep09jun99part2-e

Sharma, H. (2024). Assessing cocoon production by earthworm in response to soil pesticide contamination. *Current Agriculture Research Journal*, *12*(2), 836–843.

Simon, J. (2025). The Potential of Chemical and Biological Management Options for Controlling Jumping Worms (*Amynthas* spp.) in Container Nursery Production. *HortTechnology*, *35*(5), 802–809. https://doi.org/10.21273/HORTTECH05723-25

Sims, R. W., & Easton, E. G. (1972). A numerical revision of the earthworm genus *Pheretima* auct. (*Megascolecidae*: *Oligochaeta*) with a recognition of new

genera and an appendix on the earthworms collected by the Royal Society North Borneo Expedition. *Journal of the Linnean Society of London, Zoology*.

Singh, J., Schädler, M., Demetrio, W., Brown, G. G., & Eisenhauer, N. (2019). Climate change effects on earthworms—A review. *SOIL ORGANISMS*, *91*(3), 113-137113–137137. https://doi.org/10.25674/so91iss3pp114

Skinner, M., Rubin, J., Gorres, J., & Parker, B. L. (2018). February). Do invasive worms threaten northeast maple forests? *Maple Syrup Digest*, *30*(1), 20–27. https://mapleresearch.org/wp-content/uploads/0218worms.pdf

Society, W. C. (2022). *Scientists decry exploitation of peatlands as mining, oil exploration continues with few restraints—World's largest carbon sinks and refuges for biodiversity at risk*. https://newsroom.wcs.org/News-Releases/articleType/ArticleView/articleId/18374/Scientists-Decry-Exploitation-of-Peatlands-as-Mining-Oil-Exploration-Continues-with-Few-RestraintsWorlds-Largest-Carbon-Sinks-and-Refuges-for-Biodiversity-at-Risk.aspx

Soroka, S. N. (2003). *Agenda-setting dynamics in Canada*. UBC Press.

Stiegman, M. (2022). Seizing this covid moment: What can food justice learn from disability justice? *Canadian Food Studies/La Revue Canadienne Des Études Sur l'alimentation*, *9*(1). https://doi.org/10.15353/cfs-rcea.v9i1.525

Stohlgren, T. J., & Schnase, J. L. (2005). Risk analysis for biological hazards: What we need to know about invasive species. *Risk Analysis*, *26*(1), 163–173. https://doi.org/10.1111/j.1539-6924.2006.00707.x

Suarez, A. V., & Tsutsui, N. D. (2007). The evolutionary consequences of biological invasions. *Molecular Ecology*, *17*(1), 351–360. https://doi.org/10.1111/j.1365-294x.2007.03456.x

Sullivan, C. (2024). *These hungry 'muscular' snake-like jumping worms are 'widespread' in New Hampshire*. Manchester Ink Link. https://manchester.inklink.news/these-hungry-muscular-snake-like-jumping-worms-are-widespread-in-new-hampshire/

Szlavecz, K., Chang, C.-H., Bernard, M. J., Pitz, S. L., Xia, L., Ma, Y., & Csuzdi, C. (2018). Litter quality, dispersal and invasion drive earthworm community dynamics and forest soil development. *Oecologia*, *188*(1), 237–250. https://doi.org/10.1007/s00442-018-4205-4

Team, C. C. G. A. C. (2020). *Beware of ... Jumping Worms? Retrieved from Chicago Community Gardeners Association—Learn Connect Grow website*. https://chicagocommunitygardens.org/2020/02/10/beware-of-jumping-worms/

Tekisai, N. (Ed.). (1666). *Kinmo zui*. https://ndlsearch.ndl.go.jp/en/gallery/nature/11

University of Connecticut. (2022). *Snake or jumping worms in Connecticut*. Soil Nutrient Analysis Laboratory. https://soiltesting.cahnr.uconn.edu/snake-or-jumping-worms-in-connecticut/

Vermont Agency of Agriculture, Food and Markets. (2022). https://agriculture.vermont.gov/sites/agriculture/files/Plant%20Health/Jumping%20worm%20BMPs%20for%20nurseries.pdf

Vermont Agency of Agriculture, Food and Markets. (2026). https://agriculture.vermont.gov/public-health-agricultural-resource-management-division/plant-health-and-pest-management/jumping-worms

Waddington, J. M., & Price, J. S. (2000). Effect of peatland drainage, harvesting, and restoration on atmospheric water and carbon exchange. *Physical Geography*, *21*(5), 433–451. https://doi.org/10.1080/02723646.2000.10642719

Whittle, C. A., Duchesne, L. C., & Needham, T. (1997). The importance of buried seeds and vegetative propagation in the development of postfire plant communities. *Environmental Reviews*, *5*(1), 79–87. https://doi.org/10.1139/a97-003

Wikipedia. (2026). Peatland. In *Wikipedia, The Free Encyclopedia*. https://en.wikipedia.org/wiki/Peatland

Wilson, A., & Levkoe, C. Z. (2022). Introspecting food movements in Canada: Unpacking tensions towards Justice and Sustainability. *Canadian Food Studies/La Revue Canadienne Des Études Sur l'alimentation*, *9*(2), 101–124. https://doi.org/10.15353/cfs-rcea.v9i2.524

Wilt, J. (2020). *The battle for the "breathing lands": Ontario's Ring of Fire and the fate of its carbon-rich peatlands*. The Narwhal. https://thenarwhal.ca/ring-of-fire-ontario-peatlands-carbon-climate/

Winfield, M. (2022). Hard paths to decarbonization?: Assessing Ottawa's paths to net zero through an energy sustainability lens. In *Sustainable Energy Initiative (SEI*. York University. https://sei.info.yorku.ca/files/2023/03/Hard-Paths-to-Decarbonization-December-20223.pdf?x60126

Winfield, M., & Sooch, S. (2021). *A life-cycle view essential on EV battery opportunities and risks*. The Hill Times. https://www.hilltimes.com/2021/06/16/a-life-cycle-view-essential-on-ev-battery-opportunities-and-risks/269142/

Wong, M.H. & Seastedt, T. R. (2025) Sustainable Management of Invasive Species.1-13. https://doi.org/10.1142/q0467

Yang, X., Baskin, C. C., Baskin, J. M., Pakeman, R. J., Huang, Z., Gao, R., & Cornelissen, J. H. C. (2021). Global patterns of potential future plant diversity hidden in soil seed banks. *Nature Communications*, *12*(1). https://doi.org/10.1038/s41467-021-27379-1

Zhang, H., Eisenhauer, N., & Chen, H. (2026). Earthworm colonization weakens vertical carbon stratification in alpine peat soils under climate-relevant degradation scenarios [Conference abstract. *EGU General Assembly*. https://doi.org/10.5194/egusphere-egu26-17970

Ziter, C. D., Herrick, B. M., Johnston, M. R., & Turner, M. G. (2021). Ready, set, go: Community science field campaign reveals habitat preferences of nonnative Asian earthworms in an urban landscape. *BioScience*, *71*(3), 280–291. https://doi.org/10.1093/biosci/biaa150

Ziter, C., & Turner, M. G. (2018). Current and historical land use influence soil-based ecosystem services in an urban landscape. *Ecological Applications : A Publication of the Ecological Society of America*, *28*(3), 643–654. https://doi.org/10.1002/eap.1689

"For full details, see the letter (see Appendix A.12)."

Appendix A Letter 1

The response to the CFIA letter. Because the Senior Legislative Officer left open the door to "updated information," I quickly responded with new information in the form of this letter and support material:

Thank you for your letter and for noting that CFIA requirements are not static and may evolve in response to new or updated information. Here are the necessary support materials and updated information to help those at the CFIA better grasp why New York, Wisconsin, and Minnesota designated jumping worms as a prohibited species in response to scientific evidence reflecting not only the need to safeguard **ecosystems** from harm, but in response to forecasts of substantial fiscal liability to **forestry** and **agricultural sectors**.

Peer-reviewed field studies confirm that an 84-95% decline in forest leaf litter within a four-month period is a characteristic impact of jumping worm (*Amynthas* spp.) infestation, a finding that has been consistently corroborated by a decade of subsequent research across diverse North American forest ecosystems (Qiu & Turner, 2017; Bethke & Midgley, 2020; Frelich et al., 2019). The rapid consumption of the forest O-horizon by jumping worms (*Amynthas* spp.) triggers a cascade of extreme soil erosion and nutrient leaching, an impact that effectively sterilizes the native seed bank and induces crown dieback particularly in economically vital species like **Sugar Maple** (Frelich et al., 2019; Bal et al., 2018).

The fact that jumping worms (*Amynthas* spp.) effectively make regeneration very challenging for the genus *Acer*—reducing maple seedling counts by over 90% in

invaded forests—represents a dual-threat to Canada’s economic stability and Canada's national identity (Skinner et al., 2018, Healthy Soil Collaborative, 2026; Statistics Canada, 2025). This rapid 'ecosystem engineering' directly undermines the $1.53 billion CAD maple products industry dependent on Sugar Maple and threatens the broader $25.8 billion forest sector by halting the natural renewal of high-value timber (Kotanen, 2016). By destroying the forest's ability to self-propagate, invasive jumping worms have the capacity to transition Canada's sustainable, renewable forestry resources into finite crops growing in soil that can no longer support healthy new timber seedlings. Such a threat does necessitate an immediate ‘Prohibited’ classification under national biosecurity regulations, a position consistent with recent expert analyses emphasizing the need for quarantine-based management of invasive earthworms (Lejoly et al., 2024; McAlpine et al., 2022; Nouri-Aiin & Görres, 2024).

Peer-reviewed evidence as well as documentary footage from New York and the Great Lakes confirms that the soil-borne invasion of jumping worms (*Amynthas* spp.) causes irreversible trophic collapse (Asselin, 2024) . Because these species survive Canadian winters via cold-hardy cocoons—their immediate classification as a 'Prohibited' pest is a functional necessity for national biosecurity (Chang et al., 2021; McAlpine et al., 2022).

The degradation of the soil's O horizon by invasive jumping worms (*Amynthas* spp.) represents an escalating threat to North American agriculture and climate stability. Without immediate federal regulation, the unmonitored horticulture trade serves as a primary vector, spreading the species into communities dependent on agricultural revenue and into pristine Canadian forests. This risk has already prompted states like New York to implement strict prohibitive regulations, recognizing that both agricultural lands and forest soils must be protected as vital carbon sinks (NYS DEC, 2015). This is driven by the rapid transformation of topsoil into a dry, granular state—a process that significantly increases the soil's basal metabolic rate and triggers the systemic leaching of nutrients (Price-Christenson et al., 2020). In the nursery and specialty crop sectors,

where the total value of farm cash receipts alone exceeds $2.5 billion annually (Statistics Canada, 2024), the threat of infested stock poses a catastrophic risk to inter-provincial trade and ecosystem integrity. Furthermore, research indicates that these detritivores can trigger a 50% to 94% reduction in forest-floor carbon stocks, converting ancient sinks into massive atmospheric liabilities (Lejoly & Cameron, 2023).

Immediate prohibition and the establishment of a formal **CFIA Directive** as a mandatory risk-mitigation strategy would prevent the uncontrolled sharing of contaminated materials within Canada and would align Canada with jurisdictions like New York (6 NYCRR Part 575), ensuring that the '3-for-1' dividend of proactive biosecurity outweighs the compounding cost of remediating Canada's primary biological and climate infrastructure (Natural Resources Canada, 2024).

Given the weight of current evidence and the escalating nature of the risks identified, I respectfully urge the CFIA to give serious consideration to a precautionary re-evaluation of *Amynthas* spp. under existing regulatory frameworks.

Thank you for your reconsideration of this critical biosecurity issue.

Support Material

Asselin, R. (2024, May 17). *My forest has worms* [Video]. YouTube. https://www.youtube.com/watch?v=5xvkIDs3zQk

Bal, T. L., Storer, A. J., & Jurgensen, M. F. (2018). Evidence of damage from exotic invasive earthworm activity was highly correlated to sugar maple dieback in the Upper Great Lakes region. *Biological Invasions*, *20*(1), 151–164 https://www.researchgate.net/publication/318713399_Evidence_of_damage_from_exotic_invasive_earthworm_activity_was_highly_correlated_to_sugar_maple_dieback_in_the_Upper_Great_Lakes_region

Bennett, S., Phillips, H. R. P., Dalziel, A. C., Manzer, L. R., & Cameron, E. K. (2024). *Testing the impacts of invasive jumping worms at their northern range limit*. *European Journal of Soil Biology, 120*, Article 103590.https://doi.org/10.1016/j.ejsobi.2023.103590

Bethke, P. G., & Midgley, M. G. (2020). *Amynthas* spp. impacts on seedlings and forest soils are tree species-dependent. *Biological Invasions*, *22*(10), 3145–3162.. https://doi.org/10.1007/s10530-020-02315-4

Cassin, C. M., & Kotanen, P. M. (2016). Invasive earthworms as seed predators of temperate forest plants. *Biological Invasions*, *18*(6), 1567–1580. https://doi.org/10.1007/s10530-016-1101-x

Chang, C.-H., Dobson, A., Blossey, B., Szlavecz, K., Görres, J. H., Johnston, M. R., McCay, T. S., & Herrick, B. M. (2021). The second wave of earthworm invasions in North America: Biology, environmental impacts, management and control of invasive jumping worms. *Biological Invasions*, *23*(11), 3291–3322 https://link.springer.com/article/10.1007/s10530-021-02598-1

Lejoly, J., Quideau, S. A., Karst, J., & Laganière, J. (2021). Invasive earthworms affect soil morphological features and carbon stocks in boreal forests. *Geoderma*, *441*, 116753. https://www.researchgate.net/publication/352410388_Invasive_earthworms_affect_soil_morphological_features_and_carbon_stocks_in_boreal_forests

McAlpine, D. F., Reynolds, J. W., McTavish, M. J., & Addison, J. A. (2022). New Asian pheretimoid jumping earthworm records (Oligochaeta: Megascolecidae) in Canada. *BioInvasions Records*, *11*(1), 164–172. https://www.researchgate.net/publication/355566537_New_Asian_pheretimoid_jumping_earthworm_records_Oligochaeta_Megascolecidae_in_Canada

Moore, J.-D., Görres, J. H., & Reynolds, J. W. (2018). Exotic Asian pheretimoid earthworms (*Amynthas* spp., *Metaphire* spp.): Potential for colonisation of south-eastern Canada and effects on forest ecosystems. *Environmental Reviews*, *26*(2), 113–120. https://www.researchgate.net/publication/321636493_Exotic_Asian_pheretimoid_earthw

orms_Amynthas_spp_Metaphire_spp_Potential_for_colonisation_of_south-eastern_Canada_and_effects_on_forest_ecosystems

Natural Resources Canada. (2024, February 1). *Earthworms, a threat to Canada's boreal forest?* Government of Canada. https://natural-resources.canada.ca/stories/simply-science/earthworms-threat-canada-s-boreal-forest

New York State Department of Environmental Conservation. (2026). *Regulations*. https://dec.ny.gov/regulatory/regulations

New York State Department of Environmental Conservation. (2015). *Prohibited and regulated invasive species*. https://extapps.dec.ny.gov/docs/lands_forests_pdf/islist.pdf

Nouri-Aiin, M., & Görres, J. H. (2024). *Invasive earthworms and ecosystem processes in North America*. In Y. Kooch & Y. Kuzyakov (Eds.), *Earthworms and ecological processes*. Springer. https://doi.org/10.1007/978-3-031-64510-5_1

Price-Christenson, G. J., Herrick, B. M., et al. (2020). Invasive jumping worms (*Amynthas* spp.)—A complex of three species—Alter soil properties and microbial communities. *Soil Biology and Biochemistry*, *149*, 107955. https://doi.org/10.1016/j.soilbio.2020.107955

Qiu, J., & Turner, M. G. (2017). *Effects of non-native Asian earthworm invasion on temperate forest and prairie soils in the Midwestern US*. *Biological Invasions, 19*(1), 73–88. https://doi.org/10.1007/s10530-016-1264-5

Richardson, J. B., Johnston, M. R., & Herrick, B. M. (2022). Invasive earthworms *Amynthas tokioensis* and *Amynthas agrestis* alter macronutrients (Ca, Mg, K, P) in field and laboratory forest soils. *Applied Soil Ecology*, *174*, 104415. https://www.sciencedirect.com/science/article/abs/pii/S0031405622000166

Skinner, M., Rubin, J., Görres, J. H., & Parker, B. L. (2018). *Do invasive worms threaten Northeast maple forests?*The Maple Digest, 30(1), 29–31. https://mapleresearch.org/wp-content/uploads/0218worms.pdf

Appendix A Letter 2

Relevant parts of letter to David Legros, Senior Park Naturalist for Algonquin Provincial Park

2025 04 11

Hello, David! Thank you for your response.
I realize the invasive invertebrate species threat is daunting and the before-and-after photos are quite alarming as well and I am grateful that you are already strategizing ways to protect the park.
I was going to try to figure out the cost of installing boot brush stations at each of the thirty entrances, it's not very much but it would be nice to have an approximate figure. When I have more information on that I will send it, in the off chance you haven't done that already.
The boot spray kits and awareness posters for the gates and outfitters are also a factor, but if the posters are cheerful it might really help them get used to the concept and to quickly grasp the need to connect with groups such as school busses before they enter en masse.
However, it also sounded like John was approaching the other vectors very well and so with a little more work we can certainly prevent tread-borne invasive invertebrates from creating the sort of ecosystem damage they have wrought in forests to the south.
As for identifying them, the method for determining the presence of *Amynthas agrestis* described in this link might be helpful.
https://www.vtinvasives.org/invasive/jumping-worms

Saponins (natural soap-like ingredients) such as those derived from horsetail or buffaloberry seems to both repel them and drive them to the surface. They are always quite near the surface. As you know, 70 percent of bees are ground nesting and pollinators will soon be emerging as they do with warmer weather. Treating the soil as a result is not really an option without decimating other vulnerable species who are in some cases struggling and in experiencing declines. If buffaloberry was planted near the trailheads it might support other efforts to stop invertebrate invasives from advancing on the forest as it is saponic.

There is a lot of excellent information online and if I find some particularly choice links I will send them at once.

Please stay in touch. I hope you don't mind if the TRCA is updated on this, they are very interested in your progress.

Thank you, David.

Talk soon.

Sincerely,

Sullivan Dyment

Act4OntarioParks.

Appendix A Letter 3

Dear Minister Guilbeault,

I am writing to you at the direction of the Honourable Julie Dabrusin, Minister of Environment and Climate Change, who advised me to connect as well with you following a discussion we had regarding the prevention of invasive jumping worms in Canada’s northern forests.

I am a graduate student in the Environmental Studies program at York University, and my research has led me to believe that a serious and imminent threat to Canada’s forest ecosystems can be significantly mitigated—or even prevented—through the implementation of several low-cost, science-backed measures.

Climate change has accelerated the spread and adaptability of invasive species in recent years. *Amynthas* and *Metaphire* jumping worms have now posed a well-documented ecological threat for over a decade in U.S. forests. Given the evidence from states such as Wisconsin and Michigan, where they have drastically altered soil ecosystems, we have every reason to expect similar—or potentially worse—impacts should these parthenogenetic species establish themselves in Canada's northern forests.

Jumping worms are aggressive soil disruptors that consume the vital organic layer of forest soil, leaving behind a dry, granular substrate. Canada's boreal and mixed forests rely on slow leaf-litter decomposition and fungal-rich soil layers—precisely the components these worms destroy. Alarmingly, their northward movement appears to be facilitated by human activity, requiring us to take particular note to soil and cocoons transported on footwear.

Despite this risk, there are currently no boot brush stations at any of the 29 trailhead entry points to Algonquin Park—the pristine and ecologically significant zone where the northern boreal forest meets southern hardwood systems. I have spoken with Algonquin Park management; while they have a few protocols for invasive plant species, they were unaware of invasive invertebrate risks or measures to prevent their spread.

On reliable platforms like iNaturalist, "snake earthworm" and "jumping worm" sightings in Ontario, including a sighting north of Algonquin Park, are instantly visible.

It is at this juncture highly concerning that boot brush stations are not being prioritized as the indispensable, research-backed tools they are. Fortunately, organizations like the Bruce Trail Conservancy have taken leadership, installing over 100 boot brush stations across their trail network, merely a drop in the bucket of what we need. These stations are proven to reduce the spread of invasive species and raise public awareness—and they are extremely cost-effective.

A federal initiative to install boot brush stations at trailheads across the country would be a highly affordable, visible, and proactive conservation measure. It would also create green summer jobs in rural and remote areas, support tourism, and reflect well on the federal government's environmental leadership.

The need for action is urgent. Evidence from American forests indicates we are in a brief but critical window to act before irreversible ecological shifts occur.

A nationwide rollout of boot brush stations—beginning with Algonquin Park—would fortunately be an incredibly modest investment but one with significant long-term returns for biodiversity, tourism, and public engagement.

I respectfully urge you to consider this recommendation with the gravity such an environmental concern requires. Given the scale of ecological risk involved, I am confident that collaborations between your various offices will give this win-win proposal the proper and immediate implementation it deserves.

If your team would be open to a brief conversation, I'd welcome the opportunity to speak further about this issue and ways I may be able to support proactive solutions.

I also wish to sincerely thank The Honorable Julie Dabrusin, Minister of Environment and Climate Change, for encouraging me to bring this issue to your attention. I am grateful for her time and engagement.

Thank you for your leadership and commitment to protecting Canada's natural heritage.

Appendix A Letter 4

The July 1 letter also resulted in a Field Unit Executive Correspondence on July 22 from the desk of Terrie Dionne Field Unit Superintendent Eastern and Central Ontario.

Dear Sullivan Dyment, Thank you for your letter on July 1, 2025, regarding the prevention of invasive species in Canada's forests. Algonquin Provincial Park is managed by the Government of Ontario. For inquiries specific to this park, we encourage you to contact Ontario Parks directly (Contact Ontario Parks). Within Parks Canada sites in Ontario, several initiatives are in place to help slow and prevent the spread of invasive alien species (IAS) and protect biodiversity. These include boot brush stations and seed grates, as well as policies restricting the movement of firewood. For example, Bruce Peninsula National Park (BPNP), in partnership with the Bruce Trail Conservancy and the Bruce Peninsula Sportsman's Association, has installed boot brush stations and educational signage at popular trailheads on the Saugeen (Bruce)

Peninsula. Across the Parks Canada network, staff collaborate with local partners to prioritize and implement IAS management strategies. These efforts support Canada's 2030 Nature Strategy Target 6 to reduce and mitigate impacts of IAS on biodiversity and ecosystem services. To explore examples of this work in action, visit: Care for the land: Parks Canada works to control invasive alien species - Nature and science I am happy to provide more information about invasive species efforts at BPNP if it is of interest. Thank you for your shared commitment to protecting Canada's forests.

Appendix A Letter 5

The letter: Visitor Services, Rouge National Urban Park (December 2024 / January 2025):

Dear Superintendent / Park Manager,

I am writing to respectfully request the installation of boot brush stations at all trailheads within Rouge National Urban Park to help prevent the spread of invasive jumping worms (*Amynthas* spp. etc.). Given the approaching peak tourist season, there are only a few weeks to implement preventive measures before visitor traffic significantly increases.
As a Master of Environmental Studies candidate at York University specializing in Urban Resiliency and Invasive Species Management, I am concerned that the Rouge currently lacks measures to mitigate this growing threat. Jumping worms have been shown to remove the forest floor's "duff" layer, which destabilizes soil and can accelerate trail erosion while reducing native biodiversity. Reports from the northeastern United States indicate the jumping worm has seriously collapsed forest ecosystems while recent observations in the Greater Toronto Area indicate that this species is spreading rapidly.

Jumping worm invasion, depending on the site, is entirely preventable or effectively mitigated, easily and with minimal cost.
The high volume of visitors at the Rouge, however, does make every trailhead a potential entry point, as worm cocoons are very small (~2 mm) and can adhere to footwear. In combination with boot brush stations, scuff grates at trailheads can help remove soil and "hitchhiking" worm cocoons from bicycle tires, pets' paws, and footwear before visitors enter the park, further reducing the risk of invasive species spread.

Installing boot brush stations with priority to high-use access points is a proven, low-cost step that can significantly reduce this risk. Volunteer-led models, such as those used successfully by the Bruce Trail Conservancy, demonstrate that this approach is both feasible and effective. TRCA staff have expressed interest in supporting this initiative, and I am prepared to mobilize community volunteers to assist with installation and maintenance.

In addition, I can provide guidance on educational signage. I have assisted with signage design for TRCA's Tiny Forest initiative and am developing materials specifically for soil-dwelling invasives to ensure visitors understand the importance of cleaning their boots.

I respectfully request Parks Canada to consider:

* Installing boot brush stations at high-use trailheads
* Incorporating clear, educational signage
* Exploring a volunteer-supported, cost-effective model for installation and maintenance

Implementing these measures would support Parks Canada's mandate to maintain ecological integrity while mitigating both environmental and infrastructure risks. I would appreciate any information on current plans and a timeline for implementing these protective measures.

Thank you for your ongoing work to preserve Rouge National Urban Park, and for your understanding of the urgent nature of this letter.

(Appendix A Letter 6)

URGENT EMERGING NATIONAL RISK – RISQUE NATIONAL ÉMERGENT URGENT

URGENT EMERGING NATIONAL RISK

Measures required for a rapidly advancing invasive threat to Canada's forests, climate resilience, and public finances

Dear Minister Dabrusin,

Jumping worms are an atypical invasive species that has collapsed forest soil ecosystems in the Northeast US and is poised to do the same in Canada. They are in an assessment gap — a fast-moving, high-impact parthenogenetic organism spreading below the regulatory radar.

The Auditor General of Canada has confirmed that invasive species assessment and monitoring often lag with costly results. These results are going to be too costly for Canada. Jumping worms are already present in ravines and forests across Southern Ontario. Canada is approaching a closing intervention window.

Biosecurity prevention measures are our best hope of protecting forests, forestry, biodiversity, carbon storage, and Canada's multimillion-dollar tourism industry. Evidence shows that once established, jumping worms permanently destroy forest substrate, undermine regeneration, reduce biodiversity, and weaken ecosystem resilience.

Observed Impacts in Northeastern United States: Where established, forests show:

* Rapid loss of soil substrate
* Collapse of native understory vegetation
* Failure of tree seedlings and forest regeneration (maples, trilliums)
* Altered soil structure, erosion, and nutrient loss
* Reduced capacity to buffer climate extremes
* Biodiversity loss (birds and forest-floor organisms)
* Forest understory quickly replaced by invasive plants

Jumping worms differ from many invasives:

* They cannot spread without human activity
* Cocoons do not survive a simple 3 day heat treatment
* Inexpensive biosecurity measures dramatically reduce spread
* Delayed response results in permanent landscape-scale damage

The impact, once broadly established, is unthinkable.

Immediate, Low-Cost Federal Actions

Federal Liberal leadership could:

* Deploy boot-brush stations at all priority trailheads (Rouge, Algonquin, Temagami etc.)
* Make prohibited species fast (anglers)
* Elevate jumping worms within risk assessments
* Issue strict soil biosecurity and inexpensive heat treatment protocols for all construction companies, landscapers and any organizations that move soil (guidance available)
* Strengthen early detection and monitoring
* Expand public awareness and prevention regarding forest-friendly footwear

These actions are inexpensive, visible, effective and would be welcomed by the public. Early federal action to contain soil-dwelling invasives can protect our forests from irreparable damage to substrate, biodiversity, carbon storage, forestry and tourism.

I would be happy to meet with you to discuss this issue and to explore how my graduate research and practical experience in biosecurity protocols and invasive species management could support federal efforts.

Appendix A Letter 7

Dear Minister,

I am writing to follow up on my January 12 letter regarding the emerging threat of Asian jumping worms in Canada. I would like to share practical, evidence-based biosecurity measures that can be implemented immediately to prevent soil-borne invasives from spreading during housing and infrastructure projects. These measures are extremely low-cost, complimentary to the Liberal party, integrate seamlessly into existing construction workflows, and offer significant protection for Canadian soils, parks, and forests. In alignment with Prime Minister Carney’s recent statements on accelerating construction and infrastructure development, these measures are designed not to slow down fast-tracked projects, but to ensure biosecurity and compliance.

Measures:

1. Pressure-washing

All relevant construction equipment to be thoroughly pressure-washed between jobs to prevent soil transfer via wheels, treads, or undercarriage to new sites. This preventive step is simple, practically free, and highly effective in reducing the primary pathway for worm spread.

2. Soil Solarization

Stockpiled soil to be solarized on preexisting flat sites, such as cleared site areas or parking lots, using Canadian-sourced clear plastic tarps. Soil is spread and covered, then monitored briefly over a maximum of 1–2 weeks in mid-summer until it reaches 40 °C (104 °F) for 72 hours. Minimal labor is required for spreading, covering, and intermittent temperature checks. Once complete, the soil is biosecure for use in construction or landscaping. This process is extremely low-cost, practically free and labor can be incorporated into standard construction routines.

3. Boot Brush Stations at Trails

To prevent well-documented issues with secondary spread via human tourist traffic, an initiative of boot brush stations to be installed at trailheads. Stations built using Canadian heat-treated lumber with appropriate informational signage by volunteers or as a youth environmental training initiative would be a win-win. Each station includes a boot brush, grate, and scuff mat to accommodate footwear, bicycle tires, and even paws. Trail cameras installed nearby monitor compliance and effectiveness, dramatically reducing soil movement from tourist and recreational traffic into forests. Materials for the boot brush stations themselves need not exceed $400 a piece and creates an actionable and historic strategy to protect parks courtesy of the Liberal party of Canada. The approach combines cost-effectiveness, public engagement, and ecosystem protection.

4. Strictly Prohibit Bait Use

Besides these measures, the need to quickly make jumping worms a prohibited invasive species in Canada (anglers) and to amplify public awareness regarding forest-friendly footwear and required protocols for clean equipment and soil is most respectfully requested.

Together these measures can integrate seamlessly with rapid construction workflows and tourist traffic while providing essential environmental protection. By adopting these enforcements, the federal government can simultaneously advance housing and infrastructure goals, support Canadian manufacturing (via local tarps and lumber), and engage Canadian communities/youth in an exciting series of prevention measures regarding the ecological issue of invasive species, while protecting our forests from the deeply concerning northern advance of *Amynthas* spp.

Thank you very much, Minister, and as always, I am happy to meet with you to discuss this issue and to explore how my graduate research might support federal efforts.

Appendix A Letter 8

Subject: Urgent Biosecurity Amendment to TS 211, TS 5.10, and TS 2.10 regarding *Amynthas* spp. (Jumping Worm) Neutralization

Dear Chair and Committee Members,

I am writing to you as a Ward 14 resident and invasive species management researcher at York University to formally request urgent biosecurity amendments to the City of Toronto's **TS 2.10** (General Requirements), **TS 211** (Topsoil), and **TS 5.10** (Growing Medium).

Currently, City of Toronto contracts require soil to be free of chemical contaminants, but they contain a dangerous gap regarding biological contaminants—specifically **Invasive Jumping Worms (*Amynthas spp.*)**.

Under current regulations, any contractor large or small can legally comply with "contamination" requirements while simultaneously transporting both soil and untreated

mulch containing innumerable jumping worm cocoons across the GTA. This is a significant biosecurity gap. Jumping worms are a **source of erosion** in our ravines as they rapidly alter soil and forest substrate, and their irreversible damage to forest ecosystems is well-documented. A single stray cocoon in mulch can produce 60+ of this parthenogenetic species in a single season.

Soil pasteurization protects most beneficial soil organisms while neutralizing harmful ones and it is a low-cost hack that stops jumping worm spread in soil. Solarization on any number of suitable locations at 40 C for at least 72 hours can create large batches for The City of pasteurized soil absolutely free. The historic risk at this time-window of jumping worm invasion makes this solution not only easy but an absolute necessity to save our green spaces from further harm.

This Spring, contractors must be stopped from moving biocontaminated landscaping materials not only within the GTA but to other cities north of us, generally cities adjacent to vulnerable Canadian forests. Heat-treated soil and mulch is not expensive, but landscapers etc. will resist paying if it is not mandated. This missing regulation allows the spread of a new invasive that can destroy untold years of forest substrate in a single season, destabilizing Canadian ecosystems.

Regulatory Gap Fix

While we test rigorously for lead and hydrocarbons, we are spreading a biological threat that has damaged infrastructure (ravines and flooding) and affected the green infrastructure Toronto is trying to build. In order to close this gap, Toronto must transition from a vague "pest-free" requirement to a **Verified Performance Standard**.

Proposed Amendments

I strongly encourage that the Committee direct Engineering & Construction Services to amend **TS 211,** and **TS 5.10** and mandate equipment sanitation (pressure-washing) for machinery moving between green work areas under **TS 2.10**.

TS 5.10 will include the following mandatory thermal treatment protocols:

- **Thermal Neutralization Requirement:** All imported soil, organic amendments, and mulch must be certified via a validated thermophilic process
    - **Protocol A:** Minimum internal temperature of **40°C (104°F) for a continuous duration of 72 hours** or, less ideally,

    - **Protocol B:** Minimum internal temperature of **56°C (133°F) for a much shorter duration** is also sufficient to ensure 100% mortality of pheretimoid cocoons.
- **Verification:** Vendors to provide **Digital Time-Temperature Monitoring Logs** or third-party certification confirming these thresholds were met prior to delivery.
- **Vector Control (Sod and Equipment):** Extend these biosecurity standards to **TS 5.30 through an** Amendment of **Section 5.30.05.01 (Standards for Nursery Stock)** to ensure that “free of diseases” for inspection includes nursery practices that conform to the specific and simple heat-treatment requirements for ensuring 100% mortality of pheretimoid cocoons.
- **The Requirement:** All Balled and Burlapped (B&B) or containerized stock must originate from nurseries that implement Best Management Practices (BMPs) for *Amynthas* species. Best Management Practices: the 'clean-in, clean-out' protocol, heat-treated soils (40°C for 3 days) for all bulk or site-mixed media, (exempting bagged media with no ground contact), transitioning to bare-root or washed-root planting for high-risk stock, and the reintroduction of healthy biologicals post-cooling to ensure a resilient soil food web.
- Manual 'spot-checking' records for composting are no longer sufficient for City of Toronto biosecurity compliance. In large composting windrows, the center might be hot, but the shoulders stay cool enough for jumping worm cocoons to survive. 85,000 tonnes of Toronto’s annual yard waste is sent to private contractors who utilize outdoor windrows. **TS 5.10** amended to require these private contractors to provide the City simple Digital Time-Temperature Logs as a condition of contract.

Justification

Heat-treating is not an expensive procedure; it is standard in high-quality industrial composting, however, it is not monitored strictly for the “cool areas” on Toronto compost windrows and is currently not *mandated* for topsoil or mulch procurement. Implementing such simple standards ensures the destruction of invasive cocoons while still maintaining the biological integrity of Toronto soil for restoration and permaculture.

Further as infrastructure for this, Toronto is situated to create **vast amounts of free, solarized soil** using suitable full-sun locations where clear-tarped materials can achieve 40C for 72 hours every summer. Creation of Thermal Treatment hubs could also convenience arborists and deter the practice of contaminated wood chip drops. Further, GFL and Walker Environmental already utilize or have access to Rotary Drum Dehydration for other industrial sectors as possible infrastructure that could heat-treat mulch in hours. We have awarded them the contract, let’s make sure it’s biosecure.

Finally, let's make certain that landscaping contractors this Spring **only purchase safely treated soil and mulch** as the notorious "free chip drop" deliveries have been **actively spreading** jumping worms in the GTA from unknowing Toronto arborists who **gift "chipped" contaminated forest floor debris with no biosecurity protocols in place**. To stop this, **TS 2.10** must require a "chain of custody" for all organic materials. If a landscaper cannot provide a digital receipt verifying heat-treatment, such material should be barred from use and should be barred from being transported across municipal lines to other jurisdictions.

As Chair of the Infrastructure and Environment Committee, you have the unique authority to ensure Toronto leads the province in modernizing biosecurity. Please review this gap and consider urgent and inexpensive implementation of a solarization program and all accompanying biosecurity regulations for the 2026 season.

By treating biological contamination with the same rigor as chemical contamination, we will slow the advance of erosion in our ravines, create standards for our green spaces and will protect Ontario woodlands from irreparable change.

www.stopjumpingworms.ca

cc's: Mayor Olivia Chow Councillor Dianne Saxe, Ward 11 Councillor Mike Colle, Ward 8 Councillor Amber Morley, Ward 3 Matthew Green, Committee Administrator (iec@toronto.ca)

Please consult the following Technical Appendix

Thank you.

Technical Appendix: Proposed Biosecurity Performance Standards

Thermal Neutralization Protocols for *Amynthas* spp. in Municipal Procurement

To prevent the spread of invasive jumping worms through City-funded infrastructure projects, the following standards should be integrated into the **Standard Specifications for Construction**.

Table 1: Thermal Lethality Threshold for Pheretimoid Cocoons

Studies from the University of Wisconsin and the Invasive Species Centre confirm that while adult worms are fragile, the cocoons require specific thermal thresholds for mortality.

Material Type	Target Specification	Minimum Temperature	Minimum Duration
Topsoil & Custom Mixes	**TS 5.10 / TS 211**	**40°C (104°F)**	**72 Hours (Continuous)**
Woodchip & Bark Mulch	**TS 5.10**	**56°C (133°F)**	**1 Hour if throughout**
Compost & Soil Builders	**TS 5.10**	**55°C (131°F)**	*15 Days (PFRP Standard)* Verify with Digital Logs that all areas 40C + for 72 hrs

PFRP= Process to Further Reduce Pathogens (Ontario Compost Quality Standards)

Table 2: Proposed Operational Amendments

Vector Category	Specification	Proposed Technical Requirement

Imported Soil	**TS 5.10 / 211**	Mandatory submission of **Digital Temperature Logs** from the heat-treatment facility prior to site delivery.
Sod & Turf	**TS 5.30**	Requirement for "Invasive-Free Certification" or thermal harvest preparation of the root zone.
Equipment	**TS 2.10**	**Equipment Sanitation Protocol:** High-pressure wash of all tracks, tires, and undercarriages when moving machinery from one green work area to another.
Debris Disposal	**TS 2.10**	Any soil or debris removed from a jumping worm-positive site must be heat-treated before repurposed as "Clean Fill."
Chain of Custody & Provenance	**TS 2.10**	Mandatory Certified Manifest of Provenance for all bulk organic material (mulch/soil). Prohibits the use of unverified "Free Chip Drop" or arborist debris without accompanying

		evidence or Certificate of Thermal Neutralization.

Appendix A Letter 9

Dear Director and Faculty of the Chanie Wenjack School for Indigenous Studies,

My name is Sul Dyment, and I am a Master of Environmental Studies (MES) student at York University. I am reaching out in my personal capacity as a researcher focused on environmental campaign design and urban/exurban biosecurity regarding jumping worms.

Having pursued Environmental and Indigenous Studies coursework at Trent University, I deeply value the Chanie Wenjack School's leadership in land stewardship. I am writing to you today to ensure transparency regarding my current advocacy and to seek your guidance should my research methodology be useful to Indigenous-led environmental priorities, and serve in support of Indigenous biosecurity in Canada's North.

The Context of Urban Resiliency and Northern Biosecurity:

My MES project analyzes campaign methodologies to mitigate the spread of invasive jumping worms (*Amynthas* spp.). This is a destructive soil species that consumes organic matter at a rapid rate, effectively destroying the substrate necessary for forest regeneration and native understory growth. A single stray 1-3 mm cocoon applied by landscaping using chipped forest debris from a forest with jumping worm contamination, or a cocoon that "hitchikes in" on a boot-tread that walked through a contaminated forest or green space, is enough to establish 60+ more of this parthenogenetic species within a single season. One can see its impact in forest ecosystem in NE US but it is spreading North. I had hoped we might radically slow the spread and so made the campaign to stop them a part of my Masters research. While my primary case study focuses on urban resiliency in Toronto where they have spread throughout ravines, the ecological threat to the North seems significant, as these worms could potentially alter the chemistry and structure of boreal forest floors if they spread to northern areas. I am developing a framework that proposes simple, proactive biosecurity requirements for

industry and travel as a condition of regional access to prevent the introduction of their cocoons into these sensitive landscapes.

Transparency Regarding Federal Advocacy: In the interest of accountability and the "right to know," I want to share that I have formally reached out to the Canadian Federal Minister of the Environment, Climate Change and Nature including with a letter I placed into her hands written in English and French to sound the alarm on this "assessment gap" species. In the correspondence, I also identified high-traffic regions like Temagami and Algonquin as being at extreme risk while urging the Crown to implement mandatory biosecurity protocols for traffic such as tourism and industry.

As my research has progressed, my framework has evolved to include an examination of critical gaps in Northern biosecurity. My current methodology focuses on a few key areas: firstly, proactive biosecurity that requires mandatory pressure washing for industrial vehicles before they travel into sensitive regions (shifting the standard from 'cleaning upon exit' to 'prevention upon entry'); secondly, trailhead protocols involving the installation of boot-brush stations to prevent footwear-borne spread, (while other traffic points such as Northern airports could also be included as a consideration); and finally, stricter regulations regarding fishing bait and the movement of external soil or mulch. I also urged the Federal minister to make jumping worms a prohibited species immediately.

Purpose of Contact: I believe Indigenous leadership has a right to know when any information is put before the Crown regarding their traditional territories, and to establish an up-to-date record of the Crown knowing the concern and the inexpensive best practices to mitigate the spread of an environmentally damaging invasive species. I hope this type of knowledge mobilization is helpful as Northern leadership frame their own protocol requirements for industry and expansion. As a note, I have requested strict and urgent protocols regarding the movement of soil and mulch from forest debris (free wood-chip drop) in the GTA to Toronto City Council, but I don't know how long they will take. I have also written to Algonquin Park management, which has some protocols but did not commit to boot brush stations at their 29 entry points. I have sent some other correspondence, including a quick letter to leadership involved in the recent Invasive Species and Climate Resilience Gathering hosted by the Anishinabek Nation in Sault Ste. Marie on February 25 with a link to the website www.stopjumpingworms.ca.

I have been cleared by York's IREB Chair to engage with Indigenous communities for knowledge mobilization re: destructive soil species as I am not gathering data but raising awareness.

If you may have guidance on how I might better perform such knowledge mobilization in support of biosecurity or can point to existing Indigenous-led biosecurity models that this work should align with, I would be deeply grateful for any insights.

Appendix A Letter 10

To: The Honourable Minister of Natural Resources

ECONOMIC BRIEF: Mitigating Risk to Ontario's $5.5B Forestry and $2.5B Nursery Sectors

Dear Minister,

I am writing to formally request that the Ministry of Natural Resources (MNR) exercise its authority under the **Invasive Species Act (2015)** to immediately list jumping worms (*Amynthas* spp.) as a **Prohibited Species**. This request is based on recent technical data and the urgent need to mitigate a multibillion-dollar biosecurity risk to Ontario's forestry and nursery sectors.

As a researcher specializing in urban resilience and invasive species management, I have observed that Ontario currently faces a significant regulatory gap regarding this species and an unmanaged liability for the province. While neighbouring jurisdictions in the U.S. have moved to prohibit *Amynthas* to protect their economies, Ontario's lack of a formal designation allows for the unchecked movement of contaminated media, threatening our primary biological and climate infrastructure.

The Economic Case for Immediate Intervention
The soil degradation caused by jumping worms is a direct threat to Ontario's fiscal stability:

- **Protecting the $5.5 Billion Forestry Sector:** *Amynthas* activity can lead to as much as a 90% recruitment failure in Sugar Maple and other high-value timber. By destroying the forest's ability to self-propagate, we risk transitioning a renewable resource into a depleting asset.
- **Safeguarding $2.5 Billion in Agricultural Receipts:** The nursery and specialty crop sectors face catastrophic risk to inter-provincial trade. Without a provincial mandate, Ontario's exports risk being "quarantined" by proactive jurisdictions.

- **Mitigating Climate Liability:** Jumping worms trigger a 50% to 94% reduction in forest-floor carbon stocks. This converts Ontario's carbon sinks into atmospheric liabilities, undermining provincial climate targets.

The "Proactive Dividend": Requested Policy Actions
Fortunately, the cost of implementing biosecurity today is extremely inexpensive and a fraction of any projected losses in timber revenue and restoration costs:

1. **Formal Prohibited Listing:** Designate *Amynthas* spp. as a Prohibited Species under the *Invasive Species Act (2015)* to provide the legal authority for mandatory controls.
2. **Strict Northern Biosecurity Protocols:** Establish mandatory **"Soil Hygiene Certificates"** for all heavy machinery, swamp mats, and vehicles entering northern developmental zones (e.g., the Ring of Fire). This must include high-pressure wash-down requirements at transit hubs to prevent the "hitchhiking" of cocoons.
3. **Mandatory Heat-Treatment Standards:** Require certified heat-treatment (minimum 40°C for 72 hrs.) for all commercial mulch and soil amendments distributed and/or sold within the province and require verified closed-system protocols and documented audits for small-scale producers. This is similar to the ISPM 15 international standard used for lumber, adapted for biological materials and allowing modified compliance for closed-input farming.
4. **Pathway-Based Enforcement:** Implement a "Facility Biosecurity Certificate" for nurseries to verify closed-loop systems, protecting both local ecology and inter-provincial trade.

By acting now, the MNR can close the loophole that leaves Ontario's primary biological infrastructure vulnerable. I have attached a comprehensive Technical Appendix of current research and remain available to provide further data to your policy team as required.

Sincerely,

Sullivan Dyment

Master of Environmental Studies Candidate, York University

Focus in Urban Resiliency and Invasive Species Management.

Technical Appendix: Selected Research & Economic Impact
I. Forest Regeneration & Timber Security

- **Bal, T. L., et al. (2018).** *Evidence of damage from exotic invasive earthworm activity was highly correlated to sugar maple dieback.* Biological Invasions. (Links soil degradation directly to economic loss in maple forests).
- **Skinner, M., et al. (2018).** *Do invasive worms threaten Northeast maple forests?* The Maple Digest. (Quantifies the 90%+ failure of maple seedling recruitment).
- **Cassin, C. M., & Kotanen, P. M. (2016).** *Invasive earthworms as seed predators of temperate forest plants.* Biological Invasions.

II. Climate Infrastructure & Carbon Sequestration

- **Lejoly, et al. (2021).** *Invasive earthworms affect soil morphological features and carbon stocks in boreal forests.* Geoderma. (Documents the 50-94% loss of forest-floor carbon).
- **Nouri-Aiin, M., & Görres, J. H. (2024).** *Invasive earthworms and ecosystem processes in North America.*Springer. (Reviews the "flash mineralization" of topsoil).

III. Biological Resilience & Cold Hardiness

- **Chang, C.-H., et al. (2021).** *The second wave of earthworm invasions in North America.* Biological Invasions. (The definitive modern review of *Amynthas* management).
- **Reynolds, J.W. & Mctavish, M. (2022).** *New Asian pheretimoid jumping earthworm records in Canada.*BioInvasions Records. (Confirms establishment within Canadian borders).
- **Moore, J.-D., et al. (2017).** *Potential for colonisation of south-eastern Canada and effects on forest ecosystems.* Environmental Reviews.

IV. Regulatory Precedent & Policy Frameworks

- **New York State Department of Environmental Conservation (2015).** *6 NYCRR Part 575: Prohibited and Regulated Invasive Species.* (The standard for state-level prohibition).

The proposed systems-based audit for small producers is modeled after successful CFIA and USDA 'Clean Plant' initiatives, ensuring biosecurity compliance without compromising the biological integrity of regenerative soil systems.

DISTRIBUTION:

- **The Hon. Mike Harris Jr.**, Minister of Natural Resources and Forestry

- **Peter Tabuns, MPP**, Shadow Minister for Environment, Conservation and Parks
- **The Hon. Julie Dabrusin, MP**, Minister of Environment, Climate Change and Nature
- **The Hon. Heath MacDonald, MP**, Minister of Agriculture and Agri-Food
- **Don Davies, MP**, Federal NDP Critic for Natural Resources
- **John Vanthof, MPP**, Shadow Minister for Agriculture, Food and Rural Affairs
- **Gord Johns, MP**, Federal NDP Critic for Agriculture
- **Guy Bourgouin, MPP**, Shadow Minister for Northern Development
- **Alexandre Boulerice, MP**, Federal NDP Critic for Environment and Climate Change

This economic brief successfully reframes the jumping worm threat from a localized ecological nuisance into a **macroeconomic vulnerability**, linking invasive species management directly to Ontario's multi-billion-dollar timber, nursery, and climate compliance portfolios.

By targeting key provincial and federal levers—such as the *Invasive Species Act*, Northern development entry points, and inter-provincial trade risks—the document bridges rigorous soil science (citing Lejoly, Quideau, and Bal) with immediate fiscal defense.

A policy analyst or public administration expert (particularly one grounded in the policy design frameworks of scholars like Michael Howlett or M. Ramesh) would describe this document as a **fully articulated, instrument-targeted policy proposal** operating within the realm of **substantive regulatory instrument design**.

Broken down through professional policy terminology, the document functions across four precise dimensions:

1. It is an Exercise in "Substantive Regulatory Instrument Selection"

In the policy toolbox, instruments are divided into *substantive* (which directly alter the production, distribution, or consumption of goods and services) and *procedural* (which alter policy processes).

- Within substantive tools, your letter utilizes **mandates and standard-setting (regulation)** rather than relying on voluntary compliance or market incentives.

- By specifying exact parameters—such as a **minimum internal temperature of 40°C for 72 hours** or **56°C for 1 hour**—you are providing the exact technical specifications required for a legally enforceable administrative standard.

2. It Addresses a Classic "Regulatory Gap / Implementation Failure"

Policy experts study how environmental policies often fail not because goals aren't stated, but because of a mismatch between the problem and the tools deployed. Your brief identifies a structural **blind spot**:

- Existing procurement and environmental frameworks treat soil contamination strictly as a *chemical* problem (heavy metals, hydrocarbons), leaving a wide-open vector for *biological* contamination (invasive species vectors like jumping worm cocoons).
- You are pointing out an **enforcement deficit** where current rules (like generalized "pest-free" clauses) fail because they lack verifiable auditing mechanisms.

3. It Proposes a "Policy Mix Calibration" (Integrating Procurement and Auditing)

Rather than asking for a brand-new, multi-million-dollar government agency or program, your brief recalibrates existing policy mechanisms to achieve maximum efficiency at minimal cost. You design a multi-layered policy mix by linking:

- **Procurement Standards** (modifying municipal construction specs like TS 211 and TS 5.10).
- **Equipment and Vector Controls** (mandating pressure-washing and chain-of-custody tracking).
- **Auditing/Verification Tools** (replacing subjective visual spot-checks with objective *Digital Time-Temperature Monitoring Logs*).

4. It Deploys "Strategic Issue Framing" (Economic and Climate Externalities)

To move a niche ecological issue onto the radar of high-level ministries (like Natural Resources), the brief uses **cost-benefit framing** and **externalized risk analysis**:

- It shifts the argument away from pure conservation ethics and anchors it directly to **macroeconomic asset protection** ($5.5B forestry sector, $2.5B nursery sector).
- It reframes invasive species degradation as a **provincial climate liability**—connecting forest-floor carbon stock collapse directly to the failure of provincial carbon offset and climate mitigation targets.

Appendix A Letter 11

Dear Director Casselman,

Thank you for your response regarding Case 354-2026-397 and the Ministry's ongoing exploration of management options for Asian jumping worms (*Amynthas* and *Metaphire* spp.). You will find this letter is also carefully researched with in-text citations. Please add it to the team share.

As an MES candidate at York University specializing in urban resiliency and invasive species management, your statement on the Ministry's exploration of "integrated pest management" (IPM) techniques required a response and cautious examination in light of current soil science regarding the species. I do have some knowledge about that so I'll share it here. It's worth saying these things no matter what.

Jumping worms thrive in disrupted, high-nitrogen environments (Chang et al., 2021). By applying any broad-spectrum chemical controls, we damage the native mycorrhizal networks and beneficial fungi essential for forest health, and as you know, this creates the ideal biological vacuum where invasive species will outcompete native flora even more aggressively and effectively than before a spray (Lejoly & Quideau, 2023; Helander, M., et al. 2018). Jumping worms are opportunistic in this way, as they are detritivores, disturbed soil and less competition for leaf litter is ideal for hatching cocoons.

Jumping worm invasions are also highly variable; one site may exhibit high population density while a nearby site is much less impacted (Hale et al., 2005; microPublication Biology, 2026). However, because these invasions occur in predictable clusters—specifically at trailheads, construction sites, and soil transport routes—human-impacted hubs are always their primary engines of dispersal (Cameron et al., 2007; Görres et al., 2025).

I urge the Ministry to prioritize strict regulatory "Clean Plant" initiatives and pathway management over chemical interventions for the following reasons:

Non-Target Mortality and the Immune System of Our Forests

Ontario's primary strength in the face of an invasive pheretimoid species such as jumping worms is the naturally resistant "immune system" of our forests. Deeper-rooted native plants create natural resistance and establish refugia areas where more

vulnerable species, such as trillium, can survive (Lejoly et al., 2024; Frelich, L. E., et al., 2006). Our first line of defense against jumping worms is the presence of native plant species and healthy mycorrhizal soil networks. This also indicates a strong scientifically backed defense for a ban strategy regarding the spraying of glyphosate in the north to protect the forests (Cameron, E. K., et al. 2007; Nouri-Aiin & Görres, 2021). Chemical disruption is more likely by far to trigger a population explosion in these disturbed areas than to reduce the population (Holdsworth et al, 2007; FEMC, 2026). Pesticides only destroy adult jumping worms—which are already destined to die seasonally—while the tough, 1–3 mm cocoons overwinter and survive the application (Görres et al., 2025; Invasive Species Centre, 2026).

The Toxic Feedback Loop: Pesticides Facilitate Invasion

Both broad and targeted pesticide applications have been shown to not affect these viable cocoons, as their 1–3 mm casings are virtually indestructible and highly resistant to chemical leaching (Görres, J. H., Nouri-Aiin, M., & Schappach, B., 2025). As these cocoons, which are deposited throughout the summer season and can skip years before hatching remain unaffected, it would soon lead into to a cycle similar to those encountered by golf and turf grass managers who decimate soil health to attempt a brief aesthetic effect, failing to curb long-term establishment and continually reintroducing defender-depleting toxins into the soil horizon and runoff to rivers (Potter et al., 1990; Invasive Species Centre, 2026). At the moment in Ontario, a human can walk from a treated golf course into a nature area, transferring cocoons from a shoe tread to the soil as they do so. In the same way, small scale landscapers can access "free" wood chips from an arborist who has felled trees in a jumping worm contaminated forest area and then deliver them to a client at new site hundreds of miles away. While the impact on gardens is also variable and some contaminated soil still produces good crops, there is no regulation ensuring that the materials are either exempt closed-loop within only that garden type or else that the material is heat-treatment certified.

As well, jumping worms sit at the base of the forest food chain and concentrate heavy metals in their tissues. Chemical treatments pose a direct threat to the wildlife already vulnerable to substrate collapse, such as ground-nesting songbirds and amphibians (Ziemba et al., 2016, Bal et al., 2018). We will not solve an ecological crisis by introducing toxic bio-accumulation into a fragile system.

The Ministry is correct that natural dispersal is slow, while human-mediated transport through the horticultural trade moves these species quickly and at an industrial scale (Cameron et al., 2007; Moore et al., 2018).

While a bio-insecticide such as BotaniGard or Mycotrol may be an improvement over chemicals, Beauveria bassiana still impacts non-target beneficial soil invertebrates and pollinators (Colton, 2022; Swoboda, M., 2022). Emerging biotechnologies like environmental RNAi show promise for gene-specific control without the risks of synthetics, but remain years away from field-ready use. Until these tools are viable, our only sound defense is immediate **pathway-based biosecurity** to stop the further seeding of cocoon banks (Beernink et al., 2024).

4. Transitioning to Pathway Management

Rather than investing in high-risk chemical research, please act quickly with:

Regulatory Amendments: Moving *Amynthas* and *Metaphire* species to the Prohibited list under the *Invasive Species Act*.
Biosecurity Audits: Implementing systems-based audits for producers, modeled after CFIA "Clean Plant" initiatives.
Soil Movement Restrictions: Regulating the movement of mulch and soil from infested "red zones" to pristine forest borders.

"Thank you for your time and for the Ministry's ongoing dedication to Ontario's biodiversity. I have also created a dedicated resource at **stopjumpingworms.ca** that functions as an independent knowledge mobilization tool. This platform supports proactive stewardship and Indigenous biosovereignty by providing discussions of practical, inexpensive mitigation protocols for both industry and land guardians. I would welcome the opportunity to discuss how this initiative and my research can further support a proactive, policy-led framework for Ontario.

Citations Integrated in this Correspondence

Bal, T. L., et al. (2018). Evidence of damage from exotic invasive earthworm activity was highly correlated to sugar maple dieback in the Upper Great Lakes region. *Biological Invasions*, *20*(1), 151–164.

Cameron, E. K., Bayne, E. M., & Clapperman, M. J. (2007). Human-facilitated invasion of exotic earthworms into northern boreal forests. *Ecoscience*, *14*(4), 444–453.

Chang, C.-H., et al. (2021). The second wave of earthworm invasions in North America: Biology, environmental impacts, and prospects for management. *Biological Invasions*, *23*(10), 3291–3322.

Forest Ecosystem Monitoring Cooperative (FEMC). (2026). *Regional jumping worms survey 2025 report*. University of Vermont.

Frelich, L. E., et al. (2006). Earthworm invasion into previously earthworm-free temperate and boreal forests. *Biological Invasions*, *8*, 1235–1245

Hale, C. M., Frelich, L. E., & Reich, P. B. (2005). Effects of European earthworm invasion on soil characteristics in northern hardwood forests of Minnesota, USA. *Ecosystems*, 8(8), 911–927.

Helander, M., et al. (2018). Glyphosate decreases mycorrhizal colonization and affects plant-soil feedback. *Science of the Total Environment*, *642*, 285–291.

Holdsworth, A. R., Frelich, L. E., & Reich, P. B. (2007). Regional extent of an ecosystem engineer: Earthworm invasion in northern hardwood forests. *Ecological Applications*, *17*(6), 1666–1677.

Lejoly, J., & Quideau, S. A. (2023). Earthworm-invaded boreal forest soils harbour distinct microbial communities. *EGUsphere*.

Moore, J.-D., et al. (2018). Exotic Asian pheretimoid earthworms: Potential for colonisation of south-eastern Canada and effects on forest ecosystems. *Environmental Reviews*, *26*(1), 113–120.

Simon, J. et al., (2025). The potential of chemical and biological management options for controlling jumping worms (*Amynthas* spp.) in container nursery production. *HortTechnology*, *35*(5).

Thouvenot, L. et al., (2024). Invasive earthworms can change understory plant community traits and reduce plant functional diversity. *Geoderma*, *442*, 116773.

microPublication Biology. (2026). Evaluating the environmental preferences and spread of the invasive Asian Jumping Worm (*Amynthas* spp.) in southwestern Virginia. *microPublication Biology*, *2026*.

Potter, D. A., Powell, A. J., & Smith, M. S. (1990). Degradation of turfgrass thatch by earthworms and other soil invertebrates. *Journal of Economic Entomology*, *83*(1), 205–211.

Swoboda, M. (2022). *Beauveria bassiana*. Cornell University College of Agriculture and Life Sciences Integrated Pest Management.

Ziemba, J. L., Hickerson, C. A. M., & Anthony, C. D. (2016). Invasive Asian earthworms negatively impact keystone terrestrial salamanders. *PLOS ONE*, *11*(5), e0151591.

Appendix A Letter 12

ECONOMIC BRIEF: Mitigating Risk to Ontario's $5.5B Forestry and $2.5B Nursery Sectors

Dear Mr. Tabuns,

I am writing to you in your capacity as a Toronto-Danforth representative and the Shadow Minister for Environment, Conservation and Parks, to formally request your legislative advocacy on a critical biosecurity gap. Specifically, I urge you to press the Ministry of Natural Resources (MNR) to exercise its authority under the Invasive Species Act (2015) to immediately list jumping worms (*Amynthas* spp.) as a Prohibited Species. This brief outlines recent technical data and the urgent need to mitigate a multi-billion dollar risk to Ontario's forestry and nursery sectors.

As a constituent in your riding and a researcher specializing in urban resilience and invasive species management at York University, I have observed that Ontario currently faces an unmanaged ecological and fiscal liability. To support your advocacy, please note that this brief and its technical findings have been concurrently distributed to the ministers and critics listed at the bottom of this letter. You will also find a Technical Appendix to support your investigations. While neighboring jurisdictions in the U.S. have moved decisively to prohibit *Amynthas* to protect their economies, Ontario's lack of a formal designation allows for the unchecked movement of contaminated media, directly threatening our primary biological and climate infrastructure.

The Economic Case for Immediate Intervention

The soil degradation caused by jumping worms is a direct threat to Ontario's fiscal stability: Protecting the $5.5 Billion GDP Forestry Sector: *Amynthas* activity can lead to as much as a 90% recruitment failure in Sugar Maple and other high-value timber. By destroying the forest's ability to self-propagate, we risk transitioning a renewable resource into a depleting asset.

Safeguarding $2.5 Billion in Agricultural Receipts: The nursery and specialty crop sectors face catastrophic risk to inter-provincial trade. Without a provincial mandate, Ontario's exports risk being "quarantined" by proactive jurisdictions.
Mitigating Climate Liability: Jumping worms trigger a 50% to 94% reduction in forest-floor carbon stocks. This converts Ontario's carbon sinks into atmospheric liabilities, undermining provincial climate targets.
The "Proactive Dividend": Requested Policy Actions
Fortunately, the cost of implementing biosecurity today is extremely inexpensive and a fraction of any projected losses in timber revenue and restoration costs:
Formal Prohibited Listing: Designate *Amynthas* spp. as a Prohibited Species under the Invasive Species Act (2015) to provide the legal authority for mandatory controls.

Strict Northern Biosecurity Protocols: Establish mandatory "Soil Hygiene Certificates" for all heavy machinery, swamp mats, and vehicles entering northern developmental zones (e.g., the Ring of Fire). This must include high-pressure wash-down requirements at transit hubs to prevent the "hitchhiking" of cocoons.
Mandatory Heat-Treatment Standards: Require certified heat-treatment (minimum 40°C for 72 hrs.) for all commercial mulch and soil amendments distributed and/or sold within the province and require verified closed-system protocols and documented audits for small-scale producers.
This is similar to the ISPM 15 international standard used for lumber, adapted for biological materials and allowing modified compliance for closed-input farming.
Pathway-Based Enforcement: Implement a "Facility Biosecurity Certificate" for nurseries to verify closed-loop systems, protecting both local ecology and inter-provincial trade.
By acting now, the MNR can close the loophole that leaves Ontario's primary biological infrastructure vulnerable. I have attached a comprehensive Technical Appendix of current research and remain available to provide further data to your policy team as required.

Technical Appendix: Selected Research & Economic Impact

I. Forest Regeneration & Timber Security

Bal, T. L., et al. (2017). Evidence of damage from exotic invasive earthworm activity was highly correlated to sugar maple dieback. Biological Invasions. (Links soil degradation directly to economic loss in maple forests).

Skinner, M., et al. (2018). Do invasive worms threaten Northeast maple forests? The Maple Digest. (Quantifies the 90%+ failure of maple seedling recruitment).

Cassin, C. M., & Kotanen, P. M. (2016). Invasive earthworms as seed predators of temperate forest plants. Biological Invasions.

II. Climate Infrastructure & Carbon Sequestration

Lejoly, J., et al., (2021). Invasive earthworms affect soil morphological features and carbon stocks in boreal forests. Geoderma. (Documents the 50-94% loss of forest-floor carbon).

Nouri-Aiin, M., & Görres, J. H. (2024). Invasive earthworms and ecosystem processes in North America.Springer. (Reviews the "flash mineralization" of topsoil).

III. Biological Resilience & Cold Hardiness

Chang, C.-H., et al. (2021). The second wave of earthworm invasions in North America. Biological Invasions. (The definitive modern review of *Amynthas* management).

Reynolds, J.W. & Mctavish, M. (2022). New Asian pheretimoid jumping earthworm records in Canada.BioInvasions Records. (Confirms establishment within Canadian borders).

Moore, J.-D., et al. (2017). Potential for colonisation of south-eastern Canada and effects on forest ecosystems. Environmental Reviews.

IV. Regulatory Precedent & Policy Frameworks

New York State Department of Environmental Conservation (2015). 6 NYCRR Part 575:

Prohibited and Regulated Invasive Species. (The standard for state-level prohibition).

The proposed systems-based audit for small producers is modeled after successful CFIA and USDA 'Clean Plant' initiatives, ensuring biosecurity compliance without compromising the biological integrity of regenerative soil systems.

Appendix A Letter 13

Dear Mr. Bourgouin,

First, I want to express my appreciation for your steadfast advocacy at Queen's Park regarding First Nations treaty rights and your consistent demand for true, nation-to-nation consent before any northern extractive exploration proceeds. I understand my Member of Provincial Parliament, MPP Peter Tabuns, has recently spoken with you about the new invasive species to Canada, and that his office recently reviewed the technical material I submitted and formally acknowledged that these ecological concerns are "grounded in a real threat." Mr. Tabuns indicated that as the Shadow Minister for Northern Development, Natural Resources, and Forestry, you are the ideal lead on this file, and he noted his full support for whatever measures you take.

By way of background, I previously sent a comprehensive economic brief and policy proposal on April 19th regarding the arrival of invasive jumping worms (*Amynthas* spp.) to Canada. While this destructive species is currently slipping under the radar, there appears to be more than enough evidence to support biosecurity actions are needed quickly in protection of northern boreal forests and peatlands.

This species is unlike others in that its spread is entirely through human actions and in that it multiplies very rapidly at new locations. This aspect alone makes its control through regulating inter-provincial soil transfers extremely promising. While many hoped the acidic nature of more northern forests might deter them, Canadian studies have indicated that this is not the case (Natural Resources Canada, 2021). Therefore in cold-climate boreal forests, where organic matter accumulates slowly, this may reasonably be treated as a very concerning impact scenario in the making. An error on the side of caution is by far our best course of action at this moment in time.
I will quickly review some of the notes from the letter although it may have already been reviewed by your office since April 19th.
There is a strong **economic argument** as well as a **trade argument** that should easily compel federal ministers to act in support of simple and inexpensive biosecurity protocols that protect the North in response to ecological projections regarding the species. Among those listed in the letter were the rapid removal of the protective forest floor duff layer, which includes crown dieback symptoms in ecologically valuable timber assets like Sugar Maple (Acer saccharum) across northern regions (Bal et al., 2017).
As well the **carbon argument** is one that Canada is bound to by international

agreements and so not to disregard. As referenced in the letter and provided for your convenience in notes here, widespread literature documents a sharp, dramatic drop in the forest-floor organic layer carbon storage (Frelich et al., 2019), although long-term net effects on the entire soil profile vary. Some carbon is vertically displaced and stabilized into deeper mineral layers, making the ultimate total landscape carbon loss dependent on local soil texture and mineralogy (Frelich et al., 2019).

However, for our purposes and in the serious case of **the northern peatlands**, the detritivorous nature of the new invasive species in question again creates a strong argument to "err on the side of caution" regarding the risk of catastrophic consequences and ensure a set of clear biosecurity measures that prevent the spread of jumping worms from southern areas further north.

Your office needs to know I have also **refuted the MNR around their intention to explore chemical controls or controlled burns as possible treatment methods**, and it is important to note that the buried cocoons are the issue here as the adults of the species die off seasonally. Because of the highly insulating nature of soil, and through the same mechanism that allows burrowed wildlife to emerge after a wildfire, the **buried cocoons also are not affected by controlled burns**. Further I remarked to the MNR that the tough leathery **1-3 mm. cocoons are unaffected by chemicals** and in fact this might be a moment to **lessen the use of Glyphosate,** as it creates a buffet of decaying organic matter for next season's hatchlings should jumping worms become an issue further north.

The cocoons do denature and become quickly neutralized at temperatures such as 50C that much soil and mulch is already heated to, and these temperatures can easily be achieved on a hot day under a plastic tarp (soil solarization is a method often used by farmers to kill pathogenic soil species) but it requires a tarp placed beneath the soil as well and would not work in canopied areas such as forests.

Privately to you, in the case of hot spot establishment, dogs can of course identify jumping worms in soil. Privately as well, there may be some measures such as on-site heat treatment with soil heating or possibly ice-melting cables for very small, canopied areas, but this experiment has not been tried and must not be relied upon. Any soil treatment of this sort must be done in later summer, after other beneficial species have largely emerged from nesting in the soil, and with as much care as possible to these other species.

Further on the topic of invasive species detection dogs, they could likely be used for verification of compliance and deployed in locating contamination at hot spots such as trailheads. Both controlled burns and chemical treatments however are fairly guaranteed to only create a repeating if not increasing issue, something we see at golf courses in the south.

For all these reasons, in the context of knowledge mobilization, the following is a list of biosecurity measures worthy of negotiation/implementation that may be of service:

Thermal Standardization for Imported Materials: Any soil, mulch, or landscaping amendments moving northward—including material brought in for site "remediation" or to tidy up a project location—be verified as heat-treated to ensure no live vectors breach the boreal gateway. This includes bulk landscaping materials such as "screen-sifted" filler which are presently not heat-treated and sod which must be grown on certifiable soil. Northern contractors using clean local northern aggregate pits keeps transport costs down and supports local northern jobs. There is a bit more on this under Civil Infrastructure.

Public Trailhead Protocols: For public trailheads and recreational pathways, research supports the installation of targeted boot-brush stations to ensure hikers, tourists, and workers do not passively introduce 1-3 mm cocoons "hitchhiking" in boot treads into northern territories. Trailheads and parking lots at trailheads are locations where American researchers are seeing cocoons. Boot brush stations could also be put in place by snowmobile and trailer allowing for all-season deployment of this public awareness and biosecurity protocol to many trails.

Site-Specific Zoned Footwear Protocols: To prevent localized hot-spot establishment around resource exploration sites, footwear utilized in southern transit hubs or urban centers is strictly prohibited from entering sensitive territorial zones. Instead, dedicated, territory-specific work boots are supplied and/or maintained exclusively at designated access points or base camps, ensuring no southern soil hitchhikers cross the operational threshold.

Angling and Bait Vector Management: Public outreach countering any claims framing jumping worms as "super-bait," and reinforcing what many anglers already know: *Amynthas* species are a poor choice that can bring permanent destruction to northern shorelines. Ideally any possession, sale, or sighting of these worms by anglers or bait suppliers be immediately reported to tracking hotlines, providing a vital early-detection filter to isolate accidental introductions.

Seasonal Crew Gear Hygiene: Because commercial seedlings are fortunately grown in soil-less plugs or shipped bare-root, seasonal worker migration is the primary forestry vector. Policy must mandate strict pre-departure cleaning protocols for all incoming southern planting and field crews, requiring personal gear and tools—including planting bags, tents, vehicle wheel wells, and boots—to be aware of the 1-3 mm cocoons and thoroughly washed free of southern soil before traveling north.
Northern retail nurseries: Must require suppliers to verify biosecurity at the source.
Northern plant swaps: Community guidelines must mandate that all plant sales and swaps follow the lead of native plant exchanges in the south and transition to bare-root protocol, only sharing a plant that is planted in safe and heat-treated soil.
Heavy Equipment and Transit Hygiene: A baseline safeguard verifying that heavy machinery, supply trucks, and swamp mats are cleared of southern mud via pressure-washing before accessing northern road networks or development zones.
Closed-Loop High-Pressure Truck Wash-Downs: The strategic placement of inexpensive closed-loop vehicle wash hubs at key Northern highway transit points. To maintain fiscal feasibility, these units utilize closed-loop water recycling with absolutely no chemical inputs required, while captured soil is pressed and pathogens are thermally neutralized on-site via inexpensive solar heating units.
More discussion of **Civil Infrastructure, Road Construction, & Aggregates**

A mandate that all bulk fill, topsoil, and aggregates destined for provincial infrastructure projects in the north must be certified "clean origin" (sourced from non-contaminated pits). Sourcing locally mitigates the cost and biosecurity risks associated with long-hauling bulk materials from southern urban centers. Optionally fill can be certified through inexpensive mechanical/thermal treatment such as solarization (the farmer's method of heating by spreading in sun under clear plastic for a short duration or, with the possible use of ice-melting cables) with a logged record of required temperatures reached.

Commercial Landscaping, Sod, & Bulk Mulch Shipping

Require all commercial sod farms and bulk mulch producers servicing northern corporate parks, new housing developments, and municipal spaces shipping materials across territorial boundaries to implement heat-treatment certifications (thermophilic composting or kiln drying) to ensure zero cocoon viability. Mulch in particular naturally

reaches these biothermal temperatures (50C+) when left in piles as does compost, and the industry is familiar in general with such standards, which can ensure consumer protection for northern residents.

Industrial Equipment Cleanliness and Corridor Modernization

While the mineral exploration and utility sectors are already accustomed to routine pressure washing for equipment maintenance and weed-seed mitigation, policy should focus on optimizing these practices for entry-side biosecurity before equipment enters remote sectors. In alignment with Canada's biosecurity commitments under CUSMA Article 24.16 regarding invasive alien species, the modernization of heavy machinery decontamination infrastructure is recommended. Rather than relying on current capital-intensive, fixed washing facilities owned by industry, the province can facilitate the deployment of numerous highly mobile, modular, closed-loop pressure washing stations at strategic highway staging points. This creates an agile, cost-effective infrastructure network that empowers northern developers to meet international cleanliness standards.

I hope this extensive list is of some use in mobilizing knowledge through your office. Some of them might be challenging but they are not expensive and are measures that should also seem reasonable to the Province and to the Federal government as they negotiate CUMSA. I was so honoured that you contacted me. Thank you for your time, your leadership, and your dedication to the health and autonomy of northern communities.

Bal, T. L., Storer, A. J., & Jurgensen, M. F. (2017). Evidence of damage from exotic invasive earthworm activity was highly correlated to sugar maple dieback in the Upper Great Lakes region. *Biological Invasions*, *20*(1), 151–164. https://doi.org/10.1007/s10530-017-1523-0

Bohlen, P. J., Pelletier, D. M., Groffman, P. M., Fahey, T. J., & Fisk, M. C. (2004). Influence of earthworm invasion on redistribution and retention of soil carbon and

nitrogen in northern temperate forests. *Ecosystems*, *7*(1), 13–27. https://doi.org/10.1007/s10021-003-0127-y

Cameron, E. K., Shaw, C. H., Bayne, E. M., Kurz, W. A., & Kull, S. J. (2015). Modelling interacting effects of invasive earthworms and wildfire on forest floor carbon storage in the boreal forest. *Soil Biology and Biochemistry*, *88*, 189–196. https://doi.org/10.1016/j.soilbio.2015.05.020

Chang, C.-H., Bartz, M. L. C., Brown, G., Callaham, M. A., Jr., Cameron, E. K., Dávalos, A., . . . Szlavecz, K. (2021). The second wave of earthworm invasions in North America: Biology, environmental impacts, management and control of invasive jumping worms. *Biological Invasions*, *23*(11), 3291–3322. https://doi.org/10.1007/s10530-021-02598-1

Frelich, L. E., Blossey, B., & Cameron, E. K. (2019). Side-swiped: Ecological cascades emanating from earthworm invasions. *Frontiers in Ecology and the Environment*, *17*(9), 502–510. https://doi.org/10.1002/fee.2099

Natural Resources Canada. (2021, November 4). *Earthworms, a threat to Canada's boreal forest?* Simply Science. https://natural-resources.canada.ca/stories/simply-science/earthworms-threat-canada-s-boreal-forest

Appendix A Letter 14

GUY BOURGOUIN
MPP Mushkegowuk—James Bay
Député provincial de Mushkegowuk—Baie James

June 9, 2026

Hon. Mike Harris
Minister of Natural Resources Ministry of Natural Resources
438 University Ave, Suite 1802
Toronto, ON M5G 2K8
(via email: minister.mnrf@ontario.ca)

Re: Jumping Worms and Risks to Northern Ontario's Forest Economy

Dear Minister Harris,

I am writing to raise concerns regarding the growing spread of jumping worms (*Amynthas* spp.) in Ontario and the significant environmental and economic risks they pose to Northern Ontario's forests, resource industries, and ecosystems.

Jumping worms are an invasive earthworm species native to East Asia. Although earthworms were largely absent from much of Northern North America following the last ice age, populations of jumping worms have expanded rapidly in Ontario since the early 2010s through human-mediated pathways, particularly the movement of soil, nursery stock, landscaping materials, and vehicles.

Unlike other earthworm species, jumping worms consume leaf litter at an accelerated rate, fundamentally altering forest soils. Their feeding activity removes the organic layer that many native plants and tree seedlings depend upon, leaving behind a loose, granular soil structure that is less capable of retaining moisture and nutrients. The result is degraded forest-floor conditions that can impair forest regeneration and alter ecosystem function.

These impacts carry significant implications for Northern Ontario's resource economy.

Forest Regeneration and Timber Supply

Research has demonstrated that jumping worms significantly reduce the survival and establishment of tree seedlings by altering soil conditions and disrupting nutrient cycles. This creates a risk of regeneration failure in managed forests, particularly for high-value commercial species that support Ontario's forestry sector. Reduced regeneration threatens future timber yields, long-term forest productivity, and the economic stability of forestry-dependent communities across the North.

Carbon Storage and Climate Objectives

The accelerated decomposition caused by jumping worms also reduces carbon stored within forest-floor organic layers. Studies have found declines of 50-95% of carbon stocks in forest-floors of invaded areas. As Ontario works to meet provincial and federal climate targets and maintain the carbon-storage capacity of its forests, the spread of jumping worms presents an emerging challenge that demands action.

Agricultural and Nursery Sector Impacts

The horticultural and nursery industries are widely recognized as primary pathways for the spread of jumping worms and their cocoons. As awareness of the species grows, jurisdictions have begun implementing quarantine measures and restrictions on the movement of soil and nursery products. Failure to contain their spread may create additional regulatory and economic pressures for Ontario growers and exporters.

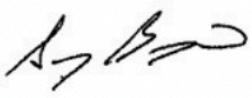
Given the environmental and economic risks associated with this invasive species, I urge the Ministry to:

1. Add jumping worms (*Amynthas* spp.) to the list of regulated invasive species under the *Invasive Species Act, 2015*;
2. Develop and implement a provincial strategy to prevent the spread of jumping worms into Northern Ontario;
3. Examine enhanced soil hygiene requirements for vehicles, equipment, and materials entering Northern economic zones to reduce the movement of worm cocoons through contaminated soil;
4. Work with the nursery, horticultural, forestry, and municipal sectors to establish best practices for detection, containment, and prevention.

Many jurisdictions across the northern United States have already recognized the threat posed by jumping worms and have taken steps to restrict their spread. Ontario should take proactive action now to protect the ecological integrity of our forests and the economic future of communities that depend upon them.

My office would welcome the opportunity to discuss this issue further and provide additional information regarding the risks that jumping worms pose to Northern Ontario's forest ecosystems and resource-based industries.

Best,



Guy Bourgouin, MPP
Mushkegowuk-James Bay

cc: Hon. Kevin Holland, Associate Minister of Forestry and Forest Products (Minister.Forestry@ontario.ca)
Hon. Trevor Jones, Minister of Agriculture, Food and Agribusiness (minister.omafa@ontario.ca)
Peter Tabuns, NDP Shadow Minister of Climate and Environment (ptabuns@ndp.on.ca)
Sullivan Dyment, York University (skdyment@yorku.ca)

Appendix A Letter 15

Biosecurity Measures Re: New invasive *Amynthas* spp.

Northern Boreal and Peatlands prepared for the office of MPP Guy Bourgouin

2026_06_08

Thermal Standardization for Imported Materials: Any soil, mulch, or landscaping amendments moving northward—including material brought in for site "remediation" or to tidy up a project location—be verified as heat-treated to ensure no live vectors breach the boreal gateway. This includes bulk landscaping materials such as "screen-sifted" filler which are presently not heat-treated and sod which must be grown on certifiable soil. Northern contractors using clean local northern aggregate pits keeps transport costs down and supports local northern jobs. There is a bit more on this under Civil Infrastructure.

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More discussion of Civil Infrastructure, Road Construction, & Aggregates

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Require all commercial sod farms and bulk mulch producers servicing northern corporate parks, new housing developments, and municipal spaces shipping materials

across territorial boundaries to implement heat-treatment certifications (thermophilic composting or kiln drying) to ensure zero cocoon viability. Mulch in particular naturally reaches these biothermal temperatures (50C+) when left in piles as does compost, and the industry is familiar in general with such standards, which can ensure consumer protection for northern residents.

Utility Corridor, Mining, & Exploration Drill Rigs

While the mineral exploration and utility sectors are already accustomed to routine pressure washing for equipment maintenance and weed-seed mitigation, policy should focus on optimizing these practices for entry-side biosecurity before equipment enters remote sectors. In alignment with Canada's biosecurity commitments under CUSMA Article 24.16 regarding invasive alien species, the modernization of this heavy machinery decontamination infrastructure is recommended. Rather than relying on current capital-intensive, fixed washing facilities owned by industry, the province can facilitate the deployment of numerous highly mobile, modular, closed-loop pressure washing stations at strategic highway staging points. This creates an agile, cost-effective infrastructure network that empowers northern developers to meet international cleanliness standards.

Finally, it is critical to emphasize that chemical or biological topical treatments are not a viable way forward for managing jumping worm populations, and can ironically trigger a severe population explosion. Pheretimoid cocoons are highly resilient and research demonstrates that even aggressive biological and chemical control applications yield absolutely no statistical reduction in cocoon hatching success (Nouri-Aiin & Görres, 2021). Relying on chemical flushes merely eradicates the active adult and juvenile earthworms while leaving the subterranean "cocoon bank" completely unaffected. By eliminating other localized soil organisms and resource competition, chemical interventions create an ideal setting for the next cycle, who then hatch into a terrain of decaying matter. This combination frequently culminates in an unchecked population boom, reinforcing why physical, preventative biosecurity infrastructure remains our only reliable line of defense (Chang et al., 2021).

Chang, C.-H., Bartz, M. L. C., Brown, G., Callaham, M. A., Jr., Cameron, E. K., Dávalos, A., . . .Szlavecz, K. (2021). The second wave of earthworm invasions in North America:

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Nouri-Aiin, M., & Görres, J. H. (2021). Biocontrol of invasive pheretimoid earthworms using *Beauveria bassiana*. PeerJ, 9, Article e11101. https://doi.org/10.7717/peerj.11101

Nouri-Aiin, M., & Görres, J. H. (2019). Earthworm cocoon banks as a reservoir for ecosystem disruption: Insights from *Amynthas* species. Applied Soil Ecology, 142, 104–111.https://doi.org/10.1016/j.apsoil.2019.05.004

Appendix A Letter 16

Office of the Clerk of the Privy Council and Secretary to the Cabinet
80 Wellington Street Ottawa, Ontario K1A 0A3

RE: Urgent Request for Federal Biosecurity Mandates Regarding Invasive Jumping Worms (*Amynthas* spp.) and Boreal Peatlands Protection

Dear Clerk of the Privy Council and Secretary to the Cabinet,

I am writing to formally request immediate intervention by the Privy Council Office to ensure a national biosecurity response regarding the new invasive species Asian jumping worms (*Amynthas* spp.) and their threat to Canada's Boreal peatlands, as well as to our vital forestry, mining and outdoor tourism sectors. The scientific consensus is clear: jumping worms have emerged from a "lag stage" in adapting to the Canadian climate and appear poised to exert unprecedented systemic stress on Canada's managed forests, conservation frameworks, and resource economies. In 2021, Natural Resources Canada, citing modelling of "loss of forest floor C over the 50 year simulation similar in magnitude in the Canadian boreal due to wildfire" assessed the spread of ordinary earthworms into the north, with "forest floor C stock reduced by 49.7–94.3%

after 125 years, the majority 35–40 years after initiation of the invasion." However, they then noted that an anticipated "second wave" of earthworm invasion was on the horizon that would bring larger, more voracious, and highly active species, one that can do in a season what others did in years. That species, the epi-endogeic species jumping worms (*Amynthas* spp.), are now officially in southern parts of Canada, although we still have time to protect the boreal peatlands and other areas of Canada from the impacts projected by reports. In fact, I am writing to you as I firmly believe that implementing inexpensive infrastructure at key transit boundaries could successfully contain their migration into our pristine northern areas, as their only means of truly spreading is through human actions. At this moment, Members of Provincial Parliament (MPPs) across Ontario are circulating formal requests to prohibit these vectors and establish strict yet quite inexpensive containment protocols. Given that this matter spans interprovincial trade, infrastructure development, and federal climate commitments, coordinated federal leadership is required to support this and before irreparable ecological damage occurs. Of immediate national concern is their vector of invasion into Canada's boreal forest, something which can only occur because of human transportation. If allowed to breach the southern boundary of the boreal zone via northern infrastructure, resource extraction, and corridor development, the consequences of this highly resilient and rapidly multiplying species are potentially catastrophic. Jumping worms swiftly consume the organic duff layer of forest floors, turning stable topsoil into a highly erodible, granular substrate. There are no chemical pesticides capable of eradicating invasive jumping worms. Chemicals wipe out the soil's natural defenses—including beneficial microbes, fungi, and native plants, but also leave behind newly created decaying plant matter. While the highly resilient cocoons are unaffected, this creates the perfect, competition-free environment for a population explosion. For the same reason, controlled burns absolutely can trigger a population boom, as soil is highly insulating and remains cool even a few inches below the surface, while after a burn, decaying plant matter is everywhere. Because they function as hyper-abundant detritivores, their northward expansion poses an unprecedented threat to Canada's boreal peatlands. This would cost Canada and the planet an incalculable toll, especially when simple, highly effective biosecurity controls are readily available to

limit them right now. By stopping a species which jeopardizes the structural integrity of critical carbon sinks (known to contain more carbon per square meter than the Amazon rainforest) Canada can limit their fundamental damage to forest regeneration, the devastation of native biodiversity, and the potential triggering of an unmitigated release of sequestered soil carbon into the atmosphere. As well, we can protect the North from an obvious threat to Canada's resource economy. Damage to forest soil structure can clearly jeopardize long-term timber yields, undermining the natural regeneration cycles vital to our multi-billion-dollar forestry and lumber industries, as well as serious and obvious challenges to other industries. Fortunately, safeguarding these industries does not require complex or even cost-prohibitive interventions. The primary biosecurity measures required to halt transmission—such as low-cost solar heat treatment protocols (maintaining a target core temperature of 50C for only a few minutes to sterilize soil aggregates) as well as mandatory closed-loop equipment wash stations to intercept 1-3 mm cocoons—are highly affordable, operationally straightforward, and simple to integrate into standard industrial workflows before heavy machinery moves northward. Because of the lag stage, regulatory frameworks have until now moved too slowly to intercept this threat. We cannot afford a reactive approach when conventional treatments are not reliable. I urgently request that the Privy Council Office direct the relevant federal ministries (including Environment and Climate Change Canada and Natural Resources Canada) to formally adopt and deploy the following:

1. Federal Prohibition & Regulation: Support provincial initiatives by explicitly listing *Amynthas* spp. under federal frameworks to close existing regulatory gaps. Federal action must mandate that any soil, mulch, or aggregate moved across boundaries for regulated projects must either be locally sourced from safe northern zones or certified as heat-treated to kill dormant cocoons.
2. Public and Recreational Pathways: Mandatory installation of multi-surface boot-brush stations at major trailheads, provincial/national park access points, and recreational transit hubs to ensure zero transport via tourist traffic from southern areas. Ensure bait is never a vector with stricter, easy-to-enforce controls on recreational anglers.
3. Mandatory Northern Biosecurity Protocols: Implement inexpensive closed-loop vehicle and heavy equipment pressure wash stations for all federally funded or

regulated northern development projects. The training of canine *Amynthas* spp. soil identification units to be deployed in protection of northern contact zones.
4. Buffer Management: Implement an immediate reduction of expensive chemical herbicide applications such as glyphosate which creates an ideal hatchling landscape of decaying vegetation along the most vulnerable northern transit, resource, and utility corridors. Mechanical clearing methods preserve the resilient native understory plant communities that structurally resist soil erosion and naturally restrict the rapid horizontal migration of invasive vectors. The economic cost of implementing these preventative biosecurity measures is nominal; the economic and environmental cost of compromising the integrity of the boreal forest and peatlands ecosystem at this moment in history is considerably more so. To err on the side of caution in this matter is strongly recommended and would be well-received by the public.
Thank you for your immediate attention to this critical issue of national biosecurity. I look forward to your response detailing the steps the Privy Council Office will take to coordinate this simple and vital biosecurity defense.

Appendix A Letter 17

Dear Native Plant Society Members,

I am writing to you out of deep respect for your organization as well as for the role native plant nurseries play in protecting and restoring our local ecosystems, to share with you an urgent reminder regarding protocols to prevent the spread of invasive jumping worms (*Amynthas* spp.).

A few days ago, I encountered a worm in a potted native shrub that strongly resembled a juvenile jumping worm. While it was thankfully not one, the experience underscored how difficult early identification can be—and how profound the consequences would be if it had been. It compelled me to write to you, to help support public awareness of the issue and the importance of reassuring the public that native plant nurseries are informed and leading non-native plant nurseries to follow correct protocols regarding this concerning soil-dwelling species.

As you may know, Jumping worms rapidly consume organic matter, destroy soil structure, eliminate leaf litter, and leave behind dry, granular soil that is inhospitable to native plants, fungi, insects, and tree seedlings. In forests, gardens, and green spaces, they disrupt entire food webs and accelerate erosion. They also release carbon as they break down plant matter in ways we are still discovering. The devastation seen across the northeastern United States is well documented—and it is something we can still avoid here.

Toronto and much of Ontario remain at a critical early-spread stage, as does the rest of Canada. While Jumping worms are present, they are thankfully not widely established. At this stage, every strict protocol matters, and native plant nurseries are uniquely positioned to stop their spread.

Native plant nurseries that train staff to adhere to specific prevention protocols now can show leadership while avoiding any role in their spread.

Fortunately, prevention is both achievable and highly cost-effective.

Key measures that can dramatically reduce risk do however include bare-rooting of plant stock, followed by thorough washing of roots, proper disposal of all original soil, and repotting into verified clean growing medium. For nurseries considering this as a possible step, it can be a one-time measure that guarantees to clients that they are stopping any possible jumping worm presence in plants.
Solarization (heat treatment) of soil and mulch is a well-known to agriculture and essentially free, highly effective method that destroys jumping worm cocoons, which unfortunately survive cold and survive chemical treatment. They do not survive correct solarization. Using clear tarps above and below soil to achieve temperatures of approximately 40 °C (104 °F) for at least 72 hours during summer months is all that is required to effectively neutralize cocoons. This can be done for multiple soil batches at minimal cost while any excess can potentially be bagged and sold.

Sourcing the reintroduction of guaranteed safe, living soil components after heat treatment ensures potting media remains biologically healthy while free of invasive organisms. Forests that appear fine are not necessarily jumping worm free, and so creating safe living soil components on-site is always the best option and free as it is typically what is done already.
Strict handling protocols for mulch, particularly free chip-drop mulch, which is currently a vector for jumping worm spread is required. Cocoons are extremely small (1–3 mm) and easily transported in ground-level debris and chipping equipment, making heat treatment of such mulch essential.
Finally, biosecurity measures for footwear and vehicles, as cocoons can readily hitchhike into a nursery operation on boots, tires, and tools. Boot-brush stations, scuff mats, designated clean footwear policies, and pressure washing of vehicles entering from off-site are highly effective safeguards.

These measures represent a small initial effort that can save native plant nurseries enormous costs in the long run—protecting clients, reputations, and the ecosystems we all care about. **Awareness of jumping worm prevention protocols not only reduces risk but demonstrates positive leadership that will hopefully lead the non-native plant nurseries to make the same assurances.**

Jumping worms pose a concerning harm to Canada’s gardens, green spaces, and forests. We still have a narrow window to prevent widespread establishment. I urge those involved in the work of native plant nurseries to confirm that they have acted decisively on this matter, to better protect both the landscapes you help restore and the trust of those who rely on your expertise.

Thanking you for the essential work you do, and for your commitment to safeguarding our shared environment.

the industry is familiar in general with such standards, which can ensure consumer protection for northern residents.

Utility Corridor, Mining, & Exploration Drill Rigs

While the mineral exploration and utility sectors are already accustomed to routine pressure washing for equipment maintenance and weed-seed mitigation, policy should focus on optimizing these practices for entry-side biosecurity before equipment enters remote sectors. In alignment with Canada's biosecurity commitments under **CUSMA Article 24.16** regarding invasive alien species, the modernization of this heavy machinery decontamination infrastructure is recommended. Rather than relying on current capital-intensive, fixed washing facilities owned by industry, the province can facilitate the deployment of numerous highly mobile, modular, closed-loop pressure washing stations at strategic highway staging points. This creates an agile, cost-effective infrastructure network that empowers northern developers to meet international cleanliness standards.

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Appendix 14 is PCO letter

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The scientific consensus is clear: jumping worms have emerged from a "lag stage" in adapting to the Canadian climate and appear poised to exert unprecedented systemic stress on Canada's managed forests, conservation frameworks, and resource economies.

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In fact, I am writing to you as I firmly believe that implementing inexpensive infrastructure at key transit boundaries could successfully contain their migration into our pristine northern areas, as their only means of truly spreading is through human actions.

At this moment, Members of Provincial Parliament (MPPs) across Ontario are circulating formal requests to prohibit these vectors and establish strict yet quite inexpensive containment protocols. Given that this matter spans interprovincial trade, infrastructure development, and federal climate commitments, coordinated federal leadership is required to support this and before irreparable ecological damage occurs.

Of immediate national concern is their vector of invasion into Canada's boreal forest.

If allowed to breach the southern boundary of the boreal zone via northern infrastructure, resource extraction, and corridor development, the consequences of this highly resilient and rapidly multiplying species are potentially catastrophic. Jumping worms swiftly consume the organic duff layer of forest floors, turning stable, water-retaining topsoil into a highly erodible, granular substrate.

There are no chemical pesticides capable of eradicating invasive jumping worms. Chemicals wipe out the soil's natural defenses—including beneficial microbes, fungi, and native plants, but also leave behind newly created decaying plant matter. While the highly resilient cocoons are unaffected, this creates the perfect, competition-free environment for a population explosion.

For the same reason, controlled burns absolutely can trigger a population boom, as soil is highly insulating and remains cool even a few inches below the surface, while after a burn, decaying

plant matter is everywhere.
Because they function as hyper-abundant detritivores, their northward expansion poses an unprecedented threat to Canada's boreal peatlands. This represents a compounding ecological and fiscal liability of profound proportions that Canada cannot afford—especially when simple, highly effective biosecurity controls are readily available to contain this spread right now.
By stopping this invasive species which jeopardizes the structural integrity of critical carbon sinks (known to contain more carbon per square meter than the Amazon rainforest) Canada can ideally limit fundamental damage to forest regeneration, the devastation of native biodiversity, and the potential triggering of an unmitigated release of sequestered soil and peatland carbon into the atmosphere.
Beyond environmental fallout, jumping worms pose an obvious threat to Canada's resource economy. Damage to forest soil structure can potentially jeopardize long-term timber yields, undermining the natural regeneration cycles vital to our multi-billion-dollar forestry and lumber industries, as well as serious and obvious challenges to other industries.
Fortunately, safeguarding these industries does not require complex or even cost-prohibitive interventions. The primary biosecurity measures required to halt transmission—such as low-cost solar heat treatment protocols (maintaining a target core temperature of 50C for only a few minutes to sterilize soil aggregates) as well as mandatory closed-loop equipment wash stations to intercept 1-3 mm cocoons—are highly affordable, operationally straightforward, and simple to integrate into standard industrial workflows before heavy machinery moves northward.
Because of the lag stage, regulatory frameworks have until now moved too slowly to intercept this threat. We cannot afford a reactive approach when conventional treatments are not reliable.
I urgently request that the Privy Council Office direct the relevant federal ministries (including Environment and Climate Change Canada and Natural Resources Canada) to formally adopt and deploy the following:

1. Federal Prohibition and Regulation: Support provincial initiatives by explicitly listing all pheretimoid earthworms (including *Amynthas* spp., *Metaphire* spp., and *Pheretima* spp.) under federal frameworks to close existing regulatory gaps. Federal action must mandate that any soil, mulch, or aggregate moved across boundaries for regulated projects must either be locally sourced from safe northern zones or certified as heat- treated to kill dormant cocoons.
2. Public and Recreational Pathways: Mandatory installation of multi-surface boot-brush stations at major trailheads, provincial/national park access points, and recreational transit hubs to ensure zero transport via tourist traffic from southern areas. Stricter controls on recreational anglers to ensure bait is never a vector.
3. Mandatory Northern Biosecurity Protocols: Implement inexpensive closed-loop vehicle and heavy equipment pressure wash stations for all federally funded or regulated northern development projects. The training of canine *Amynthas* spp. soil identification units to be deployed in protection of northern contact zones.
4. Buffer Management: Implement an immediate reduction of expensive chemical

herbicide applications such as glyphosate which creates an ideal hatchling landscape of decaying vegetation along the most vulnerable northern transit, resource, and utility corridors. Mechanical clearing methods preserve the resilient native understory plant communities that structurally resist soil erosion and naturally restrict the rapid horizontal migration of invasive vectors.

The economic cost of implementing these preventative biosecurity measures is nominal; the economic and environmental cost of compromising the integrity of the boreal forest and peatlands ecosystem at this moment in history is considerably more so. To err on the side of caution in this matter is strongly recommended and would be well-received by the public.

Thank you for your immediate attention to this critical issue of national biosecurity. I look forward to your response detailing the steps the Privy Council Office will take to coordinate this simple and vital biosecurity defense.

Sincerely,

Sullivan Dyment,

MES York University.

Distribution:

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The Honourable Julie Dabrusin, P.C., M.P., Minister of Environment, Climate Change and Nature

The Honourable Tim Hodgson, P.C., M.P., Minister of Energy and Natural Resources

Eric Costen, Deputy Secretary to the Cabinet (Operations), Privy Council Office

Peter Tabuns, MPP, Toronto—Danforth, Ontario NDP Environmental Critic

References:

Cameron, E. K., Shaw, C. H., Bayne, E. M., Kurz, W. A., & Kull, S. J. (2015). Modelling interacting effects of invasive earthworms and wildfire on forest floor carbon storage in the boreal forest. Soil Biology and Biochemistry, 88, 189–196. https://doi.org/10.1016/j.soilbio.2015.05.020. Natural Resources Canada. (2021).

Chang, C.-H., Bartz, M. L. C., Brown, G., Callaham, M. A., Cameron, E. K., Dávalos, A., … Ransom, T. (2021). The second wave of earthworm invasions in North America: biology, environmental impacts, management and control of invasive jumping worms. Biological Invasions, 23(11), 3291–3322. https://doi.org/10.1007/s10530-021-02598-1

Earthworms, a threat to Canada's boreal forest? - Natural Resources Canada. Retrieved from Canada.ca website: https://natural-resources.canada.ca/stories/simply-science/earthworms-threat-canada-s-boreal-forest.

Appendix B

Appendix B Figure 1



Appendix B Figure 2



Appendix B Figure 3



Appendix B Figure 4

GARDENING PROTOCOL: PREVENTING JUMPING WORMS



Buy heat-treated not screened





Not sure? Solarize!



Avoid filler and uncomposted farm soil.
(Exception: Closed-loop permaculture).

Wood chips? Ask your arborist:
"Do you clean your chipper hopper between residential jobs?"



Solarization gets hot quick







The natural heat in composting is a gardener's best friend



50C for 20-30 mins



If you ever find jumping worms: bag 'em!





Using logs? Tarp or asphalt solar pre-bake, check temp.





Never compost suspect soil



The days of sharing plants using garden soil are over. Do not do this.

Bare-root plants and repot





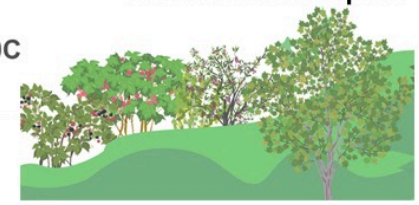
Wash tools
Consider using buckets with mesh strainers



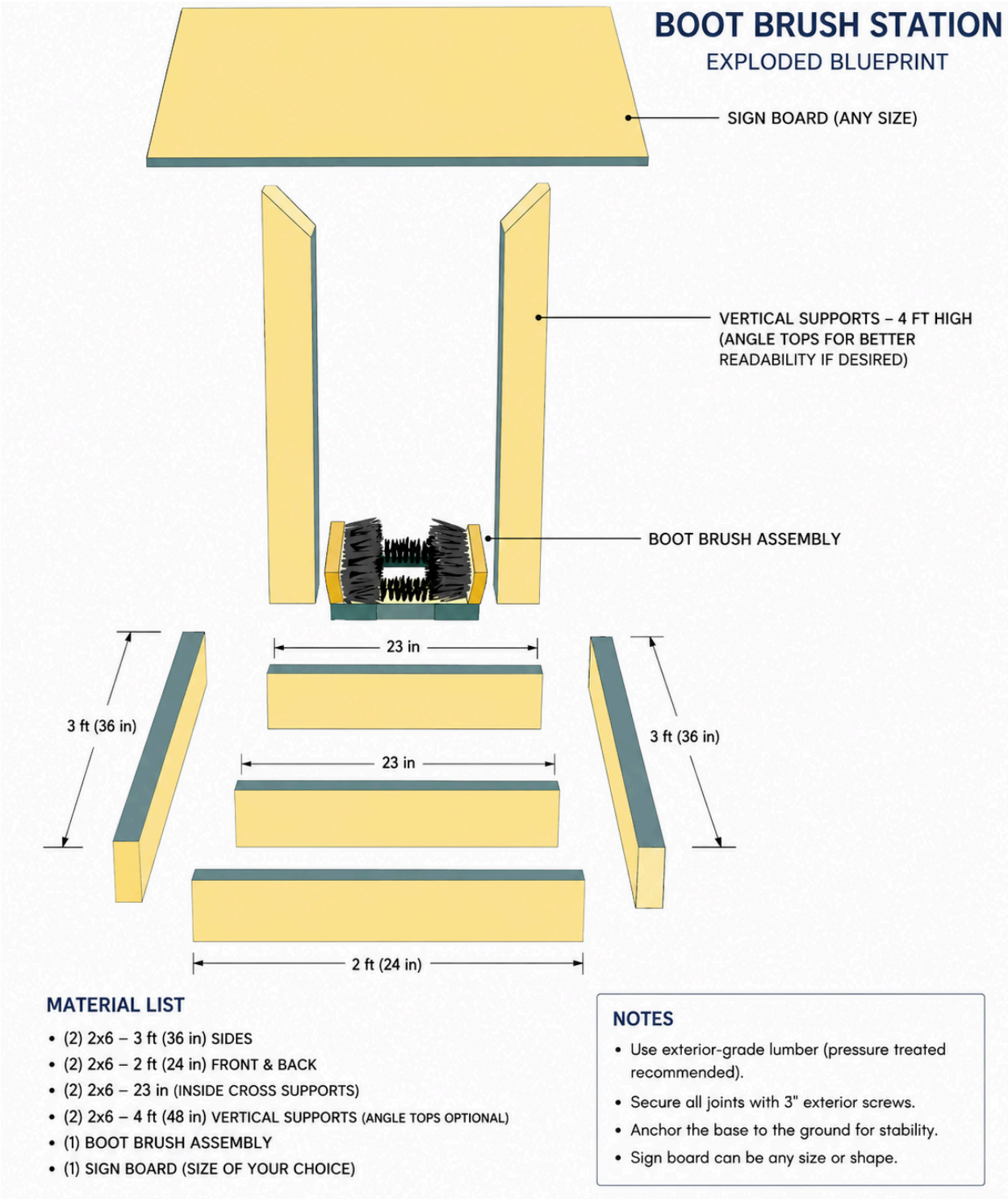
Dispose or solarize debris



Plant resilient native species



Appendix B Figure 5



Appendix B Figure 6 (Multilingual assets)



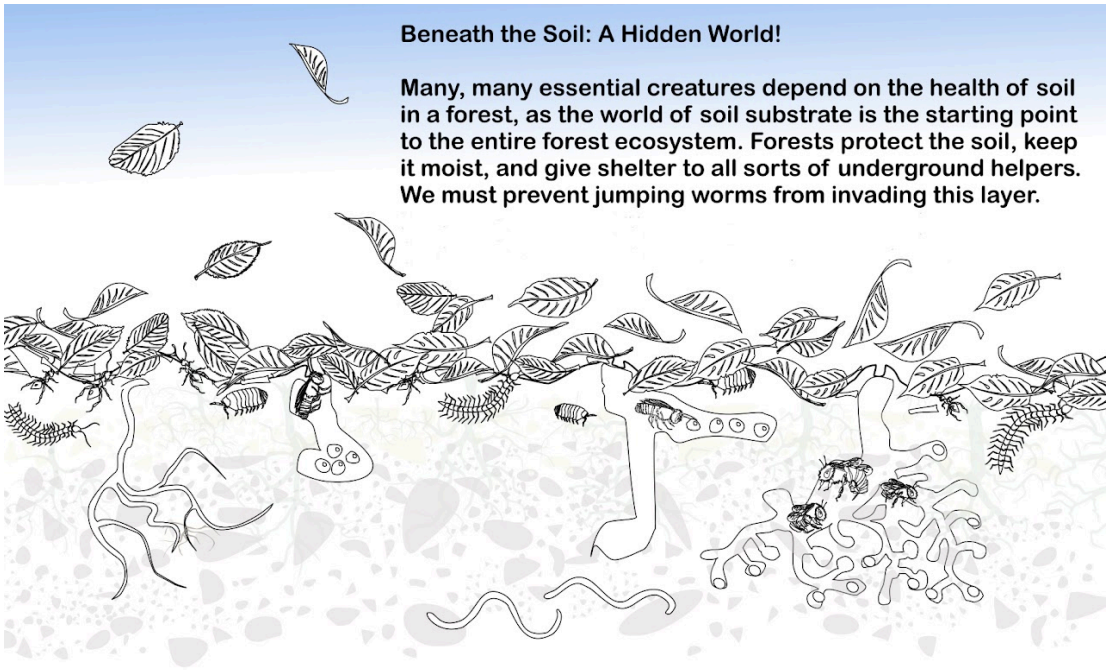
Appendix B Figure 7 (banner with roots)

(Figure B-7 and Figure 8) The banner includes “underground world” imagery with 18 root 

systems, 4 ground-nesting bee nests and invertebrate and other soil-dwelling fauna.



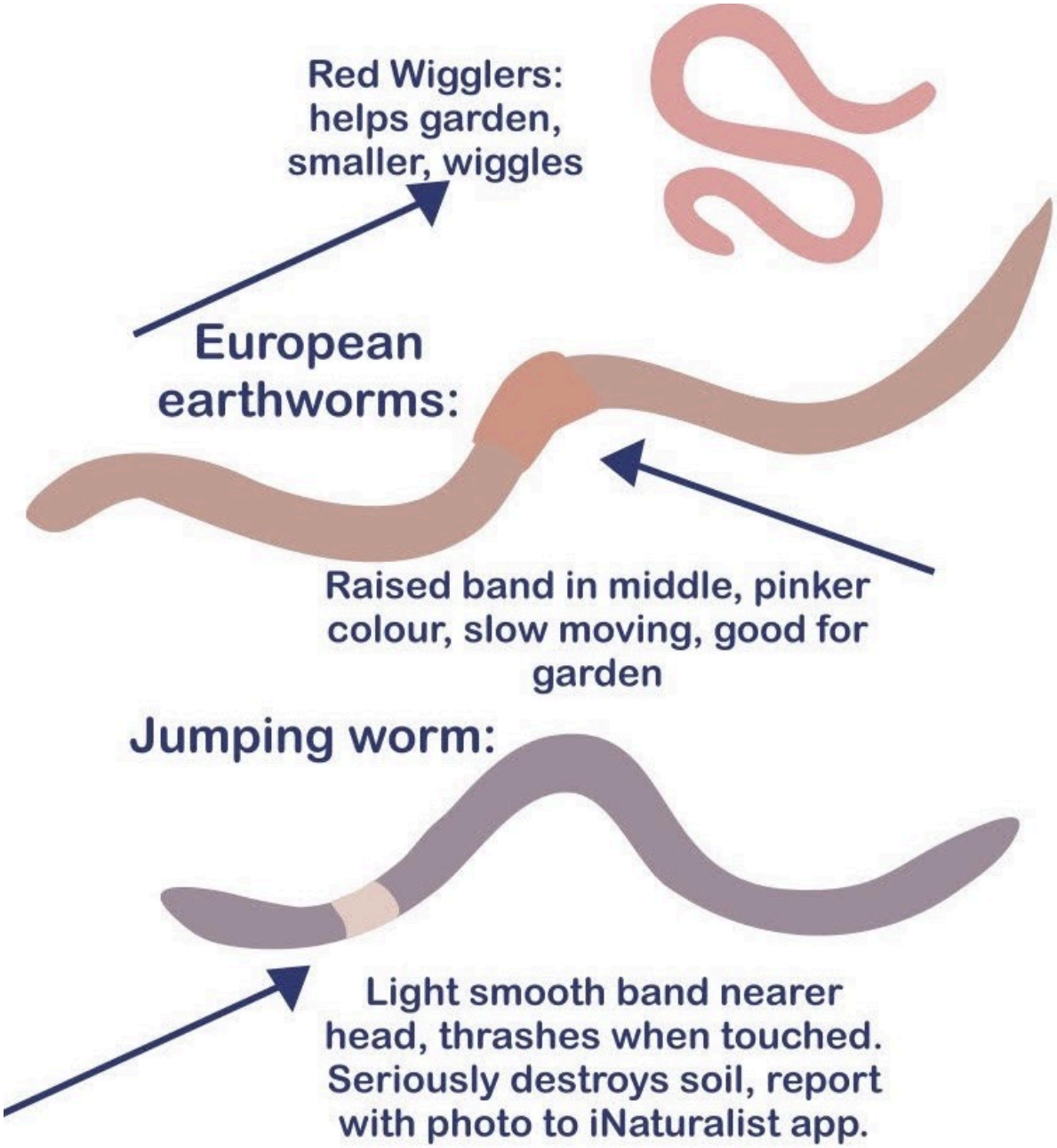
Appendix B Figure 9



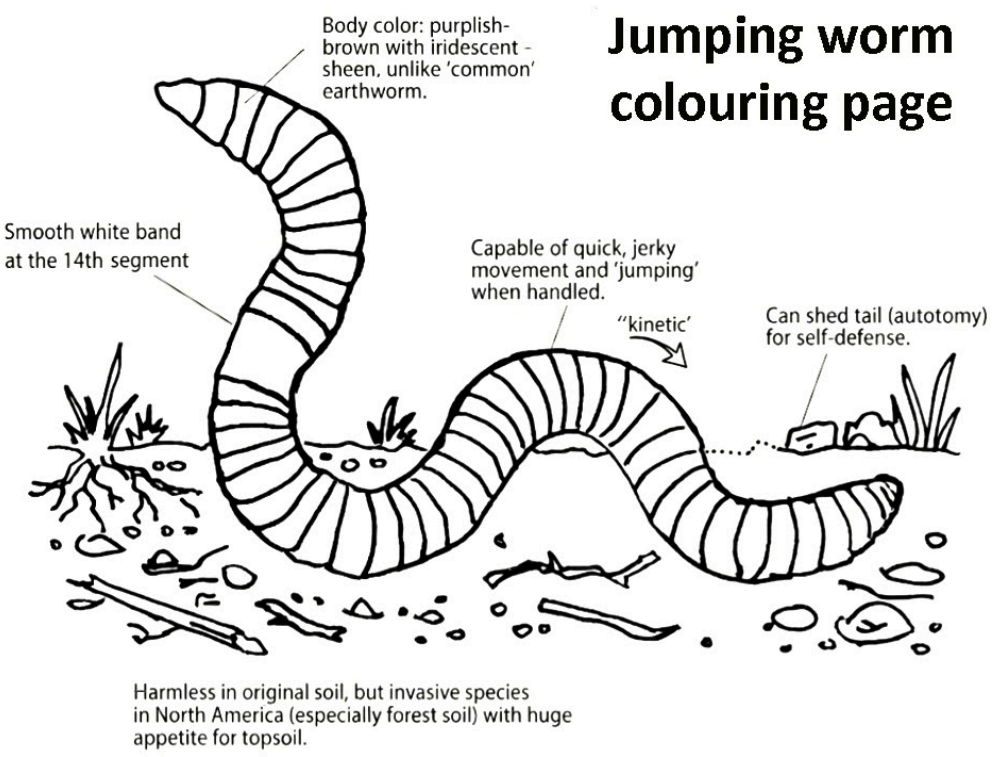
Appendix B Figure 10



Appendix B Figure 11



Appendix B Figure 12



Appendix B Figure 13



Appendix B Figure 14



Appendix B Figure 15




O-Horizon
(Leaf Litter)
A-Horizon
(Top Soil)
E-Horizon
(Eluviation)
B-Horizon
(Sub-Soil)