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Item No.13.1.1
Environment & Sustainability Standing Committee
September 4, 2025

TO: Chair and Members of Environment & Sustainability Standing Committee

FROM: Brad Anguish, Commissioner of Operations

DATE: July 30, 2025

SUBJECT: Hemlock Woolly Adelgid Management Plan

ORIGIN

November 14, 2023: Halifax Regional Council motion (Item No. 15.4.1):

MOVED by Councillor Morse, seconded by Councillor Stoddard

THAT Halifax Regional Council direct the Chief Administrative Officer (CAO) to provide a staff report on a Management Plan for Hemlock Woolly Adelgid in HRM. Woolly Adelgid is an emerging insect pest that can be fatal to hemlock. The Management Plan should include best practices for treatment, with a special focus on older hemlocks in HRM, and include funding sources to develop and implement the plan.

MOTION PUT AND PASSED UNANIMOUSLY.

EXECUTIVE SUMMARY

Hemlock Woolly Adelgid (HWA) is a highly destructive invasive pest first detected in Nova Scotia in 2017 and in Halifax Regional Municipality (HRM) in 2023. It is known to decimate native eastern hemlock (Ksu'sk, *Tsuga canadensis*) populations in as little as four years. In 2023 HRM Regional Council provided staff direction to develop a *Hemlock Woolly Adelgid Treatment and Management Plan* ("*the Plan*") in alignment with the municipality's Integrated Pest Management Guidelines (2022) to protect local eastern hemlock populations.

The Plan, which outlines Halifax's Hemlock Treatment Program, was authored by the Environment and Climate Change division of Property, Fleet and Environment with support from Parks and Recreation and Urban Forestry. It was drafted to be representative of both community input and best practices as defined by a community of expert collaborators throughout HWA's infestation range including Nova Scotia, Ontario and many eastern States, the latter of whom have been working on controlling the impacts of HWA for decades. *The Plan* was developed as an operational document with the goal of maintaining healthy eastern hemlock populations in HRM for current and future generations. It has been attached (*Attachment A*) to this report for Council review.

RECOMMENDATIONS ON PAGE 2

Currently, chemical/medicinal[1] treatment is the only option available to protect hemlocks from the worst effects of HWA. Both reactive and prophylactic (i.e., preventative) treatment will be required to reduce the impact of HWA's continued spread. It is anticipated that the Hemlock Protection Program in Halifax will be undertaken by a combination of HRM staff, volunteers, and contractors with an average cost of between $150,000 and $200,000 per year for each 5-year treatment cycle. Should the plan be approved, staff will use funding set aside in the Parks 2025/2026 budget to initiate surveys, tree marking, and potentially a staff-supervised volunteer-led treatment. It is possible that external funding could be secured to supplement the ongoing cost of treatment.

RECOMMENDATION

It is recommended that Environment & Sustainability Standing Committee recommend that Halifax Regional Council:

1. Approve the *Hemlock Woolly Adelgid (HWA) Treatment and Management Plan*, as set out in Attachment A to this report;

2. Direct the Chief Administrative Officer to direct staff to initiate treatment of eastern hemlocks with a focus on the 15 priority parks identified within the *HWA Treatment and Management Plan*; and

3. Direct the Chief Administrative Officer to carry out the actions contained in the *HWA Treatment and Management Plan* as part of the multi-year budgeting and business planning process.

BACKGROUND

Eastern hemlock is among the longest-lived species in the Wabanaki-Acadian Forest Region. There are historical reports of these trees living more than 800 years[2], however they are more commonly reported to have a ≈400-year lifespan[3,4]. They are a foundation species, meaning they perform essential functions that shape and influence the ecosystems around them.[5] Because they often grow in riparian areas (i.e., along waterways and waterbodies), they are important to maintaining specific conditions in both aquatic and terrestrial habitats. Streams flowing through hemlock forests often have better water quality, more stable temperatures, more regulated streamflow, and higher oxygenation levels than comparable waterways without such cover.[6,7,8] Hemlock roots knit stream banks together, stabilizing shorelines. Their branches

[1] According to feedback collected during an HWA-focused Indigenous Gathering Circle hosted during the Plan's development, chemical treatment should be thought of as medicine for hemlocks. As such, throughout this report and in the *HWA Treatment and Management Plan* (Attachment A), chemical treatment is always referred to as "chemical/medicinal" treatment to normalize this concept. More detail can be found in the "Indigenous Gathering Circle" section of Attachment A.

[2] Godman, RM & Lancaster, K. 1990. Tsuga canadensis (L.) Carr. Eastern hemlock. P. 604-612. In: Burns, RM & Honkala, BH, tech. coords. Silvics of North America: Vol. 1, Conifers. Agriculture Handbook 654. Washington (DC): USDA, Forest Service; 675 p

[3] Boland, T. 2012. Trees and shrubs of the Maritimes. Portugal Cove St. Phillips (NFLD): Boulder Publications.

[4] Farrar, JL. 2017. Trees in Canada. 2nd ed. Ottawa (ON): Canadian Forest Service & Natural Resources Canada.

[5] Ellison, AM. 2019. Foundation species, non-trophic interactions, and the value of being common. *iScience*. 13: 254-268. DOI: 10.1016/j.isci.2019.02.020. [ax 2025, March 14].

[6] Crossland, D, Miller, M, Rodger, MJ, Hunsinger, J. 2022. Potential options for a comprehensive chemical treatment program to conserve eastern hemlock in Nova Scotia from hemlock woolly adelgid and lessons learned from other jurisdictions. Unpubl. report NS Dept. Environment and Climate Change, Medway Community Forest Coop Ltd., 91 pp.[ax 2024, March 20].

[7] Hemlock Restoration Initiative. [date unknown]. The importance of hemlocks. https://savehemlocksnc.org/hemlocks-hwa/the-importance-of-hemlocks/. [ax 23 April, 2025]

[8] Ellison, AM, Barker-Plotkin, AA, Foster, DR, & Orwig, DA. 2010. Experimentally testing the role of foundation species in forest: the Harvard Forest Hemlock Removal Experiment. *Methods in Ecology and Evolution.* 1(2):168–179. DOI: 10.1111/j.2041-210x.2010.00025.x. [ax 2025, April 29].

intercept precipitation reducing nutrient runoff and splash erosion. Taken together, these services create improved habitat conditions for aquatic species like brook trout (*Salvelinus fontinalis*), Atlantic salmon (*Salmo salar*), and a variety of macroinvertebrates. In fact, hemlock-dominated watersheds have been found to support more aquatic biodiversity overall compared to other species compositions in the same geographic range.[9,10]

From a terrestrial standpoint, a thick, healthy hemlock canopy supports a comfortable microclimate that is more shaded, cooler, and moister than nearby areas. This deep shade slows decomposition rates, creating conditions that are unique to hemlock-dominated forests, satisfying the lifecycle and habitat requirements for a diversity of plant and animal species.[11] It is estimated that more than 120 vertebrate species spend time in mature hemlock stands[12] while up to 90 bird species have a known association with the iconic tree species. Some of these species are not known to nest anywhere else[13,14].

However, eastern hemlock is being decimated throughout its native range by a tiny, aphid-like insect from East Asia known as hemlock woolly adelgid (*Adelges tsugae*; HWA), named for the wool-like material they produce that covers their bodies and the egg sacs they lay on the underside of eastern hemlock branches.[15] HWA was first detected in Nova Scotia in 2017 in Yarmouth County and was subsequently confirmed in Digby and Shelburne Counties.[16] HWA was then detected in the counties of Lunenburg, Kings, Queens, and Annapolis counties between 2017 and 2022.[17] It was found for the first time in HRM in 2023 in Bedford. Two additional confirmed reports were made in 2024: around Sandy Lake in the Bedford area and Oakfield Provincial Park.

In late spring and early summer of 2024, eDNA traps deployed by the Canadian Forest Service detected HWA in Hemlock Ravine and Shubie Parks. However, the eDNA signals were relatively weak and thus the presence of HWA in these parks is not definitive. These results indicate that these parks are high priority for surveying to acquire visual confirmation of HWA presence. Regardless of whether HWA is currently present in these parks it is a near certainty that HWA will be detected in all areas where eastern hemlock grows in the Halifax Region in a few years.

DISCUSSION

HWA is a highly destructive insect that destroys hemlock tree populations. When HWA arrives on a hemlock branch, it attaches its long mouth parts to new buds, sucking the fluid and nutrients from young twigs. This reduces rates of photosynthesis and ultimately results in water stress and nutrient deficiency. Needles will

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[9] Ross, R, Bennett, R, Snyder, C, Young, J, Lemarie, D. 2003. Influence of eastern hemlock (Tsuga canadensis L.) on fish community structure and function in headwater streams of the Delaware River basin. *Ecology of Fresh Water Fish.* 1: 60-65. DOI: 10.1034/j.1600-0633.2003.00006.x. [ax 23, April 2025]

[10] Ward, JS, Cheah, CAS-J, Montgomery, ME, Onken, BP& Cowles, RS. 2004. Eastern hemlock forests: guidelines to minimize the impacts of hemlock woolly adelgid. NA-TP-03-04, USDA Forest Service, Northeastern Area State and Private Forestry, Morgantown, WV. [ax 2024, May 6]

[11] Ellison, et al., 2010.

[12] DeGraaf, RM, Yamasaki, M, Leak, WB, & Lanier, JW. 1992. New England wildlife: Management of forested habitats. Gen. Tech. Rep. NE-144. Radnor [now Newtown Square], PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station; 271 p

[13] Hemlock Restoration Initiative. [date unknown]. The importance of hemlocks. https://savehemlocksnc.org/hemlocks-hwa/the-importance-of-hemlocks/. [ax 23 April, 2025]

[14] Ross, RM, Redell, LA, Bennett, RM, & Young, JA. 2004. Mesohabitat use of threatened hemlock forests by breeding birds of the Delaware River Basin in Northeastern United States. *Natural Areas.* 24(4) 307-315. https://www.researchgate.net/publication/287682206_Mesohabitat_use_of_threatened_hemlock_forests_by_breeding_birds_of_the_Delaware_River_basin_in_northeastern_United_States [ax 2025 April 29]

[15] Nealis, VG. 2024. Balsam woolly adelgid. *Trees, insects, mites, and diseases of Canada's forests.* https://tidcf.nrcan.gc.ca/en/insects/factsheet/5314. [ax 2025, April 29].

[16] CFIA. 2017. Hemlock woolly adelgid confirmed in Nova Scotia. https://www.canada.ca/en/food-inspection-agency/news/2017/08/hemlock_woolly_adelgidconfirmedinnovascotia.html [ax 25 May 2023].

[17] CFIA. 2022. Amended hemlock woolly adelgid [Adelges tsugae (Annand)] infested place order. https://inspection.canada.ca/plant-health/invasive-species/insects/hemlock-woolly-adelgid/infested-place-order/eng/1591829961468/1591829961828 [ax 25 May 2023].

begin to turn yellow and fall off, eventually killing the tree. It is estimated that HWA can kill up to 95% of hemlocks in as little as three years and some stands experience complete hemlock mortality. Decline has been observed to occur more rapidly in drought-stressed trees and coastal systems. Following HWA infestation, seas of discoloured, defoliated (i.e., missing leaves or needles), and dying trees are left behind. Unlike early successional species (i.e., those that first grow after a disturbance like a hurricane), such as balsam fir, hemlocks are not expected to rebound. This means the loss of eastern hemlock from the landscape may be permanent.

Two years ago, HRM was in the early intervention stage of HWA Management, but it is rapidly shifting toward being at the leading edge where both reactive and prophylactic (i.e., preventative) treatment will be required in short order. Though this is a big undertaking, HRM is fortunate to benefit from the forest managers and scientists in the United States, Ontario, and other parts of Nova Scotia who have been working on controlling HWA for decades**.**

According to that experience chemical/medicinal treatment is the only option currently available for protecting eastern hemlocks from HWA. There are also supplemental stewardship or silvicultural actions that can be taken to increase treatment efficacy. These are described in detail in the Plan attached.

There are two modes of chemical/medicinal application used in Canada for this purpose: systemic injection and basal bark spray. Generally, injection is more expensive and slower to implement, but due to the direct mode of entry it greatly decreases 1) environmental exposure to product (i.e., insecticide) and 2) the total amount of product required for treatment. In addition, there are no application limits for injection-based treatment which means an entire park can be treated at once. Conversely, basal bark spray often requires re-entry year over year to adhere to application limits. Finally, the injection-based method is conducive to volunteer-treatment events which have been modelled with great success by organizations like Medway Community Forest Cooperative, Asitu'lisk, and the Town of Kentville.

Basal bark spray is less expensive and faster, but less targeted, which means some insecticide may be detected in the environment surrounding a sprayed tree. Basal bark spray is also prohibited within 7 metres of a waterway; thus injections are exclusively used in these areas. Some practitioners also favour injections in other areas they consider to be environmentally sensitive. Similarly, injections are sometimes favoured in areas where there is high human use like along trailways and in busy parks because areas treated using basal bark spray are typically barred from access for at least 24-hours following treatment, which can be challenging to control.

The products most used for HWA treatment contain the active ingredient Imidacloprid, a systematic neonicotinoid. Imidacloprid-based products can be applied via injection (i.e., "IMA-Jet") or basal bark spray (i.e., "Xytect 2F"). These products generally take a few months to activate in a tree and maintain their efficacy for about five years. In cases where hemlocks are already showing signs of decline due to HWA, a product called "Starkle 20 SG" is often mixed with Xytect 2F and applied via basal bark spray. The active ingredient of Starkle is Dinotefuran, also a neonicotinoid. Starkle is quick (i.e. two weeks) to act, but it is almost never used on its own as it generally only retains efficacy for two years. All products used for HWA treatment have been approved for use in Nova Scotia under emergency orders under the Pest Management Regulatory Agency, a branch of Health Canada that regulates pesticides in Canada. Further details on the regulated status of these products can be found in the *Chemical/medicinal treatment* section of *Attachment A*.

Chemical/medicinal treatment is a short-term response to an ecological crisis. It is intended as a stop-gap measure while the longer-term solution of biocontrol is under development. It is likely that one to two decades will be needed for biocontrol populations to become established. Because treatment products have an average efficacy of five years, **it is expected that repeat treatments will be required every five years for up to two decades**.

Hiring a contractor to support the establishment of Halifax's Hemlock Protection Program is likely to expedite treatment. In the first five-year treatment cycle, these contracted services are expected to be needed for up to three years, with HRM staff and volunteers completing any remaining treatments and planning for the next five-year cycle in the remaining two years. The establishment of a volunteer

treatment program is highly recommended, drawing from both 1) other HWA treatment programs in Nova Scotia and 2) well-established community-based programs led by HRM staff like LakeWatchers. The establishment of a volunteer treatment program is well-aligned with the Parks Stewardship Program, expected to be considered by Halifax Regional Council in the autumn of 2025. Consideration of the creation of a dedicated resource position is also recommended. This position would include volunteer coordination and overseeing the ongoing maturation of Halifax's Hemlock Protection Program. While this position would primarily be focused on HWA management, it would include an additional focus on the growing list of additional invasive species threatening HRM's natural areas including (but are not limited to) emerald ash borer (EAB), Japanese beetle, knotweed, dog-strangling vine, yellow-floating heart, and zebra mussel.

The anticipated costs of this program are provided in *Table 1* below. It is important to note that costs are likely to change as biocontrol and other aspects of HWA management evolve.

	Description	Year 0	Year 1 (2025-26)	Year 2 (2026-27)	Year 3 (2027-28)	Year 4 (2028-29)	Year 5 (2029-2030)
Contractors	Anticipated cost for first three years of HWA treatment	-	$100,000	$150,000	$150,000	-	-
Treatment Equipment	All necessary equipment for undertaking staff/volunteer-led treatment	$25,000	-	-	-	-	-
Product	Estimated annual product cost assuming 100 trees per hectare on 50 ha of priority park with an average stem size of 40 centimeters	-	$19,800	$19,800	$19,800	$19,800	$19,800
Incidentals	Costs of replacement gear and replenishing supplies	-	-	$8,000	$5,000	-	-
Staffing	Environmental Professional anticipated to support this work beginning in 2028	-	-	-	-	$80,000	$80,000
	Annual Total	$25,000	$119,800	$177,800	$172,800	$99,800	$99,800

Table 1: Anticipated costs of Halifax's Hemlock Protection Program

As outlined in *Attachment A*, it is recommended that HRM initiate chemical/medicinal injection applications in hemlocks growing in 15 priority parks listed in order of priority below (outlined in detail in

Table 7 in the Plan). These locations amount to approximately 50 hectares (ha) of treatment area and have been determined using provincial mapping, consultation with HRM's Urban Forestry and Parks divisions, literature review, and public feedback. Some parks contain large individual hemlock trees in addition to (or in some cases rather than) high density stands of hemlocks. It is anticipated that additional sites will be added to the treatment list as HRM's Hemlock Protection Program matures.

1. Sandy Lake (including adjacent HRM-owned parcels not formally part of the park)
2. Hemlock Ravine Park
3. Admiral Cove Park
4. Sawgrass Drive Park and Oakfield Woods Park
5. Shubie Park
6. Clarence Court Park
7. Brookhill Drive Park 3
8. Duck Lake Brook Greenway Park
9. Gordon R. Snow Community Centre Park
10. Red Pond Bridge Park
11. Settle Lake Park
12. Sir. Sandford Fleming Park
13. Point Pleasant Park
14. Shaw Wilderness Park
15. First Lake (i.e., First Lake Regional Park, Alder Crescent Park, and Sackville River Linear Park)

FINANCIAL IMPLICATIONS

It is anticipated that the injection-based treatment costs outlined in the Hemlock Treatment and Management Plan will cost, on average, between $150,000 and $200,000 per year of each 5-year treatment cycle. Park and Recreation's has budgeted approximately $100,000 for HWA treatment for 2025/2026. In 2024/2025, Parks also purchased approximately $25,000 of injection-based treatment equipment which has the dual benefit of being compatible for EAB treatment in addition to HWA treatment. However, no insecticide has been purchased to date. Either Parks or Urban Forestry will initiate the contracting process with the intent of hiring a local contractor to undertake immediate assessment of the highest priority hemlock stands in the Municipality if the Plan is approved, using the current 2025/2026 Budget.

If Council approves the program, additional funding will be requested for 2026-2027 as a Service Enhancement, in the upcoming budget process. Staff will seek funding and other partnership opportunities to further support the program.

RISK CONSIDERATION

Eastern Hemlocks are a foundational species of Wabanaki-Acadian Forests and associated ecosystems. Yet, it is estimated that HWA, a pest smaller than a grain of rice, can kill up to 95% of hemlocks in as little as four years, with some stands experiencing complete hemlock mortality over time. If hemlocks are left untreated, there will be many consequences to consider. Mature hemlocks provide bank stabilization, shade and flood impact mitigation, water quality benefits—all services that are likely to become more critical in an increasingly uncertain climate future. Additionally, mass hemlock die-off is likely to increase the risk and severity of wildfire by contributing to fuel loads and the amount of deadwood within local forest stands.

The costs of failing to treat hemlocks include (but are not limited to):

- Natural disaster response from increased flooding, sedimentation, wildfire risk, windthrow, etc.,
- Loss of microclimates that promote cooler temperatures and moister forest conditions,
- Reduction in recreational value,
- Reduction in private property values due to declining hemlock canopies,
- Liability risks of spreading HWA between parks and privately held lands, and

- Increased maintenance and removal costs due to hemlock decline in parks and streetscapes.

Though there are risks associated with the use of chemical/medicinal treatments, these can be mitigated with proper use. The environmental and climate risks associated with not treating hemlocks outweigh the risk of responsibly implementing chemical/medicinal treatment.

COMMUNITY ENGAGEMENT

Preparing the HWA Plan has been an iterative learning process in collaboration with a network of experts and practitioners throughout the Canadian Maritime region and beyond. In 2024, HRM became one of the first municipalities in the province to join the HWA Maritimes Working Group—a coalition of organizations across Nova Scotia and beyond that are collaborating to share information, strategies, and resources to more effectively manage HWA and thus protect more eastern hemlocks. HRM also has staff representation on the Nova Scotia Invasive Species Council's Steering Committee, which has aided not only in the development of HWA treatment strategies but will inform strategies for other invasive species in the future.

In addition to these connections, public engagement has been a significant component of the HWA Management and Treatment Plan's development. Some notable examples include:

- Circulating a public engagement survey notifying residents of the risks of HWA and methods available to protect eastern hemlocks [Aug 2024~Nov 2024]
- Organizing a summer and fall of community engagement including a film screening, info sessions, and pop-up events in select HRM Parks [summer 2024]:
    - HWA informational pop-up at Hemlock Ravine Park – Jul 27, 2024
    - HWA informational pop-up at Point Pleasant Park – Aug 6, 2024
    - Invasive species walk and public awareness event at Albro Lake Park – Aug 8, 2024
    - Public engagement featuring an expert panel discussion and screening of HWA documentary *In the Quiet and the Dark* at Shubie Park – Aug 22, 2024
    - HWA info session and open house at Musquodoboit Harbour Public Library – Nov 15, 2024
    - Hemlock walk with Friends of Fleming Park at Sir. Sanford Fleming Park– Nov 17, 2024
    - HWA info session and open house at Sackville Public Library – Nov 19, 2024
- Appearing on CTV's Morning Live program and CBC Information Morning [Fall 2024]
- Hosting an Indigenous Gathering Circle for Mi'kmaq Elders and Youth to share their ideas and concerns regarding HWA treatment in the Halifax Region [Feb 2025]
- Hosting an interested party's information session with different levels of government, local utilities, and other organizations to ensure different parties are aware of the tactics and strategies planned by HRM and increase collaboration [Spring 2025]
- HWA surveys in HRM-owned and maintained parks around Halifax between 2024 and 2025:
    - Sandy Lake (April 2024, led by CFIA)
    - Hemlock Ravine (May 2025, led by HRM and attended by CFIA)
    - Mount Edward Park and Bisset Lake (June 2025, led by HRM and attended by students)

Significant effort was made to notify residents of the public engagement survey including the above-described media appearances and public engagement events. Print brochures and posters featuring a QR code were also circulated. Posters were displayed at all Halifax Public Library locations in addition to being dispersed to several other public spaces throughout HRM including:

Albro Lake Beach
The Black Cultural Centre for Nova Scotia
East Dartmouth Community Centre
Fairbanks Centre
Findlay Community Centre
George Dixon Centre
HRM Community Service Desk (Alderney)
Lawrencetown Beach Café
LeBrun Recreation Centre
The North Grove
North Preston Community Centre
Sackville Heights Community Centre
St. Andrew's Community Centre
St. Margaret's Centre
Wallace Lucas Community Centre
Zatzman Sportsplex

A synthesis of survey findings and other public feedback collected is provided in *Attachment A*.

ENVIRONMENTAL IMPLICATIONS

As described throughout this report, there are environmental implications of both treatment modalities, though the environmental risks of injections are likely lesser than what might be expected from basal bark spray. There are also significant consequences of doing nothing. The implications of the latter have been found to be more consequential than the impacts of proceeding with treatment. The loss of eastern hemlocks would cause irreversible changes to local ecosystems. Unlike other successional species, hemlocks are not expected to rebound, and their loss will not only result in significant habitat loss but will exacerbate climate change consequences already being observed on the landscape across HRM and indeed Nova Scotia. The loss of hemlocks from the forests of the Halifax region would fundamentally alter the landscape. Beyond biodiversity losses, there would also be profound changes to local fluvial geomorphology, which could result in a variety of outcomes including overland flooding, increased sediment and nutrient loading to waterbodies, more catastrophic wildfire, and many others.

ALTERNATIVES

That the Environment and Sustainability Standing Committee recommend that Halifax Regional Council:

1. Not approve the *Hemlock Woolly Adelgid (HWA) Treatment and Management Plan* (i.e., choose not to treat HWA). This will lead to widespread hemlock loss and the financial (e.g., cost of removal) and ecological (e.g., increased wildfire risk) implications associated with this choice.

2. Approve the *Hemlock Woolly Adelgid (HWA) Treatment and Management Plan* subject to modifications. This may require a supplementary staff report.

The alternatives listed are not recommended for reasons outlined in this report.

LEGISLATIVE AUTHORITY

Halifax Regional Municipality Charter, SNS 2008 c 39:

7A The purposes of the Municipality are to (a) provide good government; (b) provide services, facilities and other things that, in the opinion of the Council, are necessary or desirable for all or part of the Municipality; and (c) develop and maintain safe and viable communities.

35(1) The Chief Administrative Officer shall (a) coordinate and direct the preparation of plans and programs to be submitted to the Council for the construction, rehabilitation and maintenance of all municipal property and facilities; …

77(1) The Municipality may: (a) remove dead, dying or diseased trees on public and private property. (b) recommend and encourage (i) the proper pruning, protection, and repair of privately-owned trees in the Municipality, (ii) the planting of trees of suitable species at desirable sites within the Municipality.

79A (1) Subject to subsections (2) to (4), the Municipality may only spend money for municipal purposes if (a) the expenditure is included in the Municipality's operating budget or capital budget or is otherwise authorized by the Municipality; ...

By-law P-600, Respecting Municipal Parks

By-law T-600, Respecting Trees on Public Lands

ATTACHMENTS

Attachment A: Hemlock Woolly Adelgid Treatment and Management Plan

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Report Prepared by: Shauna Doll, Environmental Specialist / Environment and Climate Change - Property, Fleet and Environment 902.497.1588

Attachment A

Halifax Regional Municipality

Attachment A: Hemlock woolly adelgid (HWA)

Treatment and Management Plan

Halifax's Hemlock Protection Program

Prepared by:

Shauna Doll
Environment and Climate Change
2025

HALIFAX

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Acknowledgements

The Halifax Regional Municipality is located in Mi'kma'ki, the ancestral and traditional lands of the Mi'kmaq people. The municipality acknowledges the Peace & Friendship Treaties signed in this Territory and recognizes that we are all Treaty People.

The Halifax Regional Municipality honours and recognizes the importance of the Indigenous people (First Nation, Métis, and Inuit) and their cultural contributions to the tapestry of our region. The municipality recognizes the significant contributions of the Indigenous people and actively work together towards reconciliation and ensuring that our Indigenous members continue to enrich the fabric of the Halifax region.

The treatment options outlines in this report were developed with the support of many experts represented by a diversity of organizations, many of whom are gathered under the moniker of the Hemlock Woolly Adelgid Maritimes Working Group (membership indicated by an asterisk). Supporters and collaborators include:

- Confederacy of Mainland Mi'kmaq*
- Kwilmu'kw Maw-klusuaqn*
- Canadian Food Inspection Agency*
- Canadian Forest Service*
- Parks Canada*
- Nova Scotia Department of Environment*
- Nova Scotia Department of Natural Resources*
- Municipality of the District of Lunenburg*
- Town of Bridgewater*
- Town of Truro*
- Town of Kentville*
- Asitu'lisk
- Community Forests International
- Medway Community Forest Cooperative*
- Mersey Tobeatic Research Institute
- Nature Conservancy of Canada
- Nature Nova Scotia
- Nova Scotia Hemlock Initiative*
- Nova Scotia Working Woodlands Trust
- Ulnooweg Education Centre
- Halifax Water
- Nova Scotia Power

HRM gratefully acknowledges the immense support offered by these collaborators, without whom the compilation of this report would not have been possible.

Executive summary

Hemlock woolly adelgid (HWA) is a highly destructive invasive pest first detected in Nova Scotia in 2017 and in Halifax Regional Municipality (HRM) in 2023. It is known to decimate native eastern hemlock (Ksu'sk, *Tsuga canadensis*) populations in as little as four years. In 2023 HRM Regional Council provided staff direction to develop an *HWA Treatment and Management Plan* in alignment with the municipality's Integrated Pest Management Guidelines (2022) to protect local eastern hemlock populations. The development of this plan was undertaken by the Environment and Climate Change division of Property, Fleet and Environment with support from Parks and Recreation and Urban Forestry. It has been drafted to be representative of community input and best practices as defined by a community of collaborators throughout the province and across the eastern edge of North America. This plan was authored with a long-term goal of maintaining healthy eastern hemlock populations in HRM for current and future generations.

HWA Management and Treatment Plan objectives

The information contained within this Plan has been synthesized into short- and long-term objectives to provide clear metrics for measuring the efficacy of HWA management and treatment. All objectives have been designed to be SMART (specific, measurable, achievable, relevant, and time-bound).

Short-term

1. Treat, by chemical/medicinal injection, all 15 priority parks identified through the HWA Management and Treatment Plan development (*Table* 7) between 2025 and 2028 to protect eastern hemlocks from decline due to HWA infestation using a combination of staff time, contracted services, and voluntary community support.
    i. Adjustments to treatment areas may be required in the early stages of treatment (i.e., 2025-2026 treatment period) to ensure that the hemlocks protected against HWA are among the most ecologically, culturally, and socially valuable and the most at risk of loss from HWA. Any necessary adjustments to treatment areas will be made based on 1) on-the-ground surveys, 2) ongoing engagement with community members, and 3) continued monitoring of HWA spread in HRM.

2. In the 2028/2029 fiscal year, consider dedicating funding to the creation of an *Integrated Pest Management Coordinator* position to 1) manage the ongoing identification, treatment, and monitoring of high priority hemlock stands in HRM and 2) coordinate a volunteer pest management program (for both HWA and other high priority invasive species in HRM).

3. Ensure HWA treatment and management in HRM is representative of the best available knowledge by continuing to participate in provincial networks of HWA managers. This

will be achieved by HRM staff attendance at the monthly HWA Maritimes Working Group regular meetings and the annual HWA Managers meetings.

4. Include the community in HWA treatment through the organization of a minimum of four volunteer-powered HWA events annually and regular community updates on the HRM Invasive species webpage or the associated HalifACT Hub. Events may include surveying parks for hemlock presence, surveying hemlocks for HWA presence, stand assessments (*Appendix C*), tree marking and tagging (*Appendix D*), HWA treatment (*Appendices E and F*), and/or monitoring the health of treated hemlock trees (*Figure 12*).

5. During and between treatment windows, collaborate with the province and other jurisdictions with the goal of aligning treatment priorities. For example, treating areas like Hemlock Ravine Park that are co-owned by the municipality and the province.

Long-term*

1. In advance of anticipated follow-up treatment in 2030, undertake a review of the *HWA Management and Treatment Plan* and update treatment approaches as needed based on current best practices. It is suggested this work be commenced in 2028.

2. Anticipate and include costs of next round of treatment in 2030/2031 budget planning.

3. Undertake repeat treatments of all hemlocks treated between 2025 and 2026 in 2030 and 2031.

4. Support efforts by external organizations to introduce HWA biocontrol agents to HRM hemlock stands as opportunities arise throughout the lifetime of this plan.

*All long-term objectives should be modified at the end of every treatment period to be representative of the next five-year treatment cycle.

Background

Eastern hemlock (Ksu'sk)

Eastern hemlock (Ksu'sk*, Tsuga canadensis (L.) Carrière*) is a characteristic conifer species in the Wabanaki-Acadian Forest Region, which covers Canada's maritime provinces and extends to the United States through Maine, Vermont, New Hampshire, and New York. These are the Territories of the Mi'kmaq, Wolastoqiyik, and Passamaquoddy peoples.[1]

Eastern hemlock is often found growing in pure stands or alongside other characteristic Wabanaki-Acadian species such as eastern white pine (*Pinus strobus*), red spruce (*Picea rubens*), yellow birch (*Betula alleghaniensis*), and American beech (*Fagus grandifola*).[2] Oftentimes, the understory in mostly pure and mature hemlock stands will be populated predominantly by red spruce saplings.

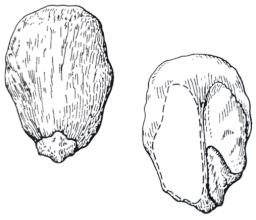
A drought-intolerant species, eastern hemlock prefers the cool, moist conditions of north-facing slopes, ravines, wetlands, and riparian zones.[3,4] Though there are four hemlock species native to North America, just three are found in Canada, and only eastern hemlock is native to the east coast. Eastern hemlock is often described as Canada's "most graceful conifer"[5], making it easy to identify once one is familiar with its form (*Figure 1*).

[1] Woodland Woman. 2021, Mar 4. Wabanaki-Acadian Forest: History, species, biodiversity. Wabanaki-Acadian Forest: History, Species, and Biodiversity. (ax. 2025, June).
[2] Hosie, RC. 1973. Native trees of Canada. 7th ed. Ottawa (ON): Canadian Forest Service & Department of the Environment.
[3] Ward, JS, Cheah, CAS-J, Montgomery, ME, Onken, BP& Cowles, RS. 2004. Eastern hemlock forests: guidelines to minimize the impacts of hemlock woolly adelgid. NA-TP-03-04, USDA Forest Service, Northeastern Area State and Private Forestry, Morgantown, WV. [ax 2024 May]
[4] Farrar, JL. 2017. Trees in Canada. 2nd ed. Ottawa (ON): Canadian Forest Service & Natural Resources Canada.
[5] *Ibid.* Hosie, 1973 (p. 76).

Trunk is profoundly tapered (particularly in mature trees), narrowing toward the crown. The leader (i.e. top branch) is often drooping in the opposite direction of prevailing winds. Branches are slender and flexible with branchlets forming horizontal flat sprays, which droop outwards toward the ends. Image adapted from Hosie, 1973.

Eastern hemlock twig and needles. Image adapted from Farrar, 2017

Eastern hemlock seed cone. Image adapted from Farrar, 2017



Eastern hemlock seed. Image adapted from Farrar, 2017

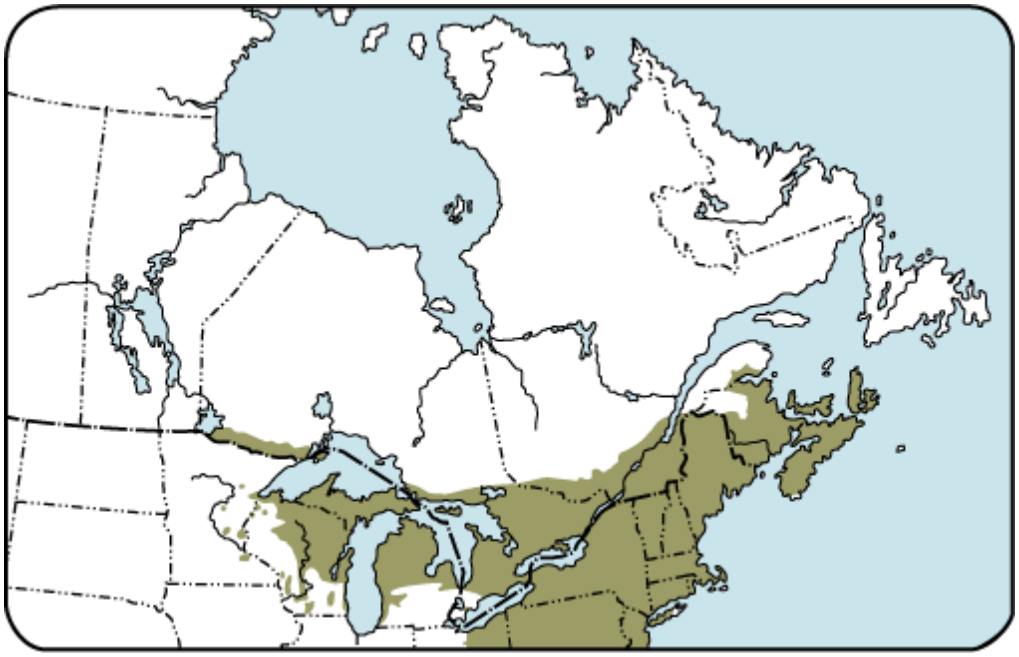
Figure 1: Identifying the eastern hemlock tree

Canada is the most northern limit of eastern hemlock's range. A narrow band of suitable habitat extends along the American border in southern Ontario and Quebec, and there are rare occurrences throughout Prince Edward Island, but New Brunswick and Nova Scotia (NS) host the majority of the Canadian eastern hemlock population (*Map 1*).[6,7] Its American extent

[6] Emilson, CE, Bullas-Appleton, E, McPhee, D, Ryan, K, Stastny, M, Whitmore, M., MacQuarrie, CJK. 2018. Hemlock woolly adelgid management plan for Canada. Sault Ste. Marie (ONT): NRCan, CFS. Report No. GLC-X 21.www.researchgate.net/publication/325581014_Hemlock_Woolly_Adelgid_Management_Plan_for_Canada. [ax 2024 May]

[7] Godman, RM & Lancaster, K. 1990. Tsuga canadensis (L.) Carr. Eastern hemlock. P. 604-612. In: Burns, RM & Honkala, BH, tech. coords. Silvics of North America: Vol. 1, Conifers. Agriculture Handbook 654. Washington (DC): USDA, Forest Service; 675 p

reaches as far south as the Appalachian Mountains of Georgia and Alabama and as far west as Minnesota.[8]



Map 1: The northern range of eastern hemlock.

Ecological significance

Eastern hemlock is among the longest-lived species in the Wabanaki-Acadian Forest Region. It is among the most shade tolerant species in eastern North America[9], which means it can live for decades supressed under the forest canopy. There are historical reports of eastern hemlock living more than 800 years[10], however they are more commonly reported to have a ≈400-year lifespan[11,12]. At present, the oldest living tree in the Canadian Maritimes known to science is the Panuke Lake hemlock, growing in Halifax County, NS. It was measured to be approximately 533 years old in 2021 meaning its life started sometime in the 1480's.[13] In some regions eastern hemlock has been known to reach heights of over 50 meters (m) and diameters of nearly 2 m[14], but in the twenty-first century heights of 30 m and widths of 1 m are more common for a mature eastern hemlock in most places[15]. The Panuke Lake hemlock was only 26 m tall with a diameter

[8] National Wildlife Federation. [date unknown]. Eastern hemlock forests. [ax 2024 May 3].
[9] *Ibid.* Ward et al. 2004
[10] *Ibid*. Godman & Lancaster, 1990.
[11] Boland, T. 2012. Trees and shrubs of the Maritimes. Portugal Cove St. Phillips (NFLD): Boulder Publications.
[12] *Ibid.* Farrar, 2017.
[13] Woudstra, E, Butt, B, & Bush, P. 2023. The oldest trees in the Maritimes: A stand analysis. Truro (NS): NS Dept of Natural Resources and Renewables. Forestry Tech Report No. 2023-001 [ax, 2025 March]
[14] *Ibid.* Ward et al., 2004.
[15] Trees, insects, and diseases of Canada's forests database. 2015. Group 5: Hemlocks, Eastern hemlock. Natural Resources Canada, Canadian Forest Service. [updated 2015, August]. https://tidcf.nrcan.gc.ca/en/trees/factsheet/75 [ax 2024 May].

of about 80 cm at the time of its aging, demonstrating that for shade-tolerant and sometimes slow growing eastern hemlocks, size is not always an accurate indicator of age.

In addition to being among the longest-lived species in Wabanaki-Acadian forests, eastern hemlocks are a foundation species. Such species can be thought of as ecosystem backbones, performing essential functions that shape and influence the ecosystems around them.[16] As noted above, eastern hemlock often grows in dense stands. As these stands mature, they create local micro-climates and unique habitat features.[17] Because eastern hemlock trees often grow in riparian areas (i.e., along waterways and waterbodies), they are important to maintaining specific conditions in both aquatic and terrestrial habitats.

For example, streams flowing through hemlock forests often have better water quality, more stable temperatures, more regulated streamflow, and higher oxygenation levels.[18,19,20] Hemlock roots knit stream banks together, stabilizing shorelines and their branches intercept precipitation reducing nutrient runoff and splash erosion. Taken together, these services create improved habitat conditions for aquatic species like brook trout (*Salvelinus fontinalis*), Atlantic salmon (*Salmo salar*), and a variety of macroinvertebrates. In fact, hemlock-dominated watersheds have been found to support more aquatic biodiversity overall compared to other species compositions in the same geographic range.[21,22]

Meanwhile on land, a thick, healthy hemlock canopy supports a comfortable microclimate that is more shaded, cooler, and moister than nearby areas. This deep shade slows decomposition rates, creating conditions that are unique to hemlock-dominated forests, satisfying the lifecycle and habitat requirements for a diversity of plant and animal species.[23] It is estimated that more than 120 vertebrate species spend time in mature hemlock stands.[24]

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[16] Ellison, AM. 2019. Foundation species, non-trophic interactions, and the value of being common. *iScience*. 13: 254-268. DOI: 10.1016/j.isci.2019.02.020. [ax 2025 March].
[17] Lustenhouwer, MN, Nicoll, L, & Ellison, AM 2012. Microclimate effects of the loss of a foundation species from New England Forests. Ecosphere. (3)(3):26. DOI: 10.1890/ES12-00019.1. [ax 2025 March].
[18] Crossland, D, Miller, M, Rodger, MJ, Hunsinger, J. 2022. Potential options for a comprehensive chemical treatment program to conserve eastern hemlock in Nova Scotia from hemlock woolly adelgid and lessons learned from other jurisdictions. Unpubl. report NS Dept. Environment and Climate Change, Medway Community Forest Coop Ltd., 91 pp.[ax 2024 March].
[19] Hemlock Restoration Initiative. [date unknown]. The importance of hemlocks. https://savehemlocksnc.org/hemlocks-hwa/the-importance-of-hemlocks/. [ax April 2025]
[20] Ellison, AM, Barker-Plotkin, AA, Foster, DR, & Orwig, DA. 2010. Experimentally testing the role of foundation species in forest: the Harvard Forest Hemlock Removal Experiment. *Methods in Ecology and Evolution.* 1(2):168–179. DOI: 10.1111/j.2041-210x.2010.00025.x. [ax 2025 April].
[21] Ross, R, Bennett, R, Snyder, C, Young, J, Lemarie, D. 2003. Influence of eastern hemlock (Tsuga canadensis L.) on fish community structure and function in headwater streams of the Delaware River basin. *Ecology of Fresh Water Fish.* 1: 60-65. DOI: 10.1034/j.1600-0633.2003.00006.x. [ax April 2025]
[22] *Ibid*. Ward et al., 2004.
[23] Ellison, et al., 2010.
[24] DeGraaf, RM, Yamasaki, M, Leak, WB, & Lanier, JW. 1992. New England wildlife: Management of forested habitats. Gen. Tech. Rep. NE-144. Radnor [now Newtown Square], PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station; 271 p

Mammal species like porcupine (*Erethizon dorsatum*) and white-tailed deer (*Odocoileus virginianus*) also depend on hemlock forests. Though the latter are not native to the Wabanaki-Acadian Forest system, they have been present in the province for more than 100 years and young hemlock foliage is an essential early season browse.[25,26] Additionally, there are a number of bird species known to have a marked association with hemlock dominated forests in NS, including the Black-throated Green Warbler (*Setophaga virens,* see *Figure 2*), Blackburnian Warbler (*Setophaga fusca)*, American Goldfinch (*Spinus tristis*), Boreal Chickadee (*Poecile hudsonicus*), Ruffed Grouse (*Bonasa umbellus*), Pine Siskin (*Spinus pinus*), Red Crossbill (*Loxia curvirostra*), White-winged Crossbill (*Loxia leucoptera),* and Ovenbird (*Seiurus aurocapilla*).[27,28,2930] In total, as many as 90 bird species throughout the eastern hemlock's native range are known to have a specific association with the iconic tree species. Some of these species are not known to nest anywhere else.[31,32]

Figure 2: Black-throated Green Warbler on a hemlock branch. Photo by Paul Turbitt.

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[25] Shubenacadie Wildlife Park. [date unknown]. White-tailed deer. https://wildlifepark.novascotia.ca/animals/white-tailed-deer.asp. [ax 2025 April].
[26] *Ibid.* Hemlock Restoration Initiative. [date unknown].
[27] Winstead, Randy. 1995. Old Growth Report Shenandoah National Park. Luray, Virginia. pp. 17-22.
[28] Nova Scotia Hemlock Initiative. [date unknown]. Eastern hemlock. https://nshemlock.ca/node/110. [ax 2024 May]
[29] Simpson, J. 2015. Restoring the Acadian Forest. 2nd ed. Halifax (NS). Nimbus Publishing.
[30] Jonas, SZ, Xi, W, Waldron, JD, & Coulson, R.N. 2012. Impacts of hemlock decline and ecological considerations for hemlock stand restoration following hemlock woolly adelgid outbreaks. *Tree and Forestry Science and Biotechnology,* 6 (Special Issue 1):22-26. https://research.fs.usda.gov/treesearch/40466 [ax 2025 April]
[31] *Ibid.* Hemlock Restoration Initiative, [date unknown]
[32] Ross, RM, Redell, LA, Bennett, RM, & Young, JA. 2004. Mesohabitat use of threatened hemlock forests by breeding birds of the Delaware River Basin in Northeastern United States. *Natural Areas.* 24(4) 307-315. https://www.researchgate.net/publication/287682206_Mesohabitat_use_of_threatened_hemlock_forests_by_breeding_birds_of_the_Delaware_River_basin_in_northeastern_United_States [ax 2025 April]

Hemlocks are also expected to be an important species under future climate scenarios. Given that NS is the northern limit of their range, eastern hemlocks are expected to increase in presence, abundance, and distribution, while according to come projections, colder-climate species like balsam fir (*Abies balsamea)* and white birch (*Betula papyrifera*) are expected to decline.[33]

Despite its ecological importance, according to the International Union for Conservation of Nature (ICUN)'s Red Book, the global population of eastern hemlock is decreasing and considered "Near Threatened".[34] Further, as a characteristic old growth forest species throughout its Canadian range, eastern hemlock may be considered by some to be of even greater conservation concern given that as little as 1% of the original extent of Wabanaki-Acadian old growth is still be standing today.[35]

Yet, even in their afterlife, hemlocks provide for the species of the forest. Standing dead trees, once known as "snags" now more commonly known as wildlife trees, provide habitat for birds, insects, and other wildlife species. As they age, fall to the ground, and begin decomposing, they enrich the soil, transforming into prolific "nurse logs". A nurse log is a fallen tree that creates ideal conditions for the growth of new trees and other plants. They also hold moisture in the ground, which can help in the prevention of catastrophic wildfire risk.[36]

There is no tree species in the Wabanaki-Acadian Forest region that can sufficiently fill the ecological niche currently occupied, and indeed created by, eastern hemlock.[37,38] Though some theorize that there may be potential substitutes like eastern white pine[39] or eastern white cedar (*Thuja occidentalis*) (Jarrar, personal communication, 14 Jan, 2025), these hypotheses have not yet been scientifically proven.

Economic significance

Despite their capacity to reach such impressive age and size, eastern hemlock trees produce knot-ridden and split-prone lumber. Thus, they have never been highly prized by the forestry industry excepting in the production of coarse wood products like pallets and railway ties and for

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[33] Steenberg, JWN, Duinker, PN, Bush, PG. 2013. Modelling the effects of climate change and timber harvest on the forests of central Nova Scotia, Canada. *Annals of Forest Science.* 70: 61-73.DOI 10.1007/s13595-012-0235-y. [ax 2025 April]
[34] Farjon, A. 2013. Tsuga canadensis. The IUCN Red List of Threatened Species 2013: e.T42431A2979676. https://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T42431A2979676.en. [ax 2025 April].
[35] Mosseler, A, Lynds, JA, & Major JE. 2003. Old-growth forests of the Acadian Forest Region. Environmental Reviews. 11(S1): S47-S77. DOI:10.1139/a03-015 [ax 2024 March]
[36] Doll, S. Waldick, R, Tolsma, K, Kelly, C, Mineau, P. 2023. Fire risk reduction in the Coastal Douglas-fir biogeoclimatic zone: A practitioners report. ISBN: 978-1-7381090-0-5. [ax 2024 March]
[37] *Ibid*. Ward et al., 2004.
[38] Limbu, S, Keena, MA, & Whitmore, MC. 2018. Hemlock Woolly Adelgid (Hemiptera: Adelgidae): A non-native pest of hemlocks in Eastern North America. *Journal of Integrated Pest Management*, 9(1), 1. DOI: 10.1093/jipm/pmy018. [ax 2024 May]
[39] *Ibid.* Ward et al., 2004.

supportive uses like timber framing.[40, 41] It also does not make ideal firewood as it throws sparks when burnt and its hard knots can easily dull an axe or saw.[42] This could be a reason that individual old growth eastern hemlock trees can sometimes be found in second- and third-growth—and sometimes even younger—forests in NS, a phenomenon easily observed in Sir. Sanford Fleming Park on the Northwest Arm in HRM.

Low quality lumber did not prevent eastern hemlock decimation in early colonial North America, however. Due to the high tannin concentration in its bark (10-12%), eastern hemlock was commercially harvested for tanning leather. This grew from a cottage industry to major industrial activity in the late nineteenth century, with approximately 64 tanneries in the Catskill Region of New York alone harvesting an estimated 70 million hemlock trees.[43, 44] This generally involved felling a hemlock tree, stripping and collecting the bark, and leaving the naked trunk behind to rot on the forest floor. The hemlock tannin harvest quickly spread throughout eastern North America, resulting in plummeting hemlock numbers that, according to some accounts, never fully recovered.[45, 46] However, just as quickly, the demand dwindled as the once abundant hemlock forests disappeared from the landscape and the chemical compounds that drove this decline were replaced with more readily available and cheaper products. For a brief time between the mid-1950s and 1970s the industry was revived as new uses for hemlock tannin were found in different industries, but ultimately its use was again found to be unsustainable and the industrial-scale tannin manufacturing plants closed. In more recent times, eastern hemlock harvesting is mostly driven by the pulp and paper industry.[47,48,49]

Eastern hemlock is also valued as an ornamental species. Due to their fine leaves, shade tolerance, and year-round full canopy they are often planted as a hedge or centrepiece in some gardens.[50] They are also sometimes propagated on tree farms to be sold as Christmas trees,

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[40] *Ibid.* Farrar, 2017.
[41] *Ibid.* Simpson, 2015.
[42] *Ibid.* Hosie, 1973.
[43] Canham, HO. 2011. Hemlock and hide: The Tanbark industry in old New York. https://rb.gy/zoonhs. [ax 2025 April].
[44] Hergert, HL. 1989. Hemlock and spruce tannins: An odyssey. In: Hemingway, RW, Karchesy, JJ, Branham, SJ. (eds) Chemistry and significance of condensed tannins. Springer, Boston, MA. DOI: 10.1007/978-1-4684-7511-1_1. [ax 2025 April]
[45] *Ibid.* Canham, 2011.
[46] Godman, RM & Lancaster, K. 1990. Tsuga canadensis. Pp. 604-612, In: Burns, RM & Honkala, BH. Silvics of North America. Volume 1.Conifers. USDA Forest Service Agric. Handbook 654, Washington, D.C. https://dendro.cnre.vt.edu/dendrology/USDAFSSilvics/116.pdf. [ax, 2025 April].
[47] *Ibid.* Godman & Lancaster, 1990.
[48] Nesom, G. 2002. Eastern hemlock. In United States Department of Agriculture Natural Resources Conservation Service's Plant Guide. https://plants.usda.gov/DocumentLibrary/plantguide/pdf/pg_tsca.pdf. [ax. 2025 April]
[49] Natural Resources Canada. 2024. Eastern hemlock. Trees, insects, mites and diseases of Canada's Forests: Trees. https://tidcf.nrcan.gc.ca/en/trees/factsheet/75 [ax. 2025 April].
[50] University of Vermont. [date unknown]. UVM Tree Profiles: Eastern hemlock – what do humans use it for? https://libraryexhibits.uvm.edu/omeka/exhibits/show/uvmtrees/eastern-hemlock/what-do-humans-use-it-for- [ax. 2025 April].

though once cut eastern hemlocks quickly shed their leaves making it a less preferable choice to more suitable Christmas tree species like balsam fir and white pine.

Cultural significance

According to one historic account, the utility of hemlock tannin "was first discovered during colonial times in North America."[51] This is a false claim. The harvest and use of hemlock bark for a variety of uses, including tanning leather, increasing water resistance of clothing, and making dye has been practiced by Indigenous peoples throughout the eastern hemlock's range since time immemorial. In fact, it is likely that early settler "discovery" of the myriad uses of hemlock bark was the result of Indigenous peoples sharing their Knowledge (Johnson, personal communication, 20 Feb, 2025). Demonstrative of this history: the Mi'kmaq word for eastern hemlock, Ksu'sk, is a reference to the tree's bark and its uses.

There are also ancient medicinal uses for hemlock. Because of its astringency, a poultice can be made from bark to help wounds heal more quickly. A tea high in vitamin C can be made from leaves and branches to combat kidney issues and help ease other sickness. Hemlock cambium also has a history of being used in cooking, being mixed with animal fat and dried berries to make a nutrient-dense food similar to pemmican.[52]

Further, eastern hemlock trees are a beloved tree by Indigenous and settler people alike. Though they once grew prolifically across Nova Scotia's landscape, they now are best known in smaller, but notable and cherished patches like the *Hemlocks and Hardwoods* trail in Kejimkujik National Park, the lock-side trails in Shubie Park, Hemlock Ravine Park, and old growth areas around Sandy Lake. Even as their population has dwindled, these trees have defined the landscape in this province for as long as people have found their homes here. American poet, Henry Wadsworth Longfellow is oft quoted in conversations about hemlocks due the vivid picture his epic *Evangeline: A Tale of Acadie* (1847) paints of the landscape as it existed at the time of the mass expulsion of the Acadian people in 1755:

> *"This is the forest primeval. The murmuring pines and the hemlocks,*
> *Bearded with moss, and in garments green, indistinct in the twilight,*
> *Stand like Druids of eld, with voices sad and prophetic,*
> *Stand like harpers hoar, with beards that rest on their bosoms.*
> *Loud from its rocky caverns, the deep-voiced neighboring ocean*
> *Speaks, and in accents disconsolate answers the wail of the forest."*

[51] *Ibid*. Hegert, 1989. p. 4
[52] *Ibid*. University of Vermont, [date unknown].

Beyond the many uses for eastern hemlock found out by humans, this species is inherently valuable. Eastern hemlocks have an innate right to stand on the landscape as they have since before there were people around to exploit them. Further, they have a shared history and established relationships with countless species native to the same range that are likewise inherently valuable. Unfortunately, the very existence of eastern hemlock is now threatened by a tiny, clonal insect no larger than a single pepper flake.

Hemlock woolly adelgid (HWA)

Eastern hemlock is being decimated throughout its native range by a tiny invasive insect from East Asia known as Hemlock woolly adelgid (*Adelges tsugae*) or HWA, so named for the wool-like material they produce that covers their bodies and the egg sacs they lay on the underside of eastern hemlock branches.[53] An explanation of the difference between an invasive and a native species has been provided in *Table 1*.

A note about invasive species

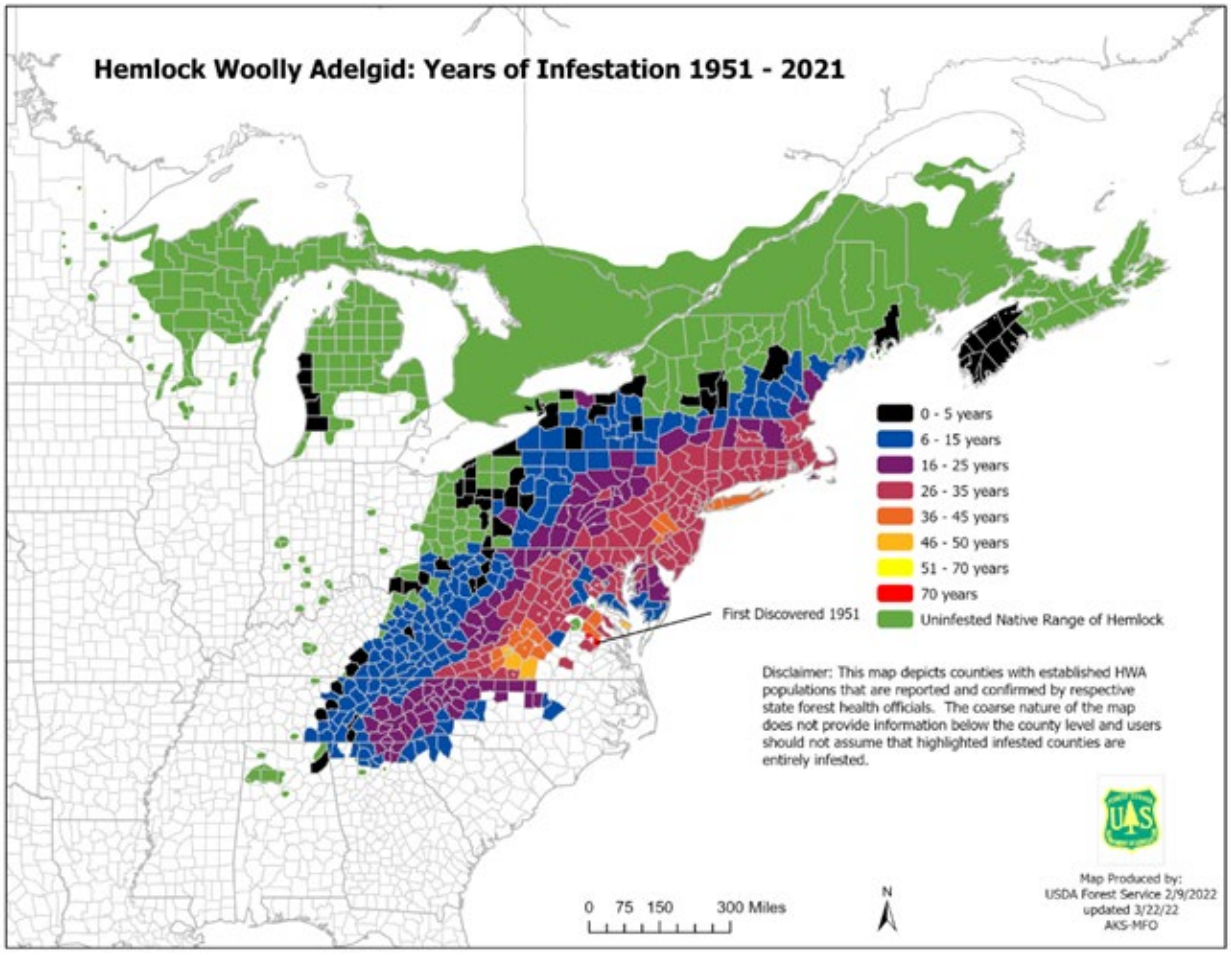
When a species is native to a given region, it has a shared life history with the other species from that place. This means they have co-evolved alongside each other, developing relationships that keep populations and ecological processes in balance. When a new species is introduced, it can throw off that balance. An invasive species is one that is introduced from somewhere else and spreads so prolifically that it outcompetes native species causing economic and environmental harm. In some cases, they can also pose a human health risk, when a plant is toxic for example. Though not all non-native species are invasive, many newly introduced species have the potential to be disruptive to local ecosystems, particularly as the climate changes and potentially creates preferrable conditions for certain species.

Table 1: Definition of invasive species

In their native range, which includes China, India, Japan, Korea, Taiwan, and western North America, HWA populations rarely grow large enough for them to be considered an invasive pest.[54,55] This is due to the presence of natural predators and a higher natural resistance in host hemlock trees.[56,57] In its introduced range; however, it is highly destructive. Symptoms are usually visible in as little of two years and mortality of a centuries old tree can occur in as little as three years, but sometimes trees will subsist for up to 15 years post-infestation.[58,59] One of

[53] Nealis, VG. 2024. Balsam woolly adelgid. *Trees, insects, mites, and diseases of Canada's forests.* https://tidcf.nrcan.gc.ca/en/insects/factsheet/5314. [ax 2025 April].
[54] *Ibid.* Limbu et al., 2018.
[55] CFIA. 2021. Adelges tsugae (HWA) - Fact Sheet. https://inspection.canada.ca/plant-health/invasive-species/insects/hemlock-woolly-adelgid/fact-sheet/eng/1325616708296/1325618964954 [ax 2024 May].
[56] *Ibid.* Emilson et al, 2018.
[57] Cheah, C, Montgomery, ME, Salom, S, Parker, BL, Costa, S, Skinner, M. 2004. Biological control of hemlock wooly adelgid. *US Forest Service.* http://www.fs.fed.us/na/morgantown/fhp/hwa. [ax. 2024, May]
[58] Doccola, J, Hascher, W, Aiken, J, & Wild, P. 2012. Treatment strategies using imidacloprid in hemlock woolly adelgid (Adelges tsugae Annand) infested eastern hemlock (Tsuga canadensis Carrière) *Trees. Arboriculture & Urban Forestry.* 38(2), 41–49. DOI: 10.48044/jauf.2012.008. [ax 2025 April]
[59] *Ibid.* Limbu et al. 2018

the earliest detections of HWA occurred in eastern North America occurred in Virgina in 1951 when it was found on infested nursery stock from southern Japan.[60] However, there are other reports that suggest its presence in the United States has been known since the 1920s.[61] It has since spread across eastern North America at an average rate of 7.6–20.4 km/year[62] and now occurs in 20 eastern American States and the Canadian provinces of Ontario and NS[63] as illustrated in *Map 2.*



Map 2: Rate of HWA spread since its initial detection in Virgina (1951). Note that because this map is recent only until 2021, the "Uninfested Native Range of Hemlock" layer is no longer accurate. HWA is now present in HRM and neighbouring Hants County. Map from USDA Forest Service, 2022.

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[60] Havill, NP, Vieira, LC, Salom, SM. 2014. Biology and control of hemlock woolly adelgid. FHTET-2014-05. Morgantown, WV: U.S. Department of Agriculture, Forest Service, Forest Health Technology Enterprise Team. 21 p. [ax 2025 March]

[61] Aldrich, E. 2024, Feb 14. Trees in peril: Eastern hemlock. *The Nature Conservancy*. https://www.nature.org/en-us/what-we-do/our-priorities/tackle-climate-change/climate-change-stories/trees-in-peril/. [ax. 2025, Jul].

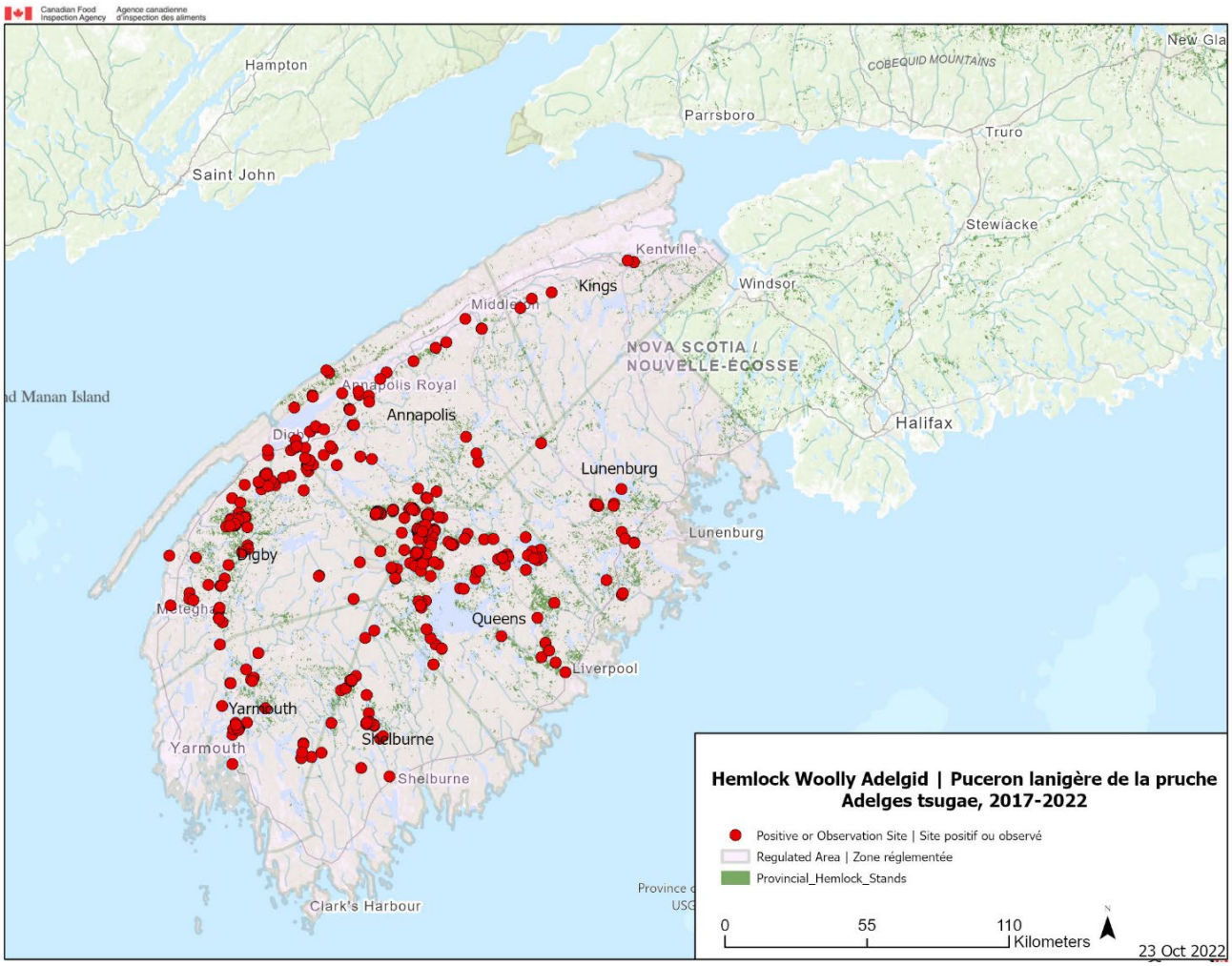
[62] Trotter, RT, Morin, RS, Oswalt, SN, Liebhold, A. 2013. Changes in the regional abundance of hemlock associated with the invasion of hemlock woolly adelgid (Adelges tsugae Annand). Biological Invasions, 15: 2667–2679. DOI: 10.1007/s10530-013-0482-3. [ax 2024 May].

[63] *Ibid.* Limbu et al., 2018.

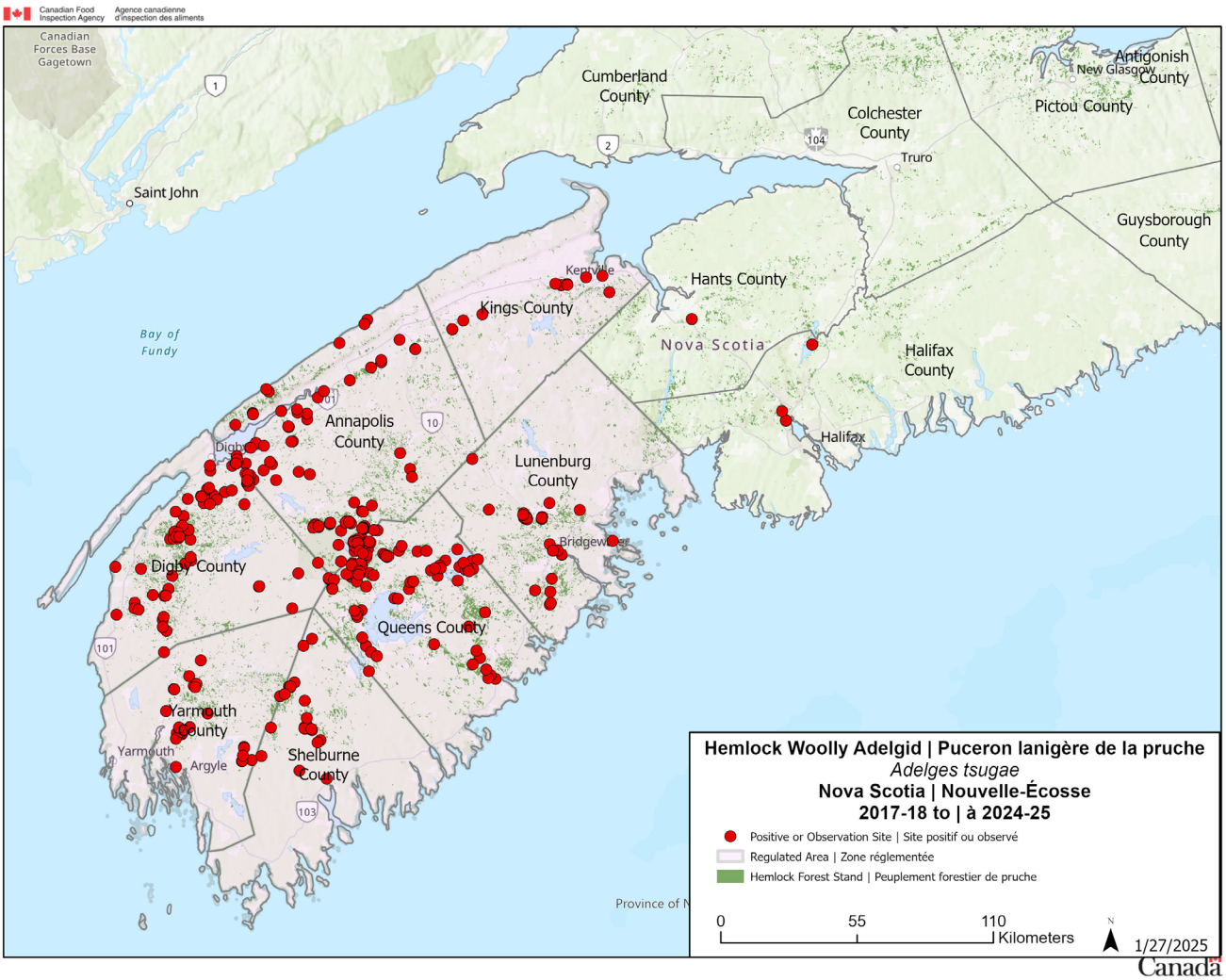
HWA in Nova Scotia and HRM

HWA was first detected in NS in 2017 in Yarmouth and Digby Counties and was subsequently confirmed in Shelburne County.[64] However, many experts believe it was likely present in NS up to a decade before the first official confirmation. Next, HWA was detected in the counties of Lunenburg, Kings, Queens, and Annapolis between 2017 and 2022.[65] This spread is illustrated in *Map 3*. It was found for the first time in the HRM in 2023 in the community of Bedford. Two additional confirmed reports were made in 2024 in a similar geographic area including around Sandy Lake in the Bedford area and Oakfield Provincial Park. These new detections within HRM are illustrated in *Map 4*.

[64]CFIA. 2017. Hemlock woolly adelgid confirmed in Nova Scotia. https://www.canada.ca/en/food-inspection-agency/news/2017/08/hemlock_woolly_adelgidconfirmedinnovascotia.html [ax 2024 May].
[65] CFIA. 2022. Amended hemlock woolly adelgid [Adelges tsugae (Annand)] infested place order. https://inspection.canada.ca/plant-health/invasive-species/insects/hemlock-woolly-adelgid/infested-place-order/eng/1591829961468/1591829961828 [ax 2024 May].



Map 3: HWA distribution in NS between 2017 and 2022. Map created by the Canadian Food Inspection Agency, 2022.



Map 4: HWA distribution in NS between 2017 and 2025. Map created by the Canadian Food Inspection Agency, 2025.

In late spring and early summer of 2024, eDNA traps deployed by the Canadian Forest Service (CFS) detected HWA in Hemlock Ravine Park (Bedford) and Shubie Park (Dartmouth). However, the eDNA signals were relatively weak and thus the presence of HWA in these parks is not definitive. These results indicate that these parks are high priority for visual surveys to acquire visual confirmation of HWA presence. Regardless of whether HWA is currently present in these parks it is a near certainty that HWA will be detected in all areas where eastern hemlock grows in the Halifax Region within a few short years.

Impacts of HWA

HWA only affects hemlocks. In eastern North American this means Carolina hemlock (*Tsuga caroliniana*) and eastern hemlock. As noted earlier in this report, only the latter grows in eastern Canada.[66]

When HWA arrives on a hemlock branch, it attaches its long mouth parts to new buds, sucking the fluid and nutrients from young twigs. This reduces rates of photosynthesis and ultimately results in water stress and nutrient deficiency. Needles will begin to turn yellow and fall off. eventually killing the tree.[67] It is estimated that HWA can kill up to 95% of hemlocks in as little as four years and some stands experience complete hemlock mortality.[68] It is theorized that decline may occur more rapidly in drought stressed trees[69] and coastal systems[70]. Following an HWA infestation, seas of discoloured, defoliated (i.e., missing leaves or needles), and dying trees are left behind, sometimes referred to as "Grey Ghosts" as shown in *Figure 3*.[71] Unlike early successional species (i.e., those that first grow after a disturbance like a hurricane), such as balsam fir, hemlocks are not expected to rebound. This means the loss of eastern hemlock from the landscape may be permanent.[72]

Figure 3: Grey Ghosts shown in the Linville Gorge area of Pisgah National Forest in North Carolina. Photo by Steve Norman, USDA Forest Service.[73]

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[66] *Ibid.* Limbu et al., 2018.
[67] *Ibid.* Limbu et al., 2018.
[68] Crossland, D. Hemlock Woolly Adelgid (HWA) in HRM. Presentation at: Halifax Regional Municipality's Environment and Sustainability Standing Committee Meeting; 2024, March 7; Halifax, NS. https://www.halifax.ca/city-hall/standing-committees/march-7-2024-environment-sustainability-standing-committee [ax 2025 March]
[69] *Ibid.* Limbu et al., 2018
[70] *Ibid.* Crossland, 2024
[71] Ackerman, N. In the quiet and the dark [video]. Season 23, Episode 21 of *Absolutely Canadian.* CBC Gem. 2023, October 6, 0~44minues. [ax 2025 May]. https://gem.cbc,ca/absolutelycanadian.
[72] *Ibid.* Crossland, 2024.
[73] Guo, Q, Potter, K, M., Ren, H, & Zhang, P. 2023. Impacts of exotic pests on forest ecosystems: An update. *Forests*, 14(3), 605. DOI:10.3390/f14030605. [ax. 2025, June].

Characteristically, foundation species, like eastern hemlocks, are regionally common and locally abundant. Usually this means such species are not of immediate conservation concern. However, when a major disturbance, like the introduction of a pathogen or pest, drives widespread decline the impacts can be catastrophic.[74]

Though it is challenging to determine the degree of ecological change that will accompany hemlock decline and die-off due to different tree densities and other site specifics across the species' range, generally it can be expected that there will be:

- changes in local tree, invertebrate, and vertebrate populations due to significant habitat shifts[75]
- increased opportunity for invasive species introductions that were once prevented by the shade coverage from dense hemlock canopies. Knotweed (*Fallopia japonica*), for example, though fairly shade tolerant has been observed to be limited in its spread under hemlock canopies in some parts of HRM.[76] Garlic mustard (*Alliaria petiolate*) and tree of heaven (*Ailanthus* altissima) are other examples of species that may thrive in the absence of hemlock.[77]
- changes in soil chemistry and moisture regimes[78]
- fluctuations in local transpiration rates and the hydrological cycle, which will influence local temperatures and shifts in water flows, this will likely have impacts on local salmonid populations.[79]

In sum, mass loss of hemlock across the landscape alone would be devastating. Unfortunately, the effects of this loss will be compounded by other ecological disturbances due to climate change.[80] For example, as hemlocks die and dry out, standing dead trees become more susceptible to windthrow and more flammable. Meanwhile, climate change compounds this risk by increasing intensity and frequency of high wind events and the risk of catastrophic wildfire. These are just two examples of climate-related risk associated with hemlock loss. A synthesis of other examples of compounding consequences of mass hemlock dieback and climate change can be seen in *Figure 4*.

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[74] *Ibid*. Ellison et al., 2010.
[75] *Ibid*. Ward et al., 2004.
[76] *Ibid*. Zonas et al., 2012.
[77] Sweeney, J. 2021. Review of non-target impacts of imidacloprid. https://nshemlock.ca/sites/nshemlock.ca/files/JS_Review%20of%20nontarget%20impacts%20of%20imidacloprid_wf.pdf. [ax. 2025, May, 2025].
[78] *Ibid.* Zonas et al., 2012.
[79] Brantley, S., Ford, CR, & Vose, J.M. 2013. Future species composition will affect forest water use after loss of eastern hemlock from southern Appalachian forests. *Ecological Applications,* 23(4): 777-790. DOI: 10.1890/12-0616.1 [ax. 2025 May].
[80] Gray, J. Nova Scotia Forest Pest Condition Update. Presentation at Nova Scotia Forest Health Workshop 2024, April 23; Truro NS.

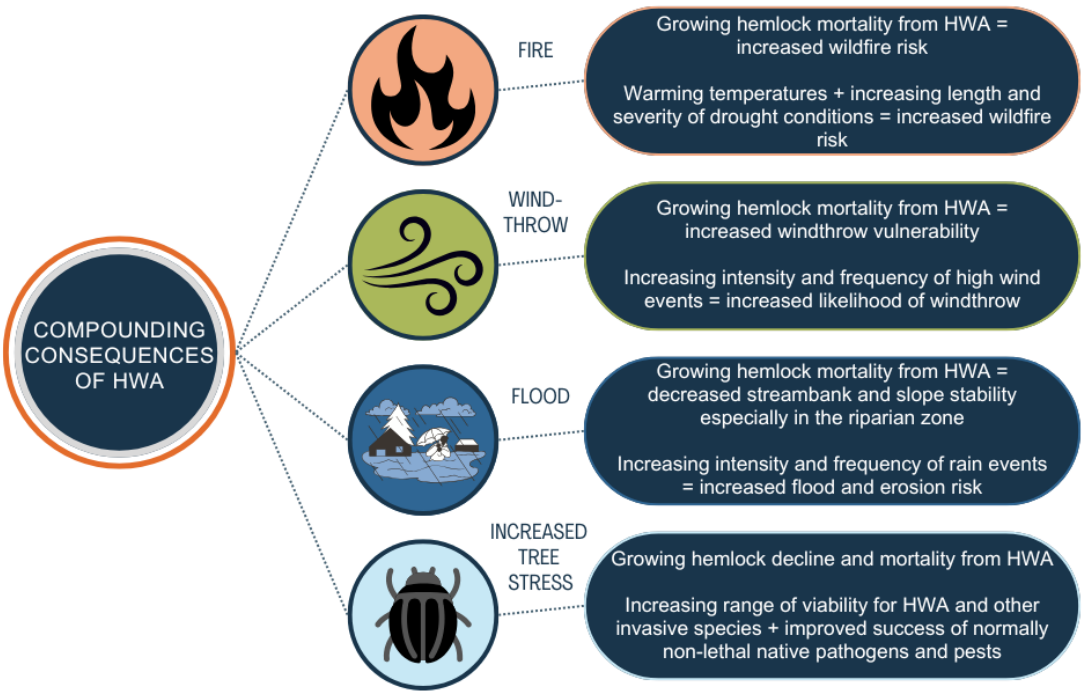
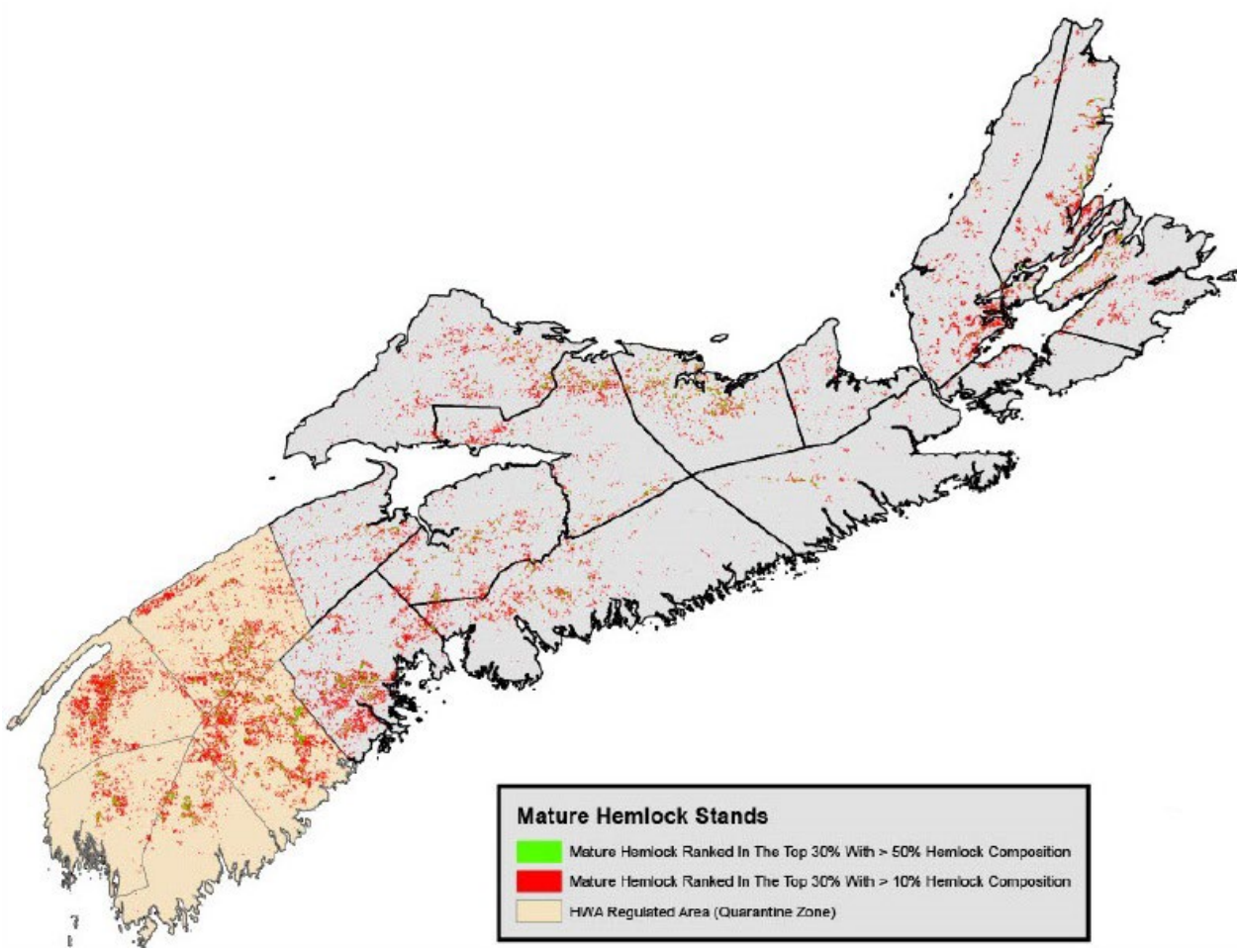


Figure 4: Some of the compounding consequences of HWA-driven hemlock loss and climate change. Figure adapted from Ogden, 2025.[81]

As climate change exacerbates the consequences of HWA infestations, so too does the HWA infestation exacerbate the climate crisis. Mass mortality of hemlocks means increased carbon emissions at a time when the maintenance of intact forests and other ecosystems as carbon sinks is more important than ever. Though some early research estimated that HWA spread in forests of the eastern United States would only reduce forest carbon uptake by 8% between 2000 and 2040, and 12% between 2040 and 2100[82], according to Nova Scotia-based forest ecologists, eastern hemlocks have superior carbon sequestration capacity comparative to other species in the Wabanaki-Acadian forest region, due to their "long-life span, large dimensions, slow decay rates and a longer growing season [relative to] deciduous trees" (p.6)[83]. Further, given that a high proportion of the limited amount of remaining old growth forest in Nova Scotia

[81] Ogden, J. Provincial Update – Nova Scotia. Presentation at Atlantic Forest Health Workshop; 2025, January 14~16; Charlottetown, PEI.
[82] Albani, M, Moorcroft, PR, Ellison, A.M., Orwig, DA, Foster, DR. 2010. Predicting the impact of hemlock woolly adelgid on carbon dynamics of eastern United States forests. Canadian Journal of Forest Research, 40(1): 119–133. DOI: 10.1139/X09-167. [ax 2024, May].
[83] *Ibid.* Crossland et al., 2022.

(i.e., by some estimates less than 1% of its original extent[84]) is populated by eastern hemlock[85], and old growth forests are known to have a greater carbon sequestration capacity than younger forests[86] it is important to conserve the old growth giants that remain. *Map 5* illustrates the remnants of mature hemlock stands in Nova Scotia, some of which still occurs in the most populated area of the province: HRM.



Map 5: Distribution of mature hemlock stands in Nova Scotia. Green indicates stands with more than 50% hemlock composition, red indicates stands with more than 10% mature hemlock composition and the yellow overlay indicates the area regulated by CFIA for HWA spread as of 2020. Map by NS Department of Lands and Forestry.

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[84] Davis, M, Gratton, L, Adams, J, Goltz, J, Stewart, C, Buttrick, S, Zinger, N, Kavanagh, K, Sims, M, Mann, G. date unknown. New England-Acadian Forests. *World Wildlife Fund.* New England-Acadian forests | Ecoregions | WWF. (ax. 2025, Jan).

[85] Mosseler, A, Lynds, JA, Major, JE. 2003. Old-growth forests of the Acadian Forest Region. *Environmental Reviews, 11 (S1).* 47-77. DOI: 10.1139/a03-015. (ax. 2025, Jan).

[86] McGarvey, J, Thompson, JR, Epstein, HE, Shugart, HH Jr. 2015. Carbon storage in old-growth forests of the Mid-Atlantic:toward better understanding the eastern forest carbon sink. *Ecology, 96 (2):* 311-317. DOI: 10.1890/14-1154.1. [ax. 2025, May]

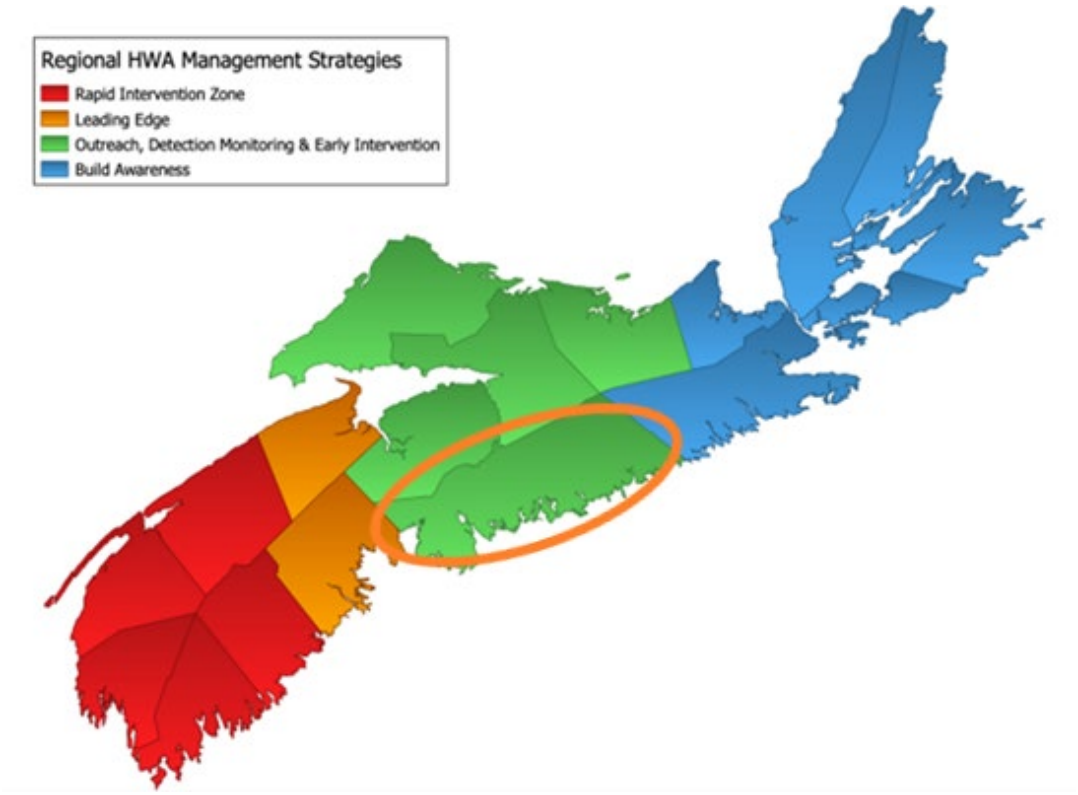
The economic consequences of mass hemlock die-off can be equally severe. Research shows that the cost of invasive forest pests is largely borne by homeowners and municipal governments, usually outweighing the cost of federal government containment programs by at least one order of magnitude.[87] However, the cost of protecting trees from forest pests through treatment programs, thus minimizing or delaying mortality, generally proves to be more cost effective than responding to the fallout from doing nothing. For example, in the case of a different forest pest, emerald ash borer (EAB, *Agrilus planipennis*) introduced to Canada in 2002, the annual federal cost to contain spread ranges from $500,000 to $2 million. However, this generates benefits between $35 and $252 million annually (depending on assumed regulation efficacy) for municipalities, homeowners, and other interested parties.[88]

While the context of HWA is different than EAB, given eastern hemlocks are not a common street tree, unlike ash species (*Fraxinus spp.)*, the economic costs of failing to treat hemlocks are likely to be high. Costs of doing nothing include (but are not limited to):

- Natural disaster response from increased flooding, sedimentation, wildfire risk, windthrow, etc.,
- Reductions in recreational value, and
- Reduction in private property values due to declining hemlock canopies in parks other municipally owned lands adjacent to private properties.

More specific costs expected for an HWA treatment and management program for HRM are summarized in the *Budget* section of this report. Without urgent action, most of HRM's hemlock forests will be badly impacted by HWA. As little as two years ago HRM was considered to be in the early intervention stage of Invasive Pest Management prioritization as shown in *Map 6*, but it is rapidly shifting toward being at the leading edge

[87] Aukema, JE, Leung, B, Kovacs, K, Chivers, C, Britton, KO, Englin, J, Frankel SJ, Haight, RG, Holmes, TP, Liebhold, AM, McCullough, DG, Von Holle, B. 2011. Economic impacts of non-native forest insects in the continental United States. *PlusOne,* 6(9):1-7. DOI: 10.1371/journal.pone.0024587 [ax.2025 May]
[88] McKenney, D. EAB Cost/Benefit Analysis: Pest Economics. Presentation at EAB Workshop; 2024, March 26~27; Moncton, NB.



Map 6: HWA intervention zones in Nova Scotia. Red indicates the "Rapid Intervention Zone" meaning HWA is well-established, urgent action is needed, and significant hemlock loss is already being experienced. Orange indicates the "Leading Edge Zone" where HWA is establishing, and thus action plans need to be rolled out post haste. Green indicates the "Outreach, Detection, Monitoring, and Early Intervention Zone" meaning HWA is not yet present or has only recently been detected and proactivity is key to avoiding the worst hemlock losses. Blue indicates the "Build Awareness Zone", where HWA has not been detected, but preparations should be made to ensure decision-makers are ready when it arrives. Map by Crossland et al., 2022 (with orange oval over HRM added).

Physical and lifecycle description of HWA

HWA are small brown insects often mistakenly described as aphids. Though they are aphid-like, adelgids are a discrete group of insects with a complex life history[89], which has been illustrated in *Figure 5***.** In North America there are two distinct but overlapping HWA generations per year: sistens and progrediens.[90]

[89] *Ibid.* Nealis, 2024.
[90] *Ibid.* CFIA. 2021.

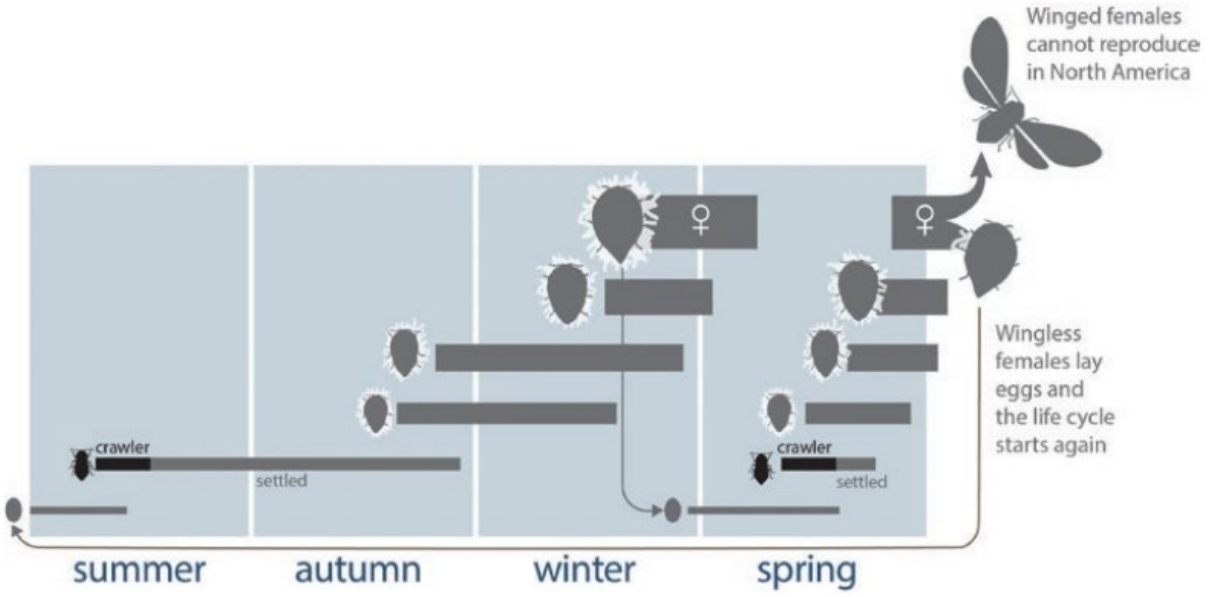


Figure 5: Simplified lifecycle of HWA within its introduced range in North America. Illustration borrowed from Havill et. al.

The HWA population in eastern North America is parthenogenic. This means that they are all-female and reproduce without males. Each generation experiences six stages of development: egg, four nymphal instars (i.e., stages), and adult.[91] When in their first instar (i.e., first nymphal phase), HWA are often called “crawlers” because this is the only time when they are mobile. In all other instars they are sessile (i.e., not moving about). When HWA is in the crawler stage—from April to September in NS—risk of spread is highest.

Sistens are the first generation and can be thought of as the overwintering generation. They hatch in late spring to early summer and survive about nine months, laying their eggs in early spring.[92] A single female can lay up to 300 eggs (but more typically between 50 and 175), which hatch to produce the second spring generation: the progrediens, consisting of both winged and wingless offspring. Progrediens survive for about three months, with the wingless individuals laying their eggs (between 25 and 125 per adult female) in early summer. The winged individuals, called sexuparae, are a sexually reproducing generation meaning they require male individuals to produce offspring. They also require the presence of a specific host species, tiger-tail spruce (*Picea torano*), which is not present in eastern North America.[93] This generation has not been observed to have reproduced or even survived in their introduced range. Despite the sterility of the winged generation, the rapid life cycle and bi-annual reproductive cycle of the

[91] Maine Department of Agriculture, Conservation, and Forestry. [date unknoqn]. Hemlock woolly adelgid life stages. https://www.maine.gov/dacf/mfs/forest_health/insects/hemlock_woolly_adelgid_life_stages.htm#:~:text=Hemlock%20woolly%20adelgids%20are%20all%20female%20in%20northeastern,adult.%20There%20are%20two%20overlapping%20generations%20per%20year. [ax 2025, March 17]
[92] *Ibid.* CFIA, 2021
[93] *Ibid.* Limbu et al., 2018

remaining two generations have allowed the HWA population to explode and spread rapidly across eastern North America.

Detecting and reporting HWA

Both generations of HWA are tiny and difficult to see with the naked eye. They are much easier to detect by the presence of their ovisacs (i.e., egg sacs). Newly laid HWA eggs are amber and darken to reddish brown as they mature. They measure between 0.35 ± 0.04 mm long and 0.21 ± 0.03 mm wide. The eggs are encompassed by a protective waxy coating produced through pores on the body surface of adult adelgids. Once laid, the egg sacs resemble cotton balls or clumps of snow, as shown in *Figure 6*. HWA lay their eggs on the underside of hemlock twigs at the base of tree needles. Though in NS, these egg sacs can be visible throughout fall, winter, and early spring, spring is the most likely time to see them.[94]

Figure 6: Adult HWA and ovisacs on an eastern hemlock branch. Photo by Jeff Ogden, Nova Scotia Department of Resources.

Typically, HWA arrives in the higher branches of a hemlock first, so egg sacs may not be immediately visible from the ground. A high-powered flashlight might be helpful in spotting these hard-to-see places. Other tactics for finding HWA include checking a tree trunk for bits of woolly material after rainfall; inspecting the underside of fallen hemlock branches immediately surrounding a standing tree; and checking shorter hemlocks around the base of taller trees.

[94] NS Hemlock Initiative. [date unknown]. When and how to detect HWA. https://www.nshemlock.ca/node/186 [ax 2025, March 17]

In the absence of visible egg sacs, signs of stress in what would otherwise be a healthy hemlock or stand of hemlocks can be indicative of HWA presence. For example, eastern hemlock typically produces sprays of lime green foliage in spring. If such growth is not present and/or noticeable needle loss, discoloration, and/or twig and branch dieback has occurred, it is possible that HWA is present.

When detected in NS, HWA should be reported to the Nova Scotia Invasive Species Council (NSISC)[95] or the Canadian Food Inspection Agency (CFIA)[96]. A report can also be made by recording an observation using the app, iNaturalist. If detected in the Halifax region, all invasive species sightings (or suspected sightings) should also be reported to HRM by calling 311.

HWA success and spread in eastern North America

There are four essential factors that have made HWA such a successful invader in North America. The first is their incredible asexual fecundity, which means that a single individual can result in an entirely new population, with some reports estimating that one individual can produce a population of 5,000 in just one year.[97]

The second is a lack of natural predators. In British Columbia (BC), HWA is believed to have been present for over 20,000 years. As such, though HWA preys on western hemlock (*Tsuga heterophylla*) trees in BC, it does so without killing them because HWA is controlled by at least four local predators.[98] In NS there is no natural predator present to control the spread of HWA.

The third is climate change. Historically, HWA was not reported in regions of eastern North America that experienced minimum low temperatures of -26.5 to 28.8º Celsius (C)[99,100] and overwintering mortality has been reported to be over 90% when temperatures fall below -20ºC and up to 100% when they fall to -35ºC or colder[101]. Warming temperatures are expanding HWA's northward range and will likely exacerbate its spread through Nova Scotia by reducing the overwintering mortality that once helped to keep populations at bay.[102] Research even shows that HWA's cold tolerance has been growing due to brief exposures during shorter cold

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[95] Nova Scotia Invasive Species Council. [date unknown]. Report an invasive species. https://nsinvasives.ca/report-an-invasive-species/ [ax 2025, April 20].
[96] CFIA. 2024. Invasive species. https://inspection.canada.ca/en/plant-health/invasive-species [ax 2025, April 30]
[97] *Ibid.* Crossland, 2024.
[98] *Ibid.* Limbu, et al., 2018.
[99] Sheilds, KS & Cheah, CAS-J. 2005. 2002-2003 Winter mortality of hemlock woolly adelgid in the northeastern United States. In: Gottschalk, Kurt W., ed. Proceedings, XV U.S. Department of Agriculture interagency research forum on gypsy moth and other invasive species 2004; 2004 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-332. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 72. [ax 2025 April 29].
[100] Paradis, A, Elkinton, J, Hayhoe, K & Buonaccorsi, J. 2007. Role of winter temperature and climate change on the survival and future range expansion of the hemlock woolly adelgid (Adelges tsugae) in eastern North America. Mitigation and Adaptation Strategies for Global Change. 13: 541–554. DOI: 10.1007/s11027-007-9127-0 [ax 2025, April 29]
[101] *Ibid.* Limbu et al., 2018.
[102] Irwin-Borg. 2019. Potential effects of climate change on mortality of the invasive species hemlock woolly adelgid (*Adelges tsugae*) in Nova Scotia, Canada. Unpublished Undergraduate Thesis, Dalhousie University, Halifax, NS.

snaps.[103] And because of their ability to asexually reproduce, if even one individual survives the winter, the population can easily rebound as temperatures warm in the spring. The reality of the role climate change is playing in HWA spread was starkly demonstrated at an HWA Managers Meeting in summer 2024 hosted in Liverpool, NS when representatives from across Canada and several eastern States including Georgia, Maine, New York, and Ohio reported on the spread of HWA within their jurisdictions. Every report noted that lowered overwintering HWA mortality due to increased average winter temperatures and reduced average snowpack were at least partially to blame for ballooning HWA populations and rates of spread (personal communication, July 30 - August 1, 2024).

The fourth factor that has supported HWA's incredible success in eastern North America is the ease with which they spread. Wind and rain are common vectors of spread with a natural dispersal rate of 30km/year or less.[104] Given their tiny size, individuals require assistance to move any sizeable distance beyond the tree where they hatched and their near invisibility to the naked eye makes HWA a highly proficient hitchhiker. Animals like birds and deer moving through an infested forest or landing in or rubbing against an infested tree can easily spread HWA well beyond the natural dispersal rate. However, humans are largely responsible for transporting HWA over long distances. Some of the most common ways this happens include the movement of infested plant material like nursery stock and firewood; an individual travelling between an HWA-infested area to a non-infested area without cleaning off shoes, clothing, camping gear, etc.; and pets picking up HWA in their coats.

Though human spread of HWA is generally accidental, it is a serious problem and biosecurity measures need to be taken to slow and prevent further spread. Simple actions people can take to reduce their contribution to this problem include:

- Actively monitor hemlock trees in their neighbourhoods for infestation and report suspected HWA sightings to 311, the NSISC, and/or CFIA.
- Avoid hanging bird feeders on or near hemlock trees.
- Only buy hemlock trees from **local** suppliers, check with the supplier to ensure that they are aware of HWA, and inspect trees carefully before purchasing.
    - Be prepared to consider treating planted hemlocks once they reach maturity
    - Consider planting other tree species as companions or alternatives (see *Table 2* for planting ideas) for the next 5-10 years
- Always use a lint brush on clothes and a bristled brush on shoes after spending time in a hemlock forest (especially if HWA presence has been confirmed in the area). If there are plans to visit another park in the area that may have hemlock present, consider changing clothes first.

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[103] Elkinton, JS, Lombardo,JA, Roehrig, AD, McAvoy, TJ, Mayfield, A, & Whitmore, M. 2017. Induction of cold hardiness in an invasive herbivore: The case of hemlock woolly adelgid (*Hemiptera: Adelgidae*). *Environmental Entomology, 46:* 118-124. DOI: 10.1093/ee/nvw143. (ax. 2025, June).
[104] *Ibid.* Emilson et al., 2018.

- Consult with local experts to determine what treatment options are available for hemlock trees growing on privately held lands.
- Visit www.nshemlock.ca or https://www.halifax.ca/about-halifax/environment-climate-change/lakes-rivers/nature-biodiversity/invasive-species-halifax for information on HWA and to find out more about upcoming volunteer events to assist with treatments to minimize HWA damage
- **Always** purchase firewood locally.

Tree species	Justification
Eastern white-cedar (*Thuja plicata)*	Often smaller in form than most mature hemlocks (though with a capacity to grow to 50 metres in some places), eastern white-cedar, while rare can be found in association with eastern hemlock. When found together, it is likely in their mutually preferred moist to wet habitat. Like eastern hemlock, eastern white-cedar is long-lived (there are records of eastern white-cedar living beyond 700 years) with a dense canopy, and decay-resistant wood. Eastern white-cedar is also a typical browse for many of the same species that favour hemlock. However, eastern white-cedar is naturally less common in the Wabanaki-Acadian Forest region than hemlock and may struggle in a warming climate. Eastern white-cedar is also relatively shallow rooted which may make it more susceptible to windthrow compared to hemlock. Eastern white-cedar may be the best option in areas with moist to wet, but not water-logged sites with alkaline soils.
Red spruce (*Picea rubens*)	Though at maturity red spruce may lack the lower limb structure typical of eastern hemlock, they have the potential to provide thermal cover to support similar microclimates. They are a similarly longed-lived species (200-400 years) that provide quality habitat for a range of wildlife species native to the Wabanaki-Acadian Forest region. Like hemlocks, red spruce is shade tolerant and can survive suppressed under the canopy for decades. Red spruce has a widespread range throughout Nova Scotia and tolerates a variety of soil and environmental conditions.
Black spruce (*Picea mariana*)	Despite being a smaller and shorter-lived (150-200 years) species than hemlock. Black spruce dominated forests provide excellent habitat for a variety of wildlife, including large mammals, songbirds and amphibians. They host ecosystem biodiversity features like dwarf mistletoe and old man's beard lichen which provide services such as nesting material and a winter food source. Like hemlock, black spruce can provide thermal cover, but this coverage is generally sparser comparative to red and white spruce. Black spruce can tolerate poor, waterlogged, swampy soils and thus may be a good option for wet and riparian areas.
White spruce (*Picea glauca*)	A wide-spread species across Canada, white spruce is one of the country's most commercial timber species. Though fairly common in Nova Scotia, white spruce is more typical to the province's Maritime Boreal habitats than the mixed-wood forests of the Wabanaki-Acadian Forest Region. As such, eastern hemlock is not typically an associate. However, white spruce dominated stands often provide thermal cover for large mammals and often retain their lower limbs and thus may mimic the thermal services provided by hemlocks. Fairly shade tolerant and moderately long-lived (250-300 years), white spruce

	is quite adaptable to a variety of environments, often found growing in old abandoned agricultural fields.
Eastern white pine (*Pinus strobus*)	The tallest growing tree in eastern Canada, the eastern white pine is a fast-growing and moderately long-lived species (average 200 years) with a varied list of habitat preferences. Few pests cause eastern white pine mortality, and their fire-resistant bark may make them a good option for more fire prone areas. Though a common companion of eastern hemlock, eastern white pine is not very shade tolerant, and their feathery canopies do not foster the same understory conditions expected in hemlock forests.
Red pine (*Pinus resinosa*)	Red pine is confined to more southern areas of Nova Scotia and generally grows in rockier, drier, and more infertile soils than eastern hemlock. Similarly shade intolerant but significantly stouter than the eastern white pine, red pine may not be the most direct substitute for eastern hemlock. However, their widespread root systems make them quite windfirm and thus useful as windbreaks, snow breaks, and shoreline protection.

Table 2: A selection of planting alternatives to eastern hemlock. [105,106,107,108,109] This is not intended to be a complete list. It is meant to serve as a short-term guide while HWA management and control is established in HRM, and indeed across Nova Scotia. It is important to note that this list was assembled assuming conifer alternatives are a more direct proxy for hemlock compared to broadleaf species. However, due to climate change driven wildfire risk, it may be advisable in some areas to consider broadleaf species in new planting projects because they are generally less flammable and more resilient to fire than most conifer species.

It is important to note that some ecologists, botanists, and other experts encourage continued planting of eastern hemlocks despite ongoing and anticipated HWA-driven population declines (Priesnitz, M, personal communication, 29, Jul 2025). This is because predator/prey relationships and natural defences evolve over time in response to threat exposure and other influences. In the case of hemlock, planting trees now or leaving target trees untreated may reveal existing resistance to pressure from HWA or allow natural resistance to develop over time. However, it is important to note that these sorts of defences naturally evolve at timescales that are typically well-beyond the average human lifespan. As such, natural and bred HWA resistance in eastern and Carolina hemlock (along with invasive predator resistance of other vulnerable species like American beech and ash species) has become an expanding field of research. The Hemlock Restoration Initiative in collaboration with North Carolina State University and the *Trees in Peril* project led by the Nature Conservancy in collaboration with research institutions, non-profit partners, and public agencies are two examples of a growing

[105] *Ibid.* Farrar, 2017.
[106] *Ibid.* Hosie, 1973.
[107] LeBlanc, HAD. 2025. An analysis of the influences on eastern hemlock succession in the aftermath of hemlock woolly adelgid infestation in Nova Scotia, Canada.[Unpublished honours thesis]. Saint Mary's University. https://library2.smu.ca/bitstream/handle/01/32144/LeBlanc_Hannah_Honours_2025.pdf?sequence=1&isAllowed=y. [ax. 2025, Jul].
[108] Jackson, D. 2015. Conifer alternatives to eastern hemlock. *Central Pennsylvania Forestry.* https://centralpaforest.blogspot.com/2015/05/conifer-alternatives-for-eastern-hemlock.html [ax. 2025, Apr].
[109] Neily,P, Basquill, S, Quigley, E, Keys, K, Maston, S, Stewart, B. 2022. Forest ecosystem classification for Nova Scotia (2022): Field Guide. *Forestry and Wildlife Branch, Natural Resources and Renewables.* Biodiversity Tech Report 2023-002. [ax. 2025, Jul].

effort to enhance host resistance against pest invasions and therefore safeguard native biodiversity.[110,111]

Connection to HRM's strategic priorities and plans

Invasive species management is connected to several HRM plans and strategies including: the Urban Forest Management Plan (initiated in 2012 and updated in 2025)[112], the Halifax Green Network Plan (2018)[113], HalifACT (2020)[114], the Integrated Pest Management Guidelines (2022)[115], and the upcoming Park Stewardship Strategy (2025)[116]. These connections are explained in more detail below.

Urban Forest Management Plan (UFMP)

In 2012, HRM approved a comprehensive urban forestry plan then known as the Urban Forest **Master** Plan, it was updated in 2025 and rebranded as the Urban Forest **Management** Plan (emphasis added to underscore the change to the plan title). It provides direction for planning, programming and regulatory activities related to managing and enhancing urban forest cover in the Halifax region. The UFMP supports all four priorities identified in HRM's 2021-2025 *Strategic Priorities Plan:* Prosperous Economy, Communities, Integrated Mobility, and Environment, as a thriving urban forest supplies all four types of ecosystem services.[117] Though there are myriad examples one example for each priority is provided below as an illustration:

An abundant urban forest canopy:

- increases property values (*Prosperous Economy*)[118],
- provides physical and mental health benefits to residents (*Community*)[119],
- improves air quality making active transport a healthy and more enjoyable option (*Integrated Mobility*), and

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[110] Hemlock Restoration Initiative. date unknown. Genetic approaches. https://savehemlocksnc.org/solutions/genetic-approaches/. [ax. 2025, Jul].
[111] *Ibid.* Alrich, 2024.
[112] HRM. 2025. Urban Forest Management Plan. https://cdn.halifax.ca/sites/default/files/documents/home-property/cc_pd_250429_ufmp_final-web.pdf. [ax. 2025, Jul].
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[114] HRM. 2020. HalifACT" Acting on Climate Together. https://cdn.halifax.ca/sites/default/files/documents/about-the-city/energy-environment/HRM_HaliFACT_vNew%20Logo_.pdf/ [ax. 2025, June].
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[116] HRM. 2025. Parks Stewardship Strategy. https://cdn.halifax.ca/sites/default/files/documents/city-hall/standing-committees/250821cped81.pdf. [ax. 2025, Aug].
[117] World Wildlife Federation. [date unknown]. Ecosystem services. *Understanding conservation.* [ax. 2025 May]. https://www.nwf.org/Educational-Resources/Wildlife-Guide/Understanding-Conservation/Ecosystem-Services
[118] Escobedo, FJ, Adams, DC, & Timilsina, N. 2015.Urban forest structure effects on property value. *Ecosystem Services*, 12: 209-217. DOI: 10.1016/j.ecoser.2014.05.002. (ax. 2025, May)
[119] O'Brien, LE, Urbanek, RE, & Gregory, JD. 2022. Ecological functions and human benefits of urban forests. *Urban Forestry & Urban Greening,* 75. DOI: 10.1016/j.ufug.2022.127707. (ax. 2025, May).

- intercepts stormwater flows reducing flood and waterway contamination risk (*Environment*)

More specific to HWA response, the UFMP identifies invasive species management as a "major concern" alongside climate change and extreme weather, an aging tree population, limited program resources, and urban development. As such, several UFMP action items are either partially or wholly dedicated to better developing HRM's response to invasive species introductions and associated compounding consequences. The most notable among them include:

> 3.1 C Implement, expand, and improve HRM's Integrated Pest Management Strategy to ensure invasive species of concern such as hemlock woolly adelgid and emerald ash borer are monitored, treated, and controlled.
>
> 3.3 E: Prepare an invasive species management strategy
>
> - Most hemlocks within HRM's jurisdiction grow in woodlands, there are very little hemlocks planted as street trees. This is a particularly significant action item as HWA and invasive species, will need to be managed through coordination of multiple different land types and a larger management strategy will be vital in this coordinated effort. locks within HRM's jurisdiction grow in woodlands.
>
> 4.1F: Leverage community capacities to support volunteer invasive species removal events

Halifax Green Network Plan (HGNP)

First approved in 2018, the HGNP was implemented to provide land management and community design direction to maintain ecologically and culturally important land and aquatic systems, promote sustainable use of natural resources and economically important open spaces and to identify, define and plan land suited for parks and corridors. One of the primary functions of preserving ecological connectivity through corridors is to safeguard essential habitat for the non-human species in HRM. For example, charismatic megafauna like the mainland moose (*Alces alces americana*) are wide-ranging and territorial, thus requiring a significant amount of unfragmented habitat for satisfying all lifecycle requirements.

Invasive species pose a significant risk to habitat maintenance due to their ability to effectively outcompete essential native species. They can be very opportunistic, readily filling ecological niches as they become available. For example, the widespread loss of a keystone species like hemlock will result in canopy openings and temperature changes that are likely to create ideal conditions for some invasive species to establish in new territories. These invasives may then outcompete native understory species and thus reduce local biodiversity. In this way, invasive species introductions can cause an ecological cascade.

The HGNP includes two actions related to invasive species management including:

Action 8: Update the landscaping requirements in the Land Use By-laws to support the implementation of the Urban Forest Master Plan by prohibiting the use of invasive species.

Action 17: Explore opportunities to develop on-going partnerships with Provincial Government departments, universities and non-profits to refine, maintain and update the key datasets needed to understand the health of the Region's ecosystems, wildlife populations and wildlife movement corridors, including the spread of invasive species.

While HGNP Action 8 will be supported through the delivery of invasive species management actions outlined in the UFMP, Action 17 has been especially supported through the development of the *HWA Management and Treatment Plan* due to the significant amount of collaboration that was essential to its completion. Collaborators include: other municipalities in Nova Scotia including Bridgewater, Kentville, and Truro among others; provincial government including the Nova Scotia Departments of Natural Resources and Environment; federal government agencies including the Canadian Food Inspection Agency, the Canadian Forest Service, and Parks Canada; First Nation government representatives including Kwilmu'kw Maw-klusuaqn; local not-for-profits and charitable organizations including Medway Community Forest Cooperative, Community Forests International, and The Ulnooweg Education Centre among others; local utilities, Nova Scotia Power and Halifax Water; and others. A complete list of collaborators can be found in the Acknowledgements section of this report.

In addition to these overarching actions on invasive species, Objective 4.5.3.2. "*Identify, preserve and celebrate valued cultural landscapes in the design and management of open spaces and developments*" is also relevant to the treatment of HWA. Because HWA presents a direct threat to places like Hemlock Ravine Park, which are valued cultural landscapes, management strategies that address the risk are needed.

HalifACT

HRM has been a long-time actor on climate change, being the fifth city in Canada to join the Federation of Canadian Municipalities' Partners for Climate Protection in 1995. However, though there were plans developed and targets set over decades, none were sufficient to drive the systemic change demanded by the scientific evidence. In 2020, Halifax Regional Council unanimously adopted HalifACT 2050, a transformational, ambitious, and scientifically informed long-term climate action plan. It is comprehensive in that its actions range from retrofitting all municipal buildings, to electrifying the municipal fleet, to educating the public, to enhancing municipal biodiversity.

Though HalifACT has not outlined specific actions directly targeting invasive species management, naturalization is a significant focus of section 5.2.7 Natural Area and Green Asset Protection. Invasive species management is a critical step in most naturalization efforts and further, invasive species removal initiatives are a common gateway to getting community members involved in park stewardship. The actions laid out in HalifACT that have been

supported by the development of the *HWA Management and Treatment Plan* and will continued to be supported by its implementation include:

> **20**: Fund and implement the Green Network Plan and Urban Forest Management Plan
>
> **21**: Continue the naturalization program through pilot projects, public education and awareness to support the development of a region-wide naturalization program
>
> **22**: Develop and implement a region-wide tree planting and re-greening program
>
> **34**: Work purposefully, meaningfully, and collaboratively, with the Mi'kmaq and other groups seeking reconciliation, including African Nova Scotian communities

Integrated Pest Management Guidelines

Integrated Pest Management (IPM) is a flexible and ecologically informed approach to invasive species management. Among other things, IPM aims to:

- minimize risks to human health and the environment,
- avoid the use of pesticides as much as possible,
- maximize operational feasibility and cost-effectiveness in decision-making, and
- maintain adaptability to ensure best practices are followed even as they evolve with practice and emerging research.

Halifax first adopted an Integrated Pest Management Guidelines in 2022. Prior to this, different municipal Business Units (BUs) took a piecemeal approach to pest management as capacity allowed largely through regular right-of-way maintenance by Public Works, Park Operations and Urban Forestry activities. This approach continues today but is becoming insufficient as an increasing number of invasive species arrive in the region due to anthropogenic spread and changing climate conditions. In 2022, the HRM developed the IPM Guidelines in response to the increasing risks of invasive species and pests. The Guidelines aim to address gaps in current pest management practices by providing a formalized, holistic, and ecological approach with reduced pesticide use.

The development of a treatment and management plan for hemlock woolly adelgid (HWA), is the first time a comprehensive and fully operational management plan has been developed to combat an invasive species in Halifax (though a plan was created for emerald ash borer (EAB) in 2019, it has not yet been formally operationalized).

According to the Invasion curve (*Figure 7*), which is a pillar of most IMP strategies, the most effective invasive pest management strategy is to prevent introduction. However, since HWA's arrival in North America in the 1950's, eradication efforts have been unsuccessful. As demonstrated by *Maps 3 and 4*, its movement across Nova Scotia since its first detection in the province in 2017 has remained steady. Long past containment, long-term control of HWA is the only option to reduce further cost and ecological loss.

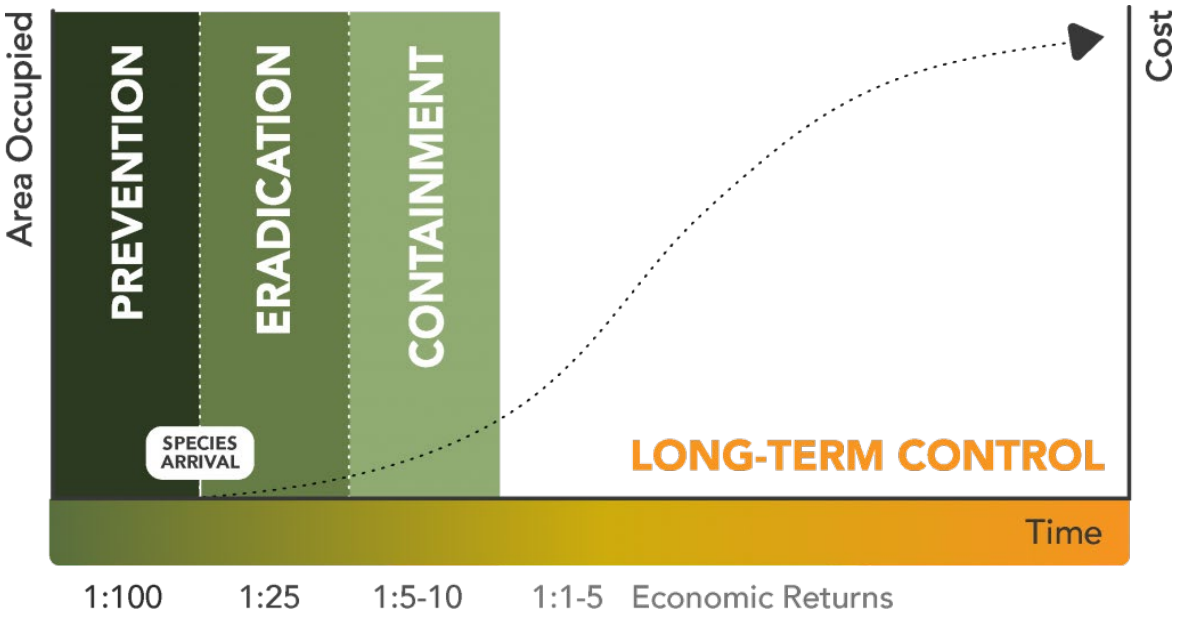

Figure 7: The Invasion curve. Borrowed from The Invasive Species Centre.[120]

Though reduced pesticide use is a primary goal of IPM, all other options for protecting eastern hemlocks from HWA have been exhausted. **At present, the only option for treating against HWA is chemical/medicinal application** (for more information on why chemical application is referred to as "medicinal" review the *Indigenous Gathering Circle* subsection of this report)**.** This is a stop-gap measure to safeguard a portion of local eastern hemlock populations until biocontrol agents are established to protect hemlocks from unmitigated loss due to HWA in perpetuity without persistent chemical/medicinal treatment. These treatment strategies are explored in more detail in the *Treatment* section of this report.

Parks Stewardship Program

Initiated in 2021 by Halifax Regional Council, the Park Stewardship Program (PSP) has been designed to facilitate citizen volunteer in HRM parks. The PSP is still in the draft phase but was presented to the HRM Community Planning and Economic Development Steering Committee on August 21, 2025, who recommended that Halifax Regional Council direct the Chief Administrative Officer develop the PSP.

With over 900 parks to manage across HRM divided between 12 supervisors, Parks Operations has been assigned a gargantuan task. Though Parks' staff do excellent work, compounding pressures including increasing instances of non-native pest invasions; declining water quality in lakes with supervised beaches; growing amounts of litter due to increasing use by a ballooning population; among many others, the amount of attention each park requires is growing every year. As attested to by ecological scientists the world over, in this age of rapid change due to

[120] Invasive Species Centre. (date unknown). Investing in prevention. https://www.invasivespeciescentre.ca/learn/invasion-curve/. [x. 2025, May].

climate change and development, all hands are needed: community scientists and trained scientists alike. In alignment with cities across the country, the PSP will create opportunities for community members to contribute to the care and well-being of local parks. Proposed activities include an “Adopt-a-Park” program, naturalization, and invasive species removal—all of which align with the idea of establishing a volunteer HWA management program.

Plan development

To combat this loss in HRM, on March 27, 2024, Halifax Regional Council unanimously voted that an *HWA Treatment and Management Plan* (*HWA Plan*) should be prepared. Though the staff report that informed this decision was drafted by Urban Forestry, the work of preparing the plan has been completed by the Environment Team of the Environment and Climate Change division of Property, Fleet and Environment. The Environment Team hired a new Environmental Specialist in February 2024 to focus on implementing the IPM Guidelines among other nature-based initiatives.

Preparing the *HWA Plan* has been an iterative learning process in collaboration with a network of experts and practitioners throughout the Canadian Maritime region and beyond. In 2024 HRM became one of the first municipalities in the province to join the HWA Maritimes Working Group—a coalition of organizations across Nova Scotia and beyond that are collaborating to share information, strategies, and resources to more effectively manage HWA and thus protect more eastern hemlocks. HRM also has staff representation on the Nova Scotia Invasive Species Council’s Steering Committee, which has aided not only in the development of HWA treatment strategies but will inform strategies for other invasive species in the future.

Some notable achievements of HWA management work in HRM to date include:

- A summer of community engagement including a film screening, info sessions, and pop-up events in select HRM Parks [summer 2024]
- Assisting with HWA tracking via eDNA trap deployment in Point Pleasant Park and Hemlock Ravine Park in collaboration with CFIA and the Invasive Species Centre for the “crawler season” (i.e., late spring and early summer) [2024 and 2025].
    - This included doing an HWA survey of both parks
- Circulation of a public engagement survey to notify residents of the risks HWA poses and the methods available to protect eastern hemlocks from this destructive pest and collating the results [August 2024~November 2024]
- Awareness raising appearances on CTV’s Morning Live program and CBC Information Morning [Fall 2024]
- Attendance at several region-wide information-sharing and training events throughout 2024 and 2025 including:
    - HWA Survey in Victoria Park, Truro (2024)
    - Hemlock Heroes Training (2024) and Tree Marking Training (2025) with Medway Community Forest Workshop, Caledonia
    - Nova Scotia Forest Health Workshop, Truro (2024) and Baddeck (2025)
        - Presentation given by HRM at 2025 workshop

    - HWA Managers Meeting, Liverpool (2024) and virtual (2025)
    - Hemlock Woolly Adelgid Chemical Treatment Training (2024)
    - Atlantic Forest Health Workshop, Charlottetown, PEI (2025)
        - Presentation given by HRM
- Hosting an Indigenous Gathering Circle for Mi'kmaq Elders and Youth to share their ideas and concerns regarding HWA treatment in the Halifax Region [Winter 2025]
- Hosting an interested party's information session with different levels of government, local utilities, and other organizations to ensure different parties are aware of the tactics and strategies planned by HRM and to increase collaboration [Spring 2025]
- Hosting HWA surveys in HRM-owned and maintained parks and other spaces around Halifax throughout 2024 and 2025 including:
    - HWA survey of Sandy Lake (April 2024)
    - HWA survey of Hemlock Ravine (May 2025)
    - HWA survey at Mount Edward Park and Bisset Lake (June 2025)
- Creation of mapping platforms to guide HWA treatment [Spring/Summer 2025]

A high-level timeline summarizing some of the key milestones in the *HWA Plan*'s development is provided in *Figure 8*.

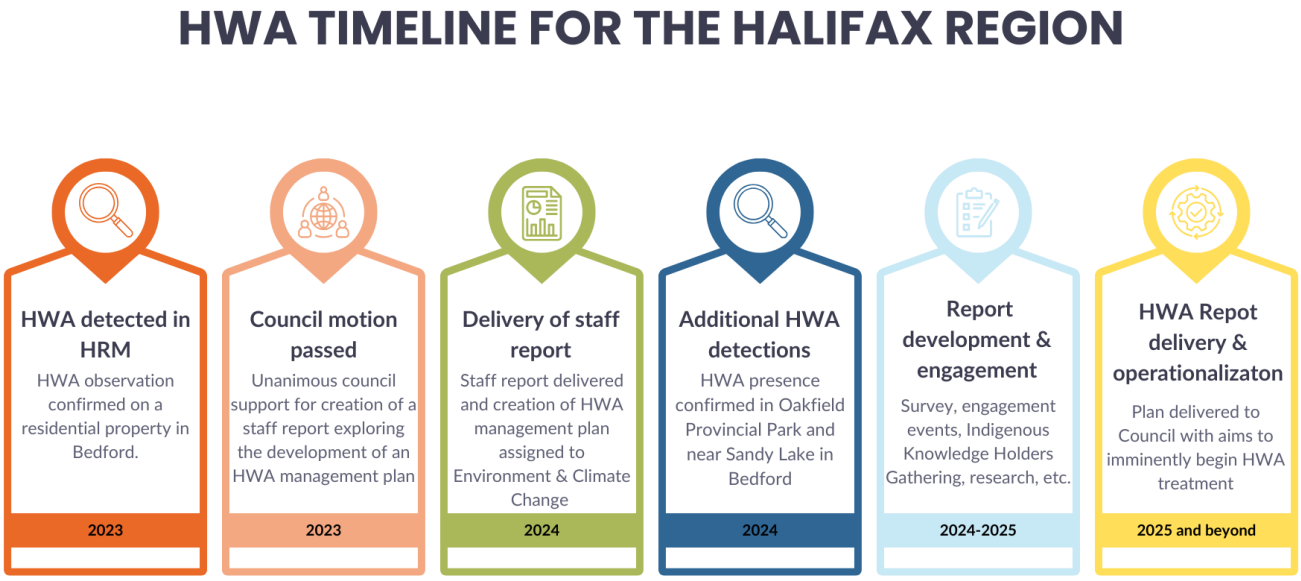

Figure 8: HWA Timeline 2023 to 2025 and beyond for HRM.

Public engagement and survey

There are many reasons for centring the *HWA Plan*'s development around collaboration and public engagement. Not the least of which include:

1. the only known treatment option to manage HWA infestation is chemical/medicinal use, which can be controversial among some community members
2. according to some expert feedback, volunteer-powered treatment programs can be a cost-effective approach to HWA management, making the development of a willing volunteer list a useful tool, should volunteer treatments be integrated into HRM's HWA treatment strategy
3. most eastern hemlock growing in HRM is located on private or non-HRM owned property, meaning that involving residents in the development of HWA treatment is likely to help disseminate information that will likely be helpful to private property holders trying to make HWA management decisions

As alluded to in the above section and *Figure 8*, over the course of the summer and fall of 2024, considerable effort was expended to not only increase public awareness of HWA presence in HRM, but also to inform potential treatment methods to prevent HWA damage and spread. Between August and November 2024 a public engagement survey was opened and accessible via HRM's invasive species webpage.

Significant effort was made to notify residents of the survey including the above-described media appearances and public engagment events. Print brochures and posters featuring a QR code were also circulated. Posters were displayed at all Halifax Public Library locations in addition to being dispersed to a number of other public spaces throughout HRM including:

Albro Lake Beach
The Black Cultural Centre for Nova Scotia
East Dartmouth Community Centre
Fairbanks Centre
Findlay Community Centre
George Dixon Centre
HRM Community Service Desk (Alderney)
Lawrencetown Beach Café
LeBrun Recreation Centre
The North Grove
North Preston Community Centre
Sackville Heights Community Centre
St. Andrew's Community Centre
St. Margaret's Centre
Wallace Lucas Community Centre
Zatzman Sportsplex

Public engagement events during the survey period were mostly concentrated in areas where hemlocks grow abundantly and thus included:

- HWA informational pop-up in Hemlock Ravine Park – July 27, 2024
- HWA informational pop-up in Point Pleasant Park – August 6, 2024
- Invasive species walk and public awareness event in Albro Lake Park – August 8, 2024
- Public engagement featuring an expert panel discussion and screening of HWA-focused documentary *In the Quiet and the Dark* at Shubie Park – August 22, 2024
- HWA info session and open house at Musquodoboit Harbour Public Library – November 15, 2024

- Hemlock walk with Friends of Fleming Park at Sir. Sanford Fleming Park – November 17, 2024
- HWA info session and open house at Sackville Public Library – November 19, 2024

The survey was also shared with several partnering organizations with a common interest in protecting hemlock populations. Despite these efforts, just over 100 responses were collected. Around this same time, work was done to better engage with Indigenous communities, and connections were made with organizations like the Confederacy of Mainland Mi'kmaq, Kwilmu'kw Maw-klusuaqn, and Ulnooweg Education Centre. As a result, an Indigenous Gathering Circle was hosted in February 2025 (described in a following section) and five additional survey responses were collected for a grand total of 118.

By and large, the survey responses demonstrated that most respondents (81%) fully support the implementation of a chemical/medicinal treatment program (particularly because it is the only option currently available to protect hemlock trees). Similarly, most respondents (81%) supported a blended treatment program, meaning the use of both injection and basal bark spray methods, if such an approach was advised by scientists and other experts. Almost all respondents (90%) expressed an interest in the development of resources and opportunities to help residents make decisions about hemlock trees growing on privately held land.

When asked whether they would support the creation of a volunteer treatment program modelled after those developed by organizations like Asitu'lisk and Medway Community Forest Cooperative, 12% of respondents were not supportive the idea. Only 1% were neutral, while 18% were supportive of the idea but not interested in volunteering. The majority, 70% were supportive and interested in volunteering—though 27% hoped for more information about what volunteering might entail before saying for sure.

Respondents had the opportunity to share their contact information if they were interested in future volunteer opportunities. Through this exercise and engagement events since the closing of the survey, a database of over 200 potential volunteers has been collected indicating that this may be a viable option for future treatment in HRM.

Respondents also shared their views on the highest priority parks for treatment. Answers were quite varied, though some consensus was reached in identifying the community's top three priority sites: Hemlock Ravine Park, Point Pleasant Park, and Sandy Lake Park. A complete list of resident-identified sites along with a breakdown of all other survey results has been provided as *Appendix A* of this report. It is important to note that several areas identified by respondents as priorities for treatment were outside of HRM's jurisdiction to treat. Those suggestions were collated and have also been provided for interest in *Appendix A.*

The final survey question was an opportunity to share any additional thoughts about treating hemlocks in HRM. The responses here fell into ten high-level thematic buckets, which are summarized in *Figure 9*. Most responses suggested a preferred action with the most common response indicating support for chemical/medicinal treatment, though many people who

responded in this way explicitly specified that they would not normally condone chemical use and that their support was contingent upon the lack of alternative options to save hemlocks. Other common responses centred around a need for: 1) more educational opportunities and resources, 2) the formation of a volunteer treatment program, and 3) more supports for private land holders.

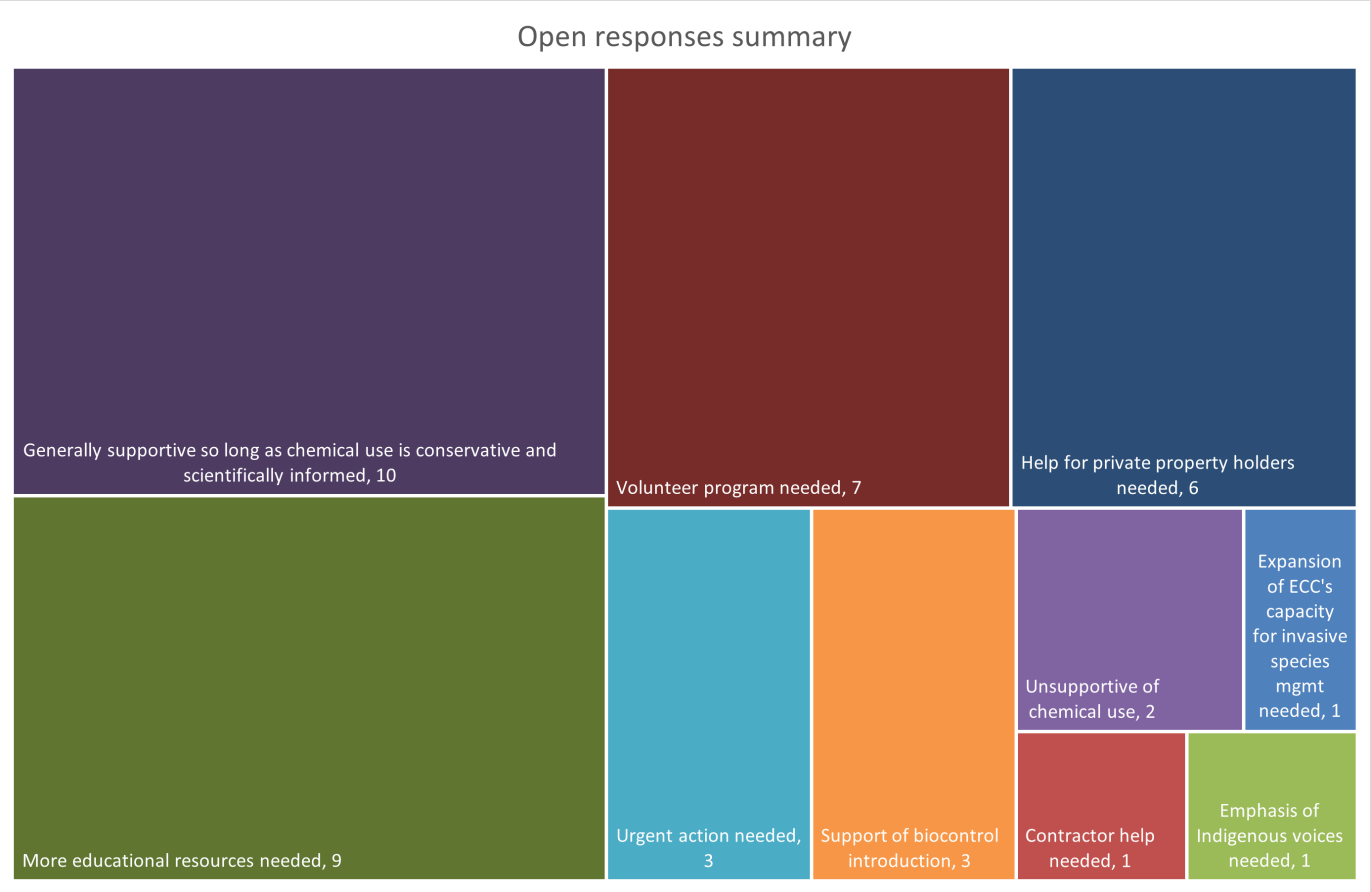

Figure 9: Responses to the open-ended question: Is there anything else you would like to share with us regarding the management of HWA? Data labels indicate the number of responses that corresponded with each theme.

UFMP Survey Results

Because development of the *HWA Plan* coincided with the UFMP update, public engagement results for the latter were considered in the drafting of the former due to some overlapping subject matter. This was a great benefit considering the low number of responses to the *HWA Plan* survey compared to the over 700 responses to the UFMP survey. Analysis of UFMP engagement results reveals a mixed public perception of HRM's efforts to manage invasive species over the past decade as illustrated in *Figure 10.* The number of uncertain responses (37%) indicate that public engagement should be a primary focus of invasive species management going forward.

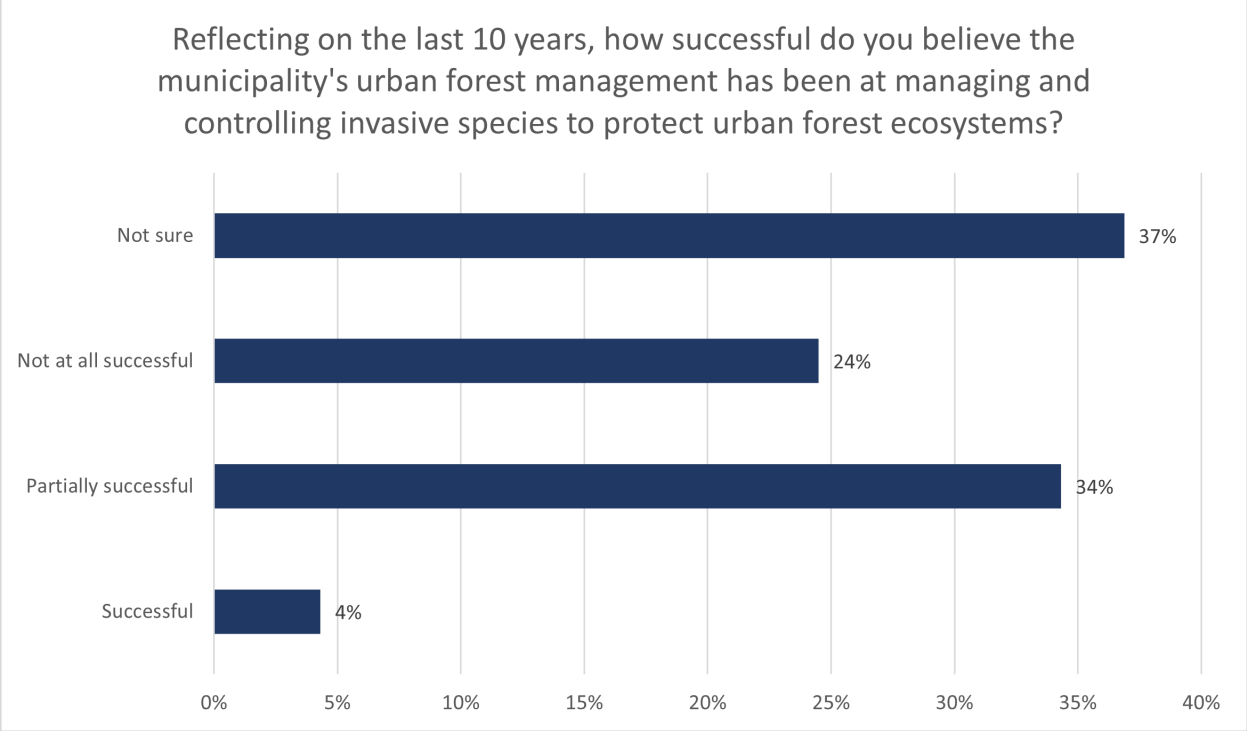

Figure 10: Responses to UFMP public engagement survey indicate that under 5% of respondents believe HRM has successfully managed invasive species over the past 10 years, 34% believe invasive species management has been partially successful, 24% say not at all successful, and the majority, 37% are not sure.

Overall, 83% of respondents indicated that “managing and controlling invasive species to protect urban forest ecosystems” should be prioritized by HRM, while 26% chose “fewer problems with pests and diseases” as one of a list of potential options that might help to show “successful management of HRM’s urban forest” in the next five years. Almost all respondents (98%) believe that invasive species are a threat, though there was an almost even split between those who think they pose a moderate versus a severe threat as illustrated in *Figure 11.* However, a keyword search of open responses within the UFMP survey dataset using the terms “hemlock”, “hemlock woolly adelgid” and “HWA” yielded low results meaning very few responses contained mention of HWA. This could be indicative of lack of interest or concern but based on the general support for invasive species management expressed in other responses, it is more likely demonstrative of the fact that HWA is still very new in HRM and public awareness of its presence and destructive potential is still very low. This suggests more education is needed.

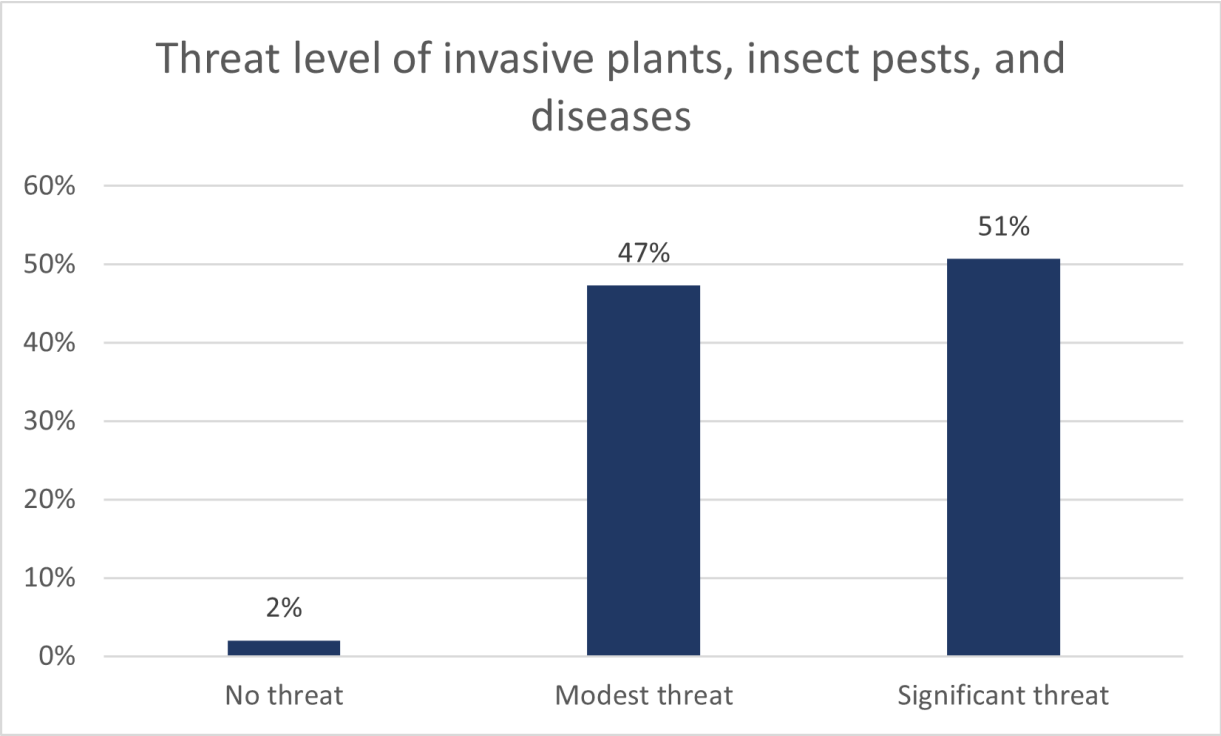

Figure 11: Responses to the UFMP public engagement survey indicate that 98% of respondents believe that invasive species are a threat to a functional urban forest and urban ecology overall.

Additionally, UFMP survey responses align with the those of the *HWA Plan* survey regarding volunteer involvement. As noted above, 70% of respondents to the *HWA Plan* survey supported the idea of creating a volunteer-driven HWA treatment program. Likewise, in response to a UFMP survey question seeking feedback on priority actions for municipal properties, "opportunities for residents to participate in public tree planting and care, such as by watering a street tree or *removing invasive species in a park*" (emphasis added) was considered a medium or high priority by 85% of respondents.

Finally, reports detailing Acadian and Francophone, Indigenous, and African Canadian, engagement during the development of the UFMP were also considered to inform the *HWA Plan.* Members of the Acadian, Francophone and African Canadian communities expressed special interest in being provided more education about invasive species management and more opportunities to be involved in HRM-led invasive species management projects. In fact, one of 15 key takeaways from the UFMP's African Canadian Engagement Summary Report was that "knowledge transfer and education on tree care and invasive species management are important". The *Indigenous Engagement Report* prepared by consultants for the UFMP update, pipikwan pêhtâkwan, did not explicitly name invasive species nor HWA management as priorities for represented communities, but a desire for increased education and knowledge-sharing was highlighted as an important takeaway. Indigenous engagement related to HWA management was explored more deeply in February 2025, when HRM hosted an Indigenous Gathering Circle to discuss the topic.

These results are not representative of all communities living in HRM. Ongoing engagement with communities that will be most impacted by HWA will be important to ensuring that HRM's treatment program is representative of community interests. For example, a high concentration of the most beloved hemlocks in Halifax are growing in Bedford. Unfortunately, all HWA populations currently confirmed in the Halifax Region are also located in the same area. The community of Bedford is richly diverse and includes many longstanding immigrant as well as newcomer families. Special care should be taken to inform and involve these communities as treatment programming is developed. This means using communication methods/channels that will reach people and meaningfully engage them. The potential to include communities that are often left behind in municipal process is another example of a potential benefit that could arise from the establishment of a volunteer treatment program.

Indigenous Gathering Circle

Background

On February 20, 2025, a community of Elders, Knowledge Holders, Grandmothers, and Youth attended an all-day Gathering Circle in Kjipuktuk (HRM) to explore the options for protecting Ksu'sk (eastern hemlock) from HWA.

HRM's Environment and Climate Change team organized the Gathering Circle in partnership with Ulnooweg Education Centre and Community Forests International (CFI) with input and guidance from the Confederacy of Mainland Mi'kmaq and Kwilmu'kw Maw-klusuaqn. The Gathering Circle was made possible via financial support from HRM's Parks and Recreation department, Ulnooweg, and CFI, with logistical support from HRM's Diversity and Inclusion (D&I) Office.

Twenty-eight people attended, including three members of HRM's ECC Team and one member of the Urban Forestry Team. Staff from Ulnooweg and CFI were also in attendance. Two staff members from Medway Community Forest Cooperative joined as subject matter experts due to their robust HWA treatment program based out of Caledonia, NS. Members of Wasoqopa'q (sometimes known in English as Acadia), Sipekne'katik, Eskasoni, and Bear River First Nations attended, as well as a representative from Keeseekoose First Nation who often works with the Mi'kmaq Native Friendship Centre and the urban Indigenous community in HRM.

Purpose

The Gathering Circle was organized as a reciprocal learning opportunity with the goal of informing culturally informed treatment options for protecting Ksu'sk from HWA, particularly in the Halifax region, but with additional applicability for treatment programs operating in other parts of the province including the injection-based program at Asitu'lisk managed by Ulnooweg with support from CFI.

HRM organizers also intended for the Gathering Circle to be a rooting point for new relationships to blossom. Because so much of ECC's work is deeply connected to the land and building its resilience, Etuaptmumk (Two-Eyed Seeing) is needed to ensure work like

restoration, climate change adaptation, and invasive species management are pursued in a good way.

Shape of the gathering

Though there was a high-level agenda for the day, events unfolded organically as attendees felt called to share their insights, ideas, and expertise. In addition to an opening prayer under a mature Ksu'sk tree in Shubie Park and a closing prayer in a circle, buckets of conversation included:

- The origin of HWA and what makes it so invasive
- The impacts HWA has had on Ksu'sk in other areas of Mi'kma'ki,
    - How such impacts are likely to extend to the Ksu'sk-dominated forests of the Halifax region
- Treatment options currently available to protect Ksu'sk
    - Medicine (Chemical)
    - Silviculture (Mechanical)
    - Biocontrol
    - Experimental methods
    - Education
- How decision-makers can incorporate Indigenous expertise into protecting Ksu'sk trees and forests in the years to come in a way that respects Indigenous Knowledge and stewardship practices.

Lessons and takeaways

The conversation and knowledge sharing during the Gathering Circle was rich and robust. Some of the key takeaways are more general, which apply to both the *HWA Plan* and HRM operations writ large, others are more specific to the *HWA Plan.* For ease, takeaways that are more general are indicated with an arrow-shaped bullet, while the HWA-specific takeaways are indicated with a star-shaped bullet.

- Language is important
    - Ksu'sk is the Mi'kmaq name for eastern hemlock, which is a name that reflects the Traditional use for the tree's bark, which crumbles when removed from the trunk and is easily beaten into a fine powder. When added to water this powder turns a vivid red and was used to cure leather and make footwear and clothing waterproof due to its high tannin content. It was noted that the bark is highly toxic and further highlighted that the word "toxic" in Mi'kmaq refers to a material or substance that though not suitable for human ingestion has other helpful uses. Conversely, the word "toxic" in English is often associated with danger or something that might be unsafe. This dichotomy between health and harm was noted to highlight that the Mi'kmaq and English languages are often at odds with one another.
- Place names are important

- Kjipuktuk is the English word often used to refer to Halifax Regional Municipality. If directly translated, Kjipuktuk means “Great Harbour”. As such, according to some attendees, the name Kjipuktuk should only be used to refer to Halifax Harbour specifically. However, many people use Kjipuktuk as a placeholder because there is no substitute word that refers to the city of Halifax or the Halifax Regional Municipality more broadly. This is because the borders that define this place are colonial/political impositions as opposed to being representative of site characteristics and cultural uses the way Mi’kmaw placenames are. Because of this, it can be clumsy and confusing when settler people use Mi’kmaq placenames, even if intentions are to be culturally sensitive.
- Similarly, the place where the Gathering Circle was held, The Fairbanks Centre in Shubie Park, is not widely recognized to have a Mi’kmaq name (according to the Mi’kmaq Place Names Digital Atlas). It was acknowledged at the beginning of the Gathering Circle that the closest known Mi’kmaq place name is *Panuk* (known in English as Lake Banook), which translates to “at the opening”. This points to Panuk being the place where Mi’kmaq people historically entered the chain of lakes in so-called Dartmouth to travel along important trade routes. However, none of this is to say that the place now known as Shubie Park does not have a Mi’kmaq name. It may be that the name is known to some in the Mi’kmaq community, but even so the loss of the widespread knowledge of Mi’kmaq placenames is the result of colonial violence and erasure.

- Stronger/formalized engagement between HRM and Indigenous community is needed
  - Though HRM has a D&I Team, there is only one person who is responsible for Indigenous outreach and engagement while simultaneously being responsible for staff training among many other accountabilities. More investment into building relationships with Indigenous community members and First Nations is needed.
    - It was suggested that, to achieve this goal, HRM should form an Indigenous Advisory Committee which could oversee a variety of activities within the municipality’s purview, but specific to HWA treatment, could also include a Traditional Ecological Knowledge expert who advises on programs like invasive species treatment and other land-based work.
- More community/volunteer events and more support for youth programs are needed
  - There is so much work that needs to be done to help nature heal in the Halifax region following centuries of damage caused by post-European settlement activities. Historically Indigenous people have been excluded from discussions on how to best restore these landscapes. Given that the ECC team at HRM is so deeply involved in naturalization programming, nature-based solution advancement, invasive species management, and other land-based activities, there is ample opportunity to call Indigenous community members, particularly youth, into educational programming and seek expert Traditional Knowledge when designing new projects.
- More training for HRM staff is needed

- Better understanding/knowledge of Traditional Ecological knowledge is essential for staff to better approach their work in a culturally sensitive way. Further, insight into Indigenous culture will better equip staff to ask the right questions, make the right preparations, and appropriately follow cultural protocols when working with Indigenous people or First Nations.

➢ Protocols and procedures are needed
- It can be challenging to prepare one-size-fits all cultural protocols when there are a diversity of Indigenous cultures and practices represented in HRM's population; however, it is important to set a standard of practice to ensure 1) Indigenous community members are treated respectfully and 2) partnerships, engagements, consultations, or events organized by HRM are reciprocal (i.e., not just for the benefit of the Municipality).
    - For example: at the beginning of the Gathering Circle, when facilitating initial introductions, the event organizer prompted the incorrect direction to move around the speaking circle based on Mi'kmaq cultural practice. Having a cultural standards resource would have demonstrated HRM's commitment to honouring cultural norms and while also avoiding making an attending Elder feel like he had to correct this mistake in real time.
- It was recommended that a cultural protocol of acknowledgement and thanks should be followed prior to engaging in chemical/medicinal treatment of hemlocks against HWA. Though engaging a Knowledge Holder or Elder to lead in this practice might be ideal, it may not always be feasible for someone to be available at every treatment that takes place in HRM. It was shared that it is acceptable for a settler person to make a land acknowledgement and offering to a tree or stand of trees, so long as their positionality is made clear prior to doing so. That is, one must be careful that their actions are done with authenticity in a way that is not extractive or culturally appropriative.

★ Openness to trying and/or facilitating pilot projects is encouraged
- In learning about the habitat preferences and behaviours of HWA, attendees shared ideas about possible experimental methods for limiting HWA spread and success. Some experimental methods suggested were smoking and promoting increased freeze using water during low temperature periods. Being open to these alternative ideas to commonly accepted practice is the way partnerships are formed and innovative solutions devised. Starting with pilot projects in small areas might be a good first step.

★ Chemical treatment should be thought of as medicine
- In general, attendees of the Gathering Circle expressed hesitation at chemical treatment and did not take the decision to employ such methods lightly. Most were more supportive of injection-based treatment methods and preferred to think of it as "medicinal" rather than chemical treatment. In alignment with the bullet noting the importance of language above, the word "chemical" can have negative connotations often referring to something toxic or dangerous. In contrast

chemical treatment of hemlocks is meant to protect them from a fatal threat, indeed resembling a medicinal injection a person might take when sick or attempting to prevent sickness. This language preference has accepted and been adopted in this document. The words “pesticide”, “insecticide”, or “product” are also used when most appropriate (e.g., when the need arises to use language that aligns with regulatory documents).

- More education and outreach are needed
  - ★ Gathering Circle attendees had a spectrum of knowledge about HWA specifically. Some were very familiar with its presence in Mi'kma'ki whereas others had never heard of the insect before. Having HWA specimens, examples of chemical/medicinal application equipment, and other hands-on props to better communicate what HWA is, and what the treatment options are would be helpful for meeting people where they are at in their understanding.
  - ➢ Though by all accounts the Gathering Circle was a success, like the HRM public engagement survey, it only provided a snapshot of the entire community’s values and Knowledge. Continuing to invest in engagement through ongoing conversations and one-on-ones with Elders to better communicate the long-term outlook of HWA infestations and treatment options will not only better shape our response to HWA but will provide opportunities to build relationships to inform how HRM can do work better in a way that honours Indigenous Knowledge, Tradition, and Cultural Practice.

Interested parties meeting

On March 19, 2025, Environment and Climate Change hosted an “Interested parties” meeting to harmonize HWA treatment efforts between different organizations with the jurisdiction and authority to treat against HWA in HRM. A few attendees from outside HRM also attended to share ideas and experiences. A list of attendees can be found in *Table 3* below.

Government	Land trusts and other not-for-profit organizations	Public Utilities
Canadian Food Inspection Agency Municipality of the District of Lunenburg (MODL) Nova Scotia Department of Environment and Climate Change Nova Scotia Department of Natural Resources Town of Bridgewater	Medway Community Forest Cooperative Nova Scotia Invasive Species Council Nature Conservancy of Canada Nova Scotia Working Woodlands Trust	Halifax Water Nova Scotia Power

Table 3: Attendees of HRM's HWA Treatment: Interested Parties meeting on March 19, 2025

Purpose

The purpose of the Interested Parties meeting was to:

1) share updates on HWA treatment and management,
2) determine collaboration points to make cross-jurisdictional HWA management efforts more effective, and
3) identify any barriers to effective HWA management.

The goal of the meeting was to establish stronger relationships and encourage collaboration on HWA management efforts in HRM. This is especially important because HWA is still so new in HRM. Establishing relationships early will be pivotal to treatment success. Many of the findings and learnings from this meeting were exploratory in nature and were more about potential future possibilities as opposed to concrete actions. Further, the HWA updates and management/treatment advice shared by attendees have been organized into different sections of this report and thus have not been disseminated in detail here.

Treatment

Without urgent action, most of HRM's eastern hemlock trees and forests will be badly impacted by HWA.

As little as two years ago HRM was in the early intervention stage of HWA Management according to the Invasive Species Curve as illustrated in *Map 6,* but it is rapidly shifting toward being at the leading edge where both reactive and prophylactic (i.e., preventative) treatment will be required in short order. Though this is a big undertaking, the HRM is fortunate to benefit from the forest managers and scientists in the United States, Ontario, and other parts of NS who have been working on controlling HWA for decades**.**

According to that experience **chemical/medicinal control is the only option currently available for protecting eastern hemlocks from HWA**. There are also stewardship or silvicultural actions that can be taken to supplement chemical/medicinal treatment. In some cases, the goal of silvicultural treatment in response to HWA is to create conditions that might support a flourishing hemlock population into the future, but in most cases silviculture treatment is intended to support a forest stand in its transition to a different forest type after hemlock loss. These are short-term actions that will safeguard hemlocks until biocontrol is further developed as a longer-term solution.

Another option is to do nothing, which is the least expensive option in the short term. In the long-term, however, it may become more expensive than treatment due to the high cost of professional removal of dead trees. Further, doing nothing is likely to result in the complete decimation of hemlock populations throughout the Halifax region. A high-level summary of all treatment options available are summarized in *Table 4.*

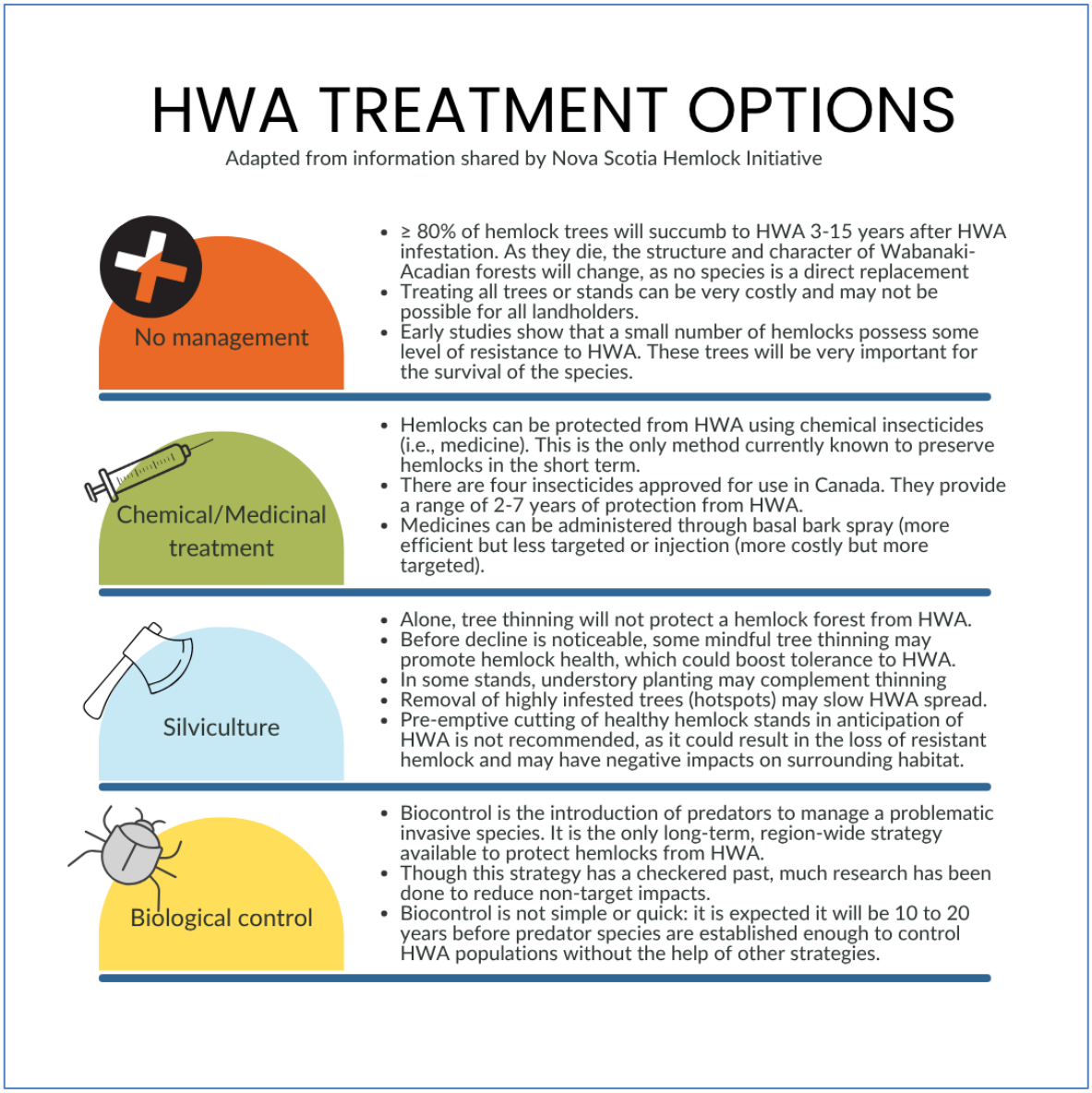

Table 4: HWA treatment options, adapted from information shared by the NS Hemlock Initiative. This table was originally created for use at the HWA Gathering Circle in February 2024.

Chemical/medicinal treatment

Chemical/medicinal HWA treatment means pesticide will be applied in hemlock stands on municipally owned land. This treatment strategy is intended to address an ecological crisis and is temporary. It is estimated that because it will take two (or possibly more) decades for biocontrol populations to become established in Nova Scotia, chemical/medicinal treatment will be needed for 10-20 years, requiring 2 to 4 rounds of application respectively.

There are two modes of application used in Canada for this purpose: systemic injection and basal bark spray. Generally, injection is more expensive and slower to implement, but due to the

direct mode of entry it greatly decreases 1) environmental exposure to the product (i.e., insecticide) and 2) the total amount of product required for treatment. In addition, there are no application limits for injection-based treatment which means an entire park can be treated at once. Conversely, basal bark spray often requires re-entry year over year to adhere to application limits. Finally, the injection-based method is conducive to volunteer-treatment events which have been modelled with great success by organizations like Medway Community Forest Cooperative, Asitu'lisk, and the Town of Kentville.

Basal bark spray is less expensive (generally around three times cheaper per treated tree) and faster, but less targeted, which means some insecticide may be detected in the environment surrounding a sprayed tree. Basal bark spray is also prohibited within 7 metres (m) of a waterway; thus injections are exclusively used in these areas. Some practitioners also favour injections in other areas they consider to be environmentally sensitive. Similarly, injections are sometimes favoured in areas where there is high human use like along trailways and in busy parks because areas treated using basal bark spray are typically barred from access for at least 24-hours following treatment.

Both treatment options:

- require tree-by-tree treatment,
- last for between 4 and 7 years, and
- are considered safe by scientists and government agencies.

Most organizations in eastern Canada currently use a blend of both options, though Asitu'lisk opted for an injection-only program due to community concerns around the safety of basal bark spraying. Currently there are four products approved for use in Canada by Health Canada's Pest Management Regulatory Agency (PMRA) that are effective against HWA.[121,122] They are listed in *Table 5*.

[121]Nova Scotia Department of Natural Resources and Renewables Forest Protection. date unknown. Hemlock woolly adelgid management program factsheet. https://novascotia.ca/natr/forestprotection/pests/. (ax. 2025, May)
[122] *Ibid.* NS Hemlock Initiative. date unknown.

Product	Active ingredient	Mode of application	Time until effect (months)	Duration of efficacy (yrs)	Current PMRA registration expiry	Decision key / Use case
IMA-Jet	Imidacloprid (5% or 10%) (Generally, 8mL of product required per 5 cm DBH)	Injection	6-9	4-7	2027-12-31	≤ 7 m from watercourses and ecologically sensitive areas ≥ 65% crown density and not suppressed in canopy.
TreeAzin Systemic Pesticide	Azadirachtin (5%)	Injection	1	1	2029-12-31	≤ 7 m from watercourses and ecologically sensitive areas Due to rapid onset of efficacy, used for stand in rapid decline.
Xytect 2F	Imidacloprid (21.4%)	Basal bark Spray	6-9	4-7	2027-08-23	≥ 65% crown density Due to longevity of protection, selected for healthy stands showing early signs of decline
Starkle 20 SG	Dinotefuran	Basal bark spray	1	1-2	2028-06-01 (Emergency registration)	≥ 45% crown density Due to rapid onset of efficacy, selected for stand in rapid decline.

Table 5: Chemicals approved for HWA treatment in Canada. All products listed are commercial pesticides and thus require a provincial pesticide applicators certificate to use. Information taken from the PMRA Pesticide Product Information Database and the Nova Scotia Hemlock Initiative.[123]

[123] *Ibid.* NS Hemlock Initiative. date unknown

Some products listed in *Table 5* can be used in combination depending on the needs and condition of a target stand. In areas where hemlocks are showing a crown density of as low as 45%, Xytect and Starkle can be mixed for basal bark application. This treatment is generally selected when a stand is in decline because Starkle provides the fastest uptake, while Xytect provides longer lasting protection. TreeAzin can also be used in conjunction with IMA-Jet in areas where basal bark spray is not permitted, though this is uncommon due to the cost and labour associated with injection-based treatments. If HRM takes quick action on HWA treatment, it is anticipated that the need for these faster acting products will be unnecessary.

Canopy density can be determined using the *Canopy Density Chart* designed by the Medway Community Forest Cooperative as part of their publicly available Treatment Decision Key. A copy has been provided as *Figure 12.*

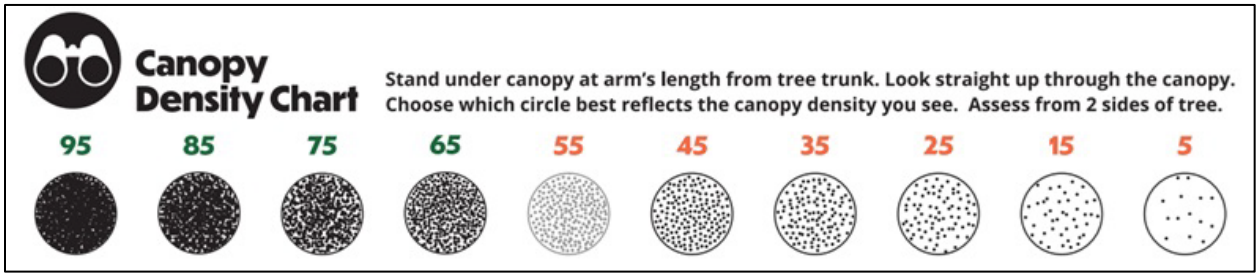

Figure 12: Canopy density chart. Designed by Medway Community Forest Cooperative.

Non-target impacts of pesticide use

One product approved for HWA treatment in Canada is derived from neem oil. It works by supressing the target's appetite and disrupting its growth. The active ingredients in the other pesticides approved for HWA treatment in Canada are dinotefuran and imidacloprid which are neonicotinoids ("neonics"), a class of systemic pesticide that are easily absorbed by plant tissues without causing plant damage or death. They directly impact the central nervous system of insects causing paralysis and eventually death. Because of their ability to target insects without having the same lethal impacts on vertebrate species, combined with their higher efficacy compared to contact sprays, neonics are among the most frequently used types of pesticides in the world, particularly in the agricultural industry.[124,125] While the use of these products has been deemed safe by regulatory bodies it is important to consider the non-target effects of their use.

In 2025, a wide-ranging study assessed and synthesized the findings of 1,705 pre-existing studies to quantify the impacts of pesticide (i.e., insecticide, herbicide, and fungicide) use on

[124] *Ibid.* Sweeney, 2021.
[125] Encyclopedia Britannica. 2025, July 3. Neonicotinoid. https://www.britannica.com/technology/neonicotinoid. [ax. 2025, Jul].

non-target organisms across trophic levels.[126] Ultimately it showed that pesticides "have broad-scale detrimental effects on all groups of non-target organisms tested. "(p. 7). These effects generally included: decreased growth and reproduction across all taxonomic groups, behavioural responses in animals, and other metabolic and physiological endpoints described by study authors as "perturbing" (p.7). More specific to neonics, research suggests that their sustained use could contribute to long-term declines of pollinators[127,128] and may lead to sublethal effects on some vertebrate species like small insectivorous birds and salamanders.[129] These effects could include reduced growth rates, fecundity, and offspring weight.

The persistence and risk of imidacloprid applied via basal bark spray was recently the subject of a two-year study based in eastern hemlock forests around Sissibo Falls and McKay Lakes, Nova Scotia. It found that though the risk of exposure to non-target soil invertebrates was highest within 200 centimeters from a treated tree, imidacloprid was detectable up to 400 cm from a tree up to two years after application, though in small values.[130].

Another recent study, investigating the impacts of basal bark spray on bees and flower flies in Nova Scotia "observed no apparent adverse effects" (p.49) on those species, but did detect potentially harmful concentrations of imidacloprid in flower species within treated areas indicating that there could be potential adverse effects on pollinators over time—especially if repeat treatment is to occur.[131] It is suggested that if basal bark spraying, all flower species in the stand be harvested prior to treatment to discourage bees from collecting pollen from the area. According to one prominent Research Scientist with the Canadian Forest Service, because hemlock is not a target species for most pollinators and because imidacloprid concentrations decrease within 50-100 cm from treated trees, HWA treatment is not expected to have a marked impact on pollinator species.[132]

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[126] Wan, NF, Fu, L, Dainese, M, Pødenphant Kiær, L, Hu, WQ, Xin, F, Goulson, D, Woodcock, BA, Vanbergen, AJ, Spurgeon, DJ, Shen, S, & Scherber, C. 2025. Pesticides have negative effects on non-target organisms. *Nature Communications*, *16* (1360). DOI: 10.1038/s41467-025-56732-x. (ax. 2025, Jul).
[127] Woodcock, BA, Isaac, NJB, Bullock, JM, Roy, DB, Garthwaite, DG, Crow, A , Pywell, RF. 2016. Impacts of neonicotinoid use on long-term population changes in wild bees in England. *Nature Communications, 7* (12459). DOI: 10.1038/ncomms12459. (ax. 2025, Jul).
[128] Tsvetkov, N, Samson-Robert, O, Patel, HS, Malena, DA, Gajiwala, PH, Maciukiewicz, P, Fournier, V, Zayed, A. 2017. Chronic exposure to neonicotinoids reduces honey bee health near corn crops. *Science, 356* (6345). 1395-1397. DOI: 10.1126/science.aam7470. [ax. 2025, Jul].
[129] Gibbons, D, Morrissey, C, Mineau, P. 2015. A review of the direct and indirect effects of neonicotinoids and fipronil on vertebrate wildlife. *Environmental Science Pollution Research 22*. 103-118. DOI: 10.1007/s11356-014-3180-5. (ax. 2025, Jul).
[130] Edge, CB, Heartz, S, Lagalante, A, Lewis, A, Sweeney, J. 2025. Risk of imidacloprid to soil invertebrates when applied as basal bark spray for the control of hemlock woolly adelgid. *Canadian Journal of Forest Research, 55.* 1-11. DOI: 10.1139/cjfr-2024-0267. (ax. 2025, Jul).
[131] Voscort LJ. 2024. Pollinators in eastern hemlock forests: non-target effects of imidacloprid basal-bark sprays for hemlock woolly adelgid management and efficacy of sampling methods [Thesis]. Acadia University. https://scholar.acadiau.ca/node/4269. [ax. 2025, Jul].
[132] *Ibid.* Sweeney, 2021.

Because HWA has been present in the United States for decades, there is an established and growing body of research investigating the impacts of neonic use on hemlocks. This library is now being expanded by Canadian researchers as HWA treatments are implemented across eastern hemlock's northern range. As demonstrated throughout this section, findings show that pesticide use often results in some degree of impact on non-target species, but these impacts are generally sub-lethal.

Despite this growing body of research, because ecological time-scales are long, spanning many human generations, there may be long-term environmental impacts that are not well understood. A primary concern of pesticide use is cumulative effects because while individual applications are generally regulated by of various levels of government, there is little comprehensive oversight to monitor landscape-level pesticide application.[133]

Despite the downfalls of neonics, generally their use in hemlock protection is in much lower concentrations than their most common use case: agriculture. Further, research suggests that the large-scale loss of hemlock forests is likely to cause significant biodiversity decline due to loss of habitat, which may outweigh the potential impacts of small-scale and short-term pesticide use.[134] This is the stance taken by all jurisdictions in Nova Scotia that have chosen to treat HWA.

HRM is following an injection-only approach to HWA treatment to, as much as possible, avoid non-target impacts of our *Hemlock Protection Program.* This approach better aligns with the Integrated Pest Management Guidelines comparative to a blended treatment approach because though it does not completely avoid pesticide use, it limits the implications of pesticide use.

It is important to note when reviewing the following sections of the *HWA Plan* that information for both injection and basal bark spray treatment options has been included. Though HRM staff advise an injection-only approach, *the HWA Plan* was drafted to ensure that all relevant information is available to decision-makers. This will eliminate the need to revert *the HWA Plan* to the draft stage to add guidance on basal bark spray should the decision be made to include it in HRM's treatment arsenal over time.

Pesticide Regulations

When using any of the products listed in *Table 5,* all parameters outlined within the *Nova Scotia Environment Act's* Pesticide Regulation ("the Regulation")[135] must be followed. Some of the key requirements by said regulation include:

- product labels must be adhered to at all times

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[133] *Ibid.* Wan et al., 2025.
[134] McCarty, E. 2020. Environmental risks to arthropods from imidacloprid applications for hemlock conservation. University of Georgia, Warnell School of Forestry & Natural Resources. Publication WSFNR-20-88A. https://bugwoodcloud.org/resource/files/18692.pdf. [ax. 2025, Jul].
[135] Nova Scotia Environmental Act. (S.N.S. 1994-1995, c1). Section. 84: Pesticide Regulation.

- a trained and certified pesticide applicator must be present at the time of treatment
- proper PPE must be worn at all times during an application
- proper storage and handling of chemicals as indicated on the product label are imperative

Some pesticide application projects require provincial regulatory approval prior to treatment. However, pesticide application activities that require such approval are outlined in the *Activities Designation Regulations* (ADR)[136] (section 66 of the *Environment Act*). Though pesticide application on "Forested land" is one of the circumstances listed under the ADR, "Forested land" "includes, but is not limited to, land used for the production of pulp, sawlogs, lumber or firewood, but does not include land used to grow Christmas trees".

Because hemlock treatment in HRM will not occur on "forested lands" as defined by the provincial legislation but rather will occur on protected and conserved areas (e.g. regional parks) and other areas of municipal use, no pre-approval from the province would be required prior to commencing treatment. Determinations relating to the need for approval are made on a case-by-case basis. If staff determines an application is needed for any specific site, then an application will be made prior to commencing treatment.

This, and other applications of the Regulation as it pertains to *the Plan* are described in more detail in the *Steps to chemical/medicinal treatment* sub-section.

The explanation of the *Regulation's* applicability to HRM's *HWA Treatment and Management Plan* may not be exhaustive. Anyone planning to commence HWA treatment in the Halifax Region should first review and familiarize with the *Regulation* and other associated legislation to ensure it is being appropriately followed.

Steps to chemical/medicinal treatment

The protocols and parameters set out in *The Plan* have been informed by those designed and followed by the NS Department of Natural Resources and affiliates. It is anticipated that a blend of contractors, staff, and volunteers will undertake treatment in HRM. Regardless of who is carrying out treatment, the protocols and parameters set out in *The Plan* must be followed. Any amendments for volunteer-based treatments have been explained in the *Volunteer program* section of this document.

1. Mapping and assessment

Prior to marking specific trees for treatment, site assessments verifying where, and in what quantities eastern hemlock is growing on municipal land is needed. Mapping applications using layers developed by the Province of Nova Scotia been used to assist in locating stands where a

[136] Nova Scotia Environmental Act. (S.N.S. 1994-1995, c1). Section. 66: Activities Designation Regulation.

high concentration of hemlock is likely to occur, but this mapping must be groundtruthed. This will involve significant travel throughout the municipality.

At each site, the assessor is to use provided mapping tools (specifically Field Maps and Survey123) to outline specific blocks for treatment. In some cases, boundaries will be provided, but the assessor must adjust the boundaries accordingly based on where eastern hemlock is actually found. At each site a variety of metrics must be recorded:

a) Site access

In most cases, site access notes will be brief considering the size and location of most HRM municipal parks. However, it is important to record access details to ensure follow-up visits can be made for monitoring and future treatment. Details that should be recorded include:

- Proximity to the nearest road,
- Degree of public access (e.g., trails),
- Known recreational uses,
- Terrain (e.g. washouts, sinkholes),
- Waterbodies
- Notable landmarks
- Any access challenges

b) Assessment plots

Once a hemlock stand is located, an assessment must be undertaken to better understand hemlock density and condition.

Detailed steps to completing an assessment are detailed in *Appendix C* of this plan.

c) Treatment decision

Typically, following assessment the assessor will take note of which pesticide treatment may be best suited to the site (i.e., injection or basal bark spray). For example, in some cases basal bark spray is prohibited (i.e., hemlocks within 7 m of a waterbody,) in others local site conditions may make basal bark spray unappealing (i.e., high public presence or recreational use).

If planning to basal bark spray, the marking process should begin with checking the treatment area for waterbodies. It is important to look for a variety of features such as noticeable canals or dried stream beds. Even if a waterbody does not contain water at the time of marking, it is still considered a waterbody and thus a 7 m buffer should be maintained between the waterbody and the nearest tree flagged for basal bark spray. When identifying the water line, take note of features like slope or a highwater mark. If the waterbody contains water at the time of marking, measurement of the 7 m buffer should start at the highwater mark.

Wet areas should be treated the same as waterbodies. Wet areas can be defined as wetlands (e.g. bogs, fens, marshes), areas with visible standing water, or areas showing signs of having once held standing water. An example of the latter is a vernal pool. Without the presence of water, these areas can be hard to identify. Look for telltale signs like growth of sphagnum moss or algae, presence of clay soils, or indications of a highwater mark to distinguish these areas. Wet areas, particularly vernal pools, provide critical habitat for a variety of wildlife, and it is imperative to identify these areas during the marking process.

Generally, hemlocks growing in riparian areas should be prioritized due to their ecological value and the myriad services they provide to both aquatic and terrestrial habitats. If contractors complete this step (as opposed to staff or staff-led volunteers) they would take note of local conditions and consult with HRM before making a final treatment decision.

Because HRM staff recommends an injection-only approach, this decision has already been made. This sub-step has been left in *The Plan* in case such a time arises when basal bark spray is added to the arsenal of treatment options for hemlocks on HRM property.

2. Safety assessment

Prior to commencing treatment, sites must be assessed for safety to identify and mitigate potential hazards (e.g. slips, trips and falls) to ensure safe and controlled use of insecticides. This can be done during the initial assessment and/or tree marking, but applicators must also be cautious and aware of any hazards during treatment (particularly in cases where conditions have changed, e.g. extreme weather events).

The following is a list of mandatory documentation that must be checked/reviewed prior to treatment, and should always be on site during treatments:

- SDS and Product Labels
- Atlantic Canada Pesticide Applicator Training Manual Series
  - Applicator Core Training Manual
  - Forestry Training Manual
- Poison Control and Emergency contact numbers

It is also advised that the supervising pesticide applicator on site keeps a copy of their license or license number on their person while a treatment is underway.

3. Tree tagging and marking

After stand assessment, individual hemlocks will be tagged and marked with flagging tape to indicate that they have been selected for chemical/medicinal treatment. This is an essential precursor to actual treatment, as the measurements and condition assessments collected will determine the treatment type and the volume of product needed to protect target hemlocks from HWA.

Tags are a long-term record of treatment that will help future practitioners locate treated trees when doing follow-up treatments or monitoring. Flagging tape is temporary. It is used to communicate treatment information to those doing the chemical/medicinal application. As treatment is completed, flagging tape will be removed and properly disposed of to ensure it does not wind up littering HRM parks.

It is best practice to use different colour flagging tape for each application type (i.e., basal bark spray or injection). Each colour corresponds with a particular product (*Table 5)* and treatment type. The colour code for HRM's HWA flagging tape provided in *Table 6*.

Treatment Type	**Tree Tag**	**Flagging Tape Color**
Injection (IMA-Jet)	Last 2 digits of the year and letter I	Orange
Basal bark spray (Xytect 2F)	Last 2 digits of the year and letter X	Pink
Basal bark spray (Starkle 20SG)	Last 2 digits of the year and letter S	Green
Basal bark spray (Xytect 2F + Starkle 20SG)	Last 2 digits of the year and letter M	Yellow

Table 6: Tagging and flagging conventions for HRM's HWA treatment program.

As noted in the *Community notice* section below, HRM will always erect or supply temporary signage (depending on whether the work is to be done by HRM staff or contractors) to communicate the reason for marking to the public. This signage will be used frequently in treatment areas where it is best visible.

If using basal bark spray as a mode of application, there are annual limits to the amount of product (i.e., Xytect 2F) that can be used per hectare (ha). If most hemlocks in a stand have a DBH of ≤80 cm the application limit is calculated per centimeter with the maximum set at 1,638 cm DBH/ha. If most trees have a DBH of ≥80 cm the limit is calculated by volume (mL) of product needed with the maximum set at 1,900 mL/ha. Because of these limitations, tree markers must be selective of the trees they select for treatment. It is ideal to select trees that are evenly distributed by location and age class within each treatment block (hectare). Selecting only larger trees will result in less trees being treated overall. Alternatively, only choosing younger trees will greatly alter the canopy of the stand and may result in the loss of more mature trees that are of great ecological and genetic value. Tree condition must also be considered. Only selecting trees that are already in decline may mean that healthier trees are overlooked, while only choosing tree that appear healthy may mean declining trees will pass into a condition beyond saving before the next round of treatments occurs. Thus, a balanced approach must be taken in the tree marking phase.

There is no maximum application rate for injection (IMA-Jet 5 or IMA-Jet-10), trees can be marked and treated in the same year regardless of the size of the area.

Once the location of any waterbodies and wet areas has been confirmed (as outlined in the *Mapping and assessment* section above), the marking process can begin. Tree marking is best completed with two people: one to collect measurements and the other to record the information into Survey 123. The steps to marking are as follows:

- Open Survey123 and start a new Survey
- Inspect tree for crown foliar health, bark damage, visible signs of dieback, decay etc.
    - Until the tree marking crew gains some experience, the Canopy Density Chart provided in *Figure 12* is helpful for assessing crown foliar health
- Measure DBH at the standard 1.3 metres from the highest side of the tree.
    - Trees with a DBH of ≤15 cm should not be marked for treatment.
- Flag tree based on treatment type and use permanent marker to indicate amount of product needed based on tree size
    - Basal bark spray: spray seconds
    - Injection: number of injection sites needed
- Input the DBH into Survey123, which for basal bark spray will produce the total number of seconds to spray the tree, for injection it will produce the total number of injection sites needed
- Tag the tree on the north facing side (i.e. face the tree with your compass pointing south), on the tag there must be the application type (i.e., indicating which chemical will be used) and the year of chemical application

Detailed steps to completing tree tagging and marking are detailed in *Appendix D* of this plan.

4. Community notice

In some cases, there is a regulatory requirement to provide public notice of a chemical application a minimum of 20-days prior to treatment. This is not currently required of HRM, but because the majority of HWA treatment will occur in popular public parks the regulatory requirement of 20-days notice will be upheld as best practice.

Other municipalities in Nova Scotia have struggled with community members removing flagging tape attached to trees targeted for treatment. It is assumed this has been due to a misunderstanding about what the flagging tape signifies (i.e., people may have thought the trees were going to be cut down). This has resulted in a duplication of work and timeline setbacks. Learning from this experience, abundant HWA treatment signage will be deployed in advance of tree marking. Signs should be deployed at reasonably regular intervals throughout the treatment area, in visible, high traffic places. If the treatment area is a park, signs should also be deployed at all official entrances.

Signs will be made available through HRM's Environment and Climate Change division in collaboration with Corporate Communications. They will be multi-purpose in that they will briefly explain HWA treatment and tree marking, while also notifying community members of upcoming treatment dates in the area. To make signs reusable, they will contain a blank space where stickers indicating the date and time of upcoming chemical treatment can be attached. All signs will remain in place for a minimum of 24-hours and a maximum of 14-days post-treatment.

Finally, residents within 500 metres of a park selected for treatment will be notified via a Canada Post mail-out a minimum of 20-days before the scheduled treatment.

If an injection-only approach is taken, HRM parks will not need to be closed during treatments. If basal bark spray is to be incorporated, parks must be closed a minimum of 24-hours post-treatment to ensure all product has dried prior to re-entry into the treatment area. It is important to read the product labels and adhere to any specific public communication instructions they may require prior to treatment.

5. Product delivery, storage, handling, and spill procedures

All pesticides must be stored correctly in accordance with provincial and federal regulations and product labels. Most often this means product should be stored at the appropriate temperature in its original, leak-proof container. Product must be locked in a designated leak-proof storage cabinet or building. No more than 24 litres of product for HWA treatment will be stored in HRM facilities at any one time without the development of an emergency response plan.

Under no circumstances can pesticide or pesticide equipment be stored overnight outside.

Pesticide must always be stored in a leakproof container during transportation, storage and handling. Take care when choosing an acceptable site for loading product. Loading is prohibited within 30 m of a watercourse or waterbody. Loading must be done within a spill berm with the pesticide stored in a leakproof container. Unless being actively mixed or applied, pesticide must be stored in a leakproof container with the lid closed. All necessary safety equipment must be available at stages of pesticide use including during pesticide storage and when handling pesticides whether at storage facilities, during transportation, or at treatment sites. This includes:

- A spill kit
- Safety datasheets (SDS) and product labels,
- Eye wash apparatus/station

Working communication equipment and emergency contact numbers, including poison control must also be on site and easily accessible. A more complete safety equipment list to appropriately react to an incident like an injury or spill is provided in *Appendix B* of this plan.

In addition to safety equipment, proper signage must be posted at the storage facility in accordance with legislative requirements.

All pesticide application equipment should be properly cleaned and maintained before and after each use. This is best practice to ensure that chemical/medicine is being applied at the correct dosages, equipment is maintained in proper working order, and to prevent any leakages.

Special care should also be taken to protect everyone working with insecticides. Personal protective equipment (PPE) must be provided to all chemical/medicine applicators in accordance with the safety information on product labels. Applicators must ensure their PPE is in proper condition at the beginning of each field day. Applicators should always have spare clothes on hand in case of an accidental exposure. It is also good practice to change clothes and PPE if visiting more than one treatment site in a day to prevent unintentionally spreading HWA from one site to another. All clothes should then be washed at the end of an application day. Recommended PPE can be found in the equipment lists for injections and basal bark spray in *Appendix B* of this plan.

It is essential that applicators take the utmost care to clean all equipment, PPE, and other clothing when moving between treatment sites. HWA is not yet widespread in HRM, and precautions must be taken to avoid facilitating further spread. A lint brush to remove any debris from clothing and hair and brushes to clean off boots will be essential tools.

A hose should never be used under any circumstances when working with pesticide. If water is needed, fill a container with water at a fill station and bring it to the loading station.

If contractors are to purchase, store, mix, and transport pesticide on behalf of HRM, they must follow the guidance in this plan in addition to being aware of and following all necessary legislation regarding pesticide storage, mixing, and transportation.

In the event of an incident such as a leak, spill, or exposure to pesticide, follow the proper response protocols as outlined on product labels and other safety information that is required to be on site at all times. If the incident is a spill or leak the appropriate response would likely involve deploying spill kits and an absorbent material like kitty litter. The spill/contamination should be reported to NS Department of Environment and Climate, either to the closest local regional office (Regional and District Office Locations | Department) or emergency line (1-800-565-1633). If the incident is an exposure the appropriate response might include administering First-Aid and consulting poison control or contacting the appropriate emergency contact. An incident report should also be completed regardless of the incident type.

If such an incident occurs in the course of work done by a contractor, said contractor is responsible for damages and fines as a result of improper practice. This includes, among others, improper storage, faulty equipment stemming from lack of maintenance, and improper following of PPE and handling of pesticides.

6. Chemical/medicinal treatment

The final step in the treatment process is the chemical/medicinal application.

(a) Injections

As noted throughout this report, injection is the only method of application permitted within 7 m of a watercourse, waterbody, or wet area. Injections are also recommended in other ecologically sensitive areas, like known species at risk habitat. HRM has access to a comprehensive species occurrence dataset assembled and managed by the Atlantic Canada Conservation Data Centre. It is recommended that species occurrences within a 1 km radius of a new treatment area is checked prior to treatment. Finally, injections may be the best option in areas of high human use where the 24 hour closures recommended for spray applications may not be feasible.

Prior to treatment, ensure all equipment has been properly maintained. The type of injection system used will determine the auxiliary equipment needed (e.g., the type of air compressor). Based on thorough review and testing not only by HRM, but the treatment community throughout the province, the EcoJect system will be used for staff-led and volunteer-powered treatments.[137] It is incredibly important to take care when working with pressurized air systems. Thoroughly read all manuals, and do not increase air pressure past the maximum amount specified. Ensure all persons involved in treatment (regardless of pesticide license status) have read the equipment manual or have had training in its proper use. All persons should also have read product labels and SDS prior to beginning treatment. Refer to product labels and SDS for required PPE. Proper eyewear and face shields are especially critical to ensuring proper protection. Understanding the type of injection system used, appropriate maintenance measures, and proper and safe use will contribute to preventing splash back on the applicator and environmental contamination.

It will be necessary to have a drill and spare batteries and drill bits to undertake injection treatments. Injection sites will be bored into the tree at regular intervals along root flares at ground level. It is important that holes are evenly distributed to ensure even distribution of chemical/medicine throughout the tree, Generally, one injection site is required for every 5 cm of a tree's DBH, but this depends on the concentration of active ingredient. The quantity of chemical used should be confirmed upon review of the product label. Drill bits must be of the appropriate size and should be changed frequently to prevent as much damage to the tree as possible. Injection is not recommended for hemlocks with a DBH of ≤12.7 cm DBH because the drilling of injection sites into these immature trees is likely to do them more harm than good.[138] This is a bit of a moot point of a however, as generally HWA treatment is not completed on any tree with a DBH of ≤ 15 cm.

Make note of the location of drill holes as they made. They can easily blend into a tree's bark and become lost. This step is imperative because drilling more holes than necessary due to

[137] Crossland et al., 2022
[138] Crossland et al., 2022.

failure to mark original drill sites will cause undue damage to the tree and impact the overall quality of work.

The injection process will differ based on the system used, complete details of chemical/medicinal application using the EcoJect system have been provided in *Appendix E* of this report.

(b) Basal bark spray

Initial treatments in HRM will be injection-only with potential to include basal bark spraying in the future if decided by Regional Council and appropriate sites are identified.

Basal bark spray is applied using a backpack sprayer to ensure relatively targeted application on a tree-by-tree basis, as compared to more blanket application approaches such as boom spraying. It is widely considered the most cost-effective way to treat HWA and is well suited to remote areas with low human use and areas that are densely populated by hemlocks.

As noted in the *Tree tagging and marking* section of *The Plan,* basal bark spraying is not permitted within 7 m of a waterbody or wet area. Likewise chemical mixing is not permitted within 30 m of a watercourse, waterbody, or wet area. There are also re-entry restrictions following basal bark spray (i.e., no admittance to the area within 24 hours of chemical/medicinal application). Finally, there are annual application limits on the amount of product used within a hectare. This means some areas will need to be returned to, year-over-year, to ensure all target hemlocks are protected.

Basal bark spraying depends on seasonal timing and weather. The *Timing and weather* considerations section of the report outlines optimal treatment times and restrictions.

Complete details of chemical/medicinal mixing and application using basal bark spray have been provided in *Appendix F* of this report.

Timing and weather considerations

Chemical treatments can be done anytime within the growing season, specifically when the ground is thawed. This is generally from the beginning of April to the end of November in Nova Scotia, though there can be some variance from year to year. **The spring season is the best time to treat hemlocks**. However, treatment may also occur in the fall because it is another period of active growth and transpiration.[139]

There are a variety of weather constraints and site requirements to consider prior to chemical/medicinal treatment. Weather should be checked daily and on site to maximize

[139] Cornell University New York State Hemlock Initiative. 2025. HWA treatment options. https://blogs.cornell.edu/nyshemlockinitiative/hwa-management/hwa-treatment-options/. [ax. 2025, Jul].

productivity and conduct treatment in the safest manner possible. The following guidelines will be used by HRM.

Weather considerations for injection-based treatment:

- Do not inject 24 hours after a significant rainfall event
    - Significant rainfall event is defined as ≥10mm of rainfall a day, or continuous rainfall of 1~5mm over 2-3 days.
- Injection can be conducted if <5mm of rainfall occurred the day before treatment and no additional rain is projected for the day following treatment.
- It is important to note that consistent rain events/wet conditions will affect the ability of the tree to uptake the chemical, for optimal results plan treatments accordingly.

Weather considerations for basal bark spraying:

- Do not spray if wind speed is higher than 20km/h.
    - Wind gust: It is possible to spray if wind gust is at 20km/h or higher depending on the frequency of gust. Treatment area near a large body of water will likely have higher frequency of gust. It is less of a constraint in inland areas where the forest shields applicators from wind.
- Do not spray 24 hours before or after a significant rainfall event.
    - Spraying can be conducted if <5mm of rainfall occurred the day before treatment and no additional rain is projected for the day following treatment.
    - Avoid spraying if it is projected to rain > 5mm the day following treatment.
- Due to the protective equipment needed to conduct spraying and the and weight of full back tanks, do not spray for a prolonged period if the temperature is above 25° Celsius.
    - If high temperatures are forecast, conduct spray treatments in the morning when and stop at noon when the temperature stats to climb.

Resources for confirming appropriate weather conditions for treatment:

- Windy: Wind map and weather forecast
- SpotWx: Various location specific numerical weather models
- Nova Scotia Weather for Emergency Managers: Local weather-related situational awareness page
- NASA Worldview: Various layers to understand local weather conditions
- Environment Canada: Weather radar provides short-term forecast information

Treatment equipment

Equipment checklists for each treatment step have been provided in *Appendix B*, as well as a complete list of specific equipment recommended by HRM for use in HWA treatment in *Appendix F.* Care should be taken to adhere as closely as possible to the equipment specified in *Appendix F* to maintain treatment consistency between different practitioners (e.g., volunteers, HRM staff, contractors). The suggested equipment list includes basal bark spray equipment with a special focus on spray nozzles that have been found to decrease spray drift. As elsewhere in *The Plan*, this information has been supplied as a resource in the event that HRM decides to incorporate basal bark spray as a treatment method.

Site prioritization and selection

In the absence of landscape-level management tactics to protect hemlocks from HWA and contain its spread until a robust biocontrol program is established, stand prioritization for treatment will be necessary. **HRM has jurisdiction to treat only on municipally owned lands** and as such chemical/medicinal treatment by HRM will be in HRM-owned and managed Parks, however there may also be instances where treatment is completed in the right-of-way, or non-park lands referred to as 'open land'. Based on data shared by NS Department of Natural Resources, out of HRM's 900 municipal parks, nearly 350 are expected to contain some amount of eastern hemlock. The total park area occupied by hemlock in the region is estimated to be around 70 ha, based on some initial ground truthing. Though it may be feasible to treat all of these trees over time, the top priority sites have been identified for immediate treatment.

Priority sites in the municipality have been identified using a combination of public feedback, local research, and a scoring system originally developed by Cornell University and modified for use by the province of Nova Scotia is being used. This system, which can also be thought of as a prioritization framework, ranks hemlock stands using values for various criteria like hemlock density, stand age-class, and cultural significance to ensure the stands selected for treatment are those with the greatest ecological and cultural benefit. Urgency has also been considered, since to date all HWA identified in the municipality have been found in the Bedford area, making hemlock stands in that area of the city particularly vulnerable. It is important to keep this variety of decision-making metrics in mind when scrutinizing this list.

Based on current knowledge, a list of fifteen priority parks have been assembled in *Table 7*. They have been listed in the suggested order of treatment. This list is not exhaustive. It has made the assumption that the largest woodland parks and parks with the highest proportion of hemlocks in the Halifax Region are of highest priority. There are several smaller and more manicured parks in HRM with lower numbers of hemlocks that should be considered for treatment once priority sites have been protected, and the *Hemlock Protection Program* matures. Further, not all municipally owned, non-park property (e.g., rights-of-way (ROWs)) have been considered in this first prioritization analysis due to 1) some limitations in mapping/gaps in available information regarding hemlock locations in these areas and 2) publicly accessible parks being of highest community value.

Another reason ROWs have been omitted from this initial analysis is that eastern hemlocks are not commonly planted as street trees (approximately 50 candidates (i.e., DBH of ≥ 16 cm) known in Halifax ROWs) and furthermore ROWs are narrow and not necessarily ideal hemlock habitat. Rather, areas with the densest hemlock populations have been prioritized for treatment first. Once these priority areas have been treated, ROW hemlocks should be considered for management as they will be at risk of conflicting with infrastructure if/when they begin to decline.

It is important to keep in mind that additional treatment sites will likely be identified during the lifetime of HWA treatment in the Halifax region.

Park	HRM community	Approx. hemlock coverage (ha)	Site selection justification	Action plan (2025-2026)
Sandy Lake* ** Includes other HRM-owned parcels adjacent which are not formally part of the park*	Bedford	36.32	• Confirmed HWA detection (2024) • Old growth hemlocks present • High local community engagement • Ranked highly in public engagement responses • Identified as a priority site using provincial data layers	Immediately treat [Autumn 2025]
Hemlock Ravine Park* ** Includes Grosvenor-Wentworth Par*	Bedford	3.88	• Proximal to confirmed HWA detections • Among highest density of hemlocks on HRM-owned land • High local community engagement • Ranked highly in public engagement responses • Identified as a priority site using provincial data layers • High public use makes it a good public awareness-building site	Assess and make treatment decision [Autumn/Winter 2025]
Admiral Cove	Bedford	0.02	• Proximal to confirmed HWA detection in Sandy Lake area • Identified as a priority site by local research project (Machat & Duinker, 2022)	Assess and make treatment decision [Autumn/Winter 2025]
Sawgrass Drive Park and Oakfield Woods Park	Oakfield	0.81	• Identified as a priority site using provincial data layers • Proximal to confirmed HWA detection in Oakfield Provincial Park	Assess and make treatment decision [Winter 2025/Spring 2026]

Shubie Park* ** Includes Michael Wallace Elementary School Park*	Dartmouth	1.06	• Identified as a priority site using provincial data layers • Ranked in public engagement responses • High public use makes it a good public awareness-building site • HWA eDNA detection (low signal) in 2024	Assess and make treatment decision [Winter 2025/Spring 2026]
Clarence Court Park	Fletcher's Lake	0.90	• Identified as a priority site using provincial data layers	Community survey to confirm hemlock presence [Winter 2025/Spring 2026]
Brookhill Drive Park 3* **There are three parks in this area, Brookhill Drive Park 3 is the target treatment area*	Grand Lake	0.86	• Identified as a priority site using provincial data layers	Community survey to confirm hemlock presence [Winter 2025/Spring 2026]
Duck Lake Brook Greenway Park	Windsor Junction	0.88	• Identified as a priority site using provincial data layers	Community survey to confirm hemlock presence [Winter 2025/Spring 2026]
Gordon R. Snow Community Centre Park	Fall River	0.63	• Identified as a priority site using provincial data layers	Community survey to confirm hemlock presence [Winter 2025/Spring 2026]

Red Bridge Pond Park	Dartmouth	0.57	• Identified as a priority site using provincial data layers	Community survey to confirm hemlock presence [Winter 2025/Spring 2026]
Settle Lake Park	Dartmouth	1.13	• Identified as a priority site using provincial data layers	Community survey to confirm hemlock presence [Winter 2025/Spring 2026]
Sir. Sandford Fleming Park	Halifax	None mapped	• Identified as a priority site by local research project (Machat & Duinker, 2022) • Old growth hemlocks present • High local community engagement • High public use makes it a good public awareness-building site	Assess and make treatment decision [Winter 2025/Spring 2026]
Point Pleasant Park	Halifax	None mapped	• Identified as a priority site by local research project (Machat & Duinker, 2022) • Ranked in public engagement responses • A high proportion of trees planted during Hurricane Juan recovery efforts in 2007 and 2008 were eastern hemlocks • High public use makes it a good public awareness-building site	Assess and make treatment decision [Spring 2026]
Shaw Wilderness Area	Halifax	None mapped	• Ranked highly in public engagement responses	Assess and make treatment decision [Spring 2026]
First Lake (First Lake Regional	Sackville	1.43	• Ranked in public engagement responses	Assess and make treatment decision

Park, Alder Crescent Park, and Sackville River Linear Park)* ** Includes other HRM-owned parcels adjacent which are not part of these parks*			• Proximal to healthy hemlock population in adjacent Sackville Lakes Provincial Park	[Spring 2026]
Total treatment area for first phase of treatment against HWA		48.49		

Table 7: Priority treatment sites for treating eastern hemlock against HWA on HRM-owned property. It is important to note that some parks contain large individual hemlock trees in addition to (or in some cases rather than) high density stands (i.e., groupings) of hemlocks.

Over time, hemlocks in the right-of-way (ROW) may also be important to consider for treatment. It is estimated that there are more than 50 treatable (i.e., DBH over 16 cm) hemlocks in HRM lands zoned as ROW. These trees will be at greater risk of conflicting with infrastructure if they start to decline. This will likely mean higher removal and maintenance costs compared to removal in a park setting.

Monitoring

HWA Spread

As indicated in the *Plan development* section of this plan, regular surveys and monitoring have been scheduled in target parks throughout the Halifax region since the initial detection of HWA. The sheer size of HRM matched with limited staff capacity have made volunteers essential to monitoring the spread of HWA. Community members have been called into this work through social media campaigns and educational outreach sessions. eDNA traps have also been deployed in the springs of both 2024 and 2025 at key parks like Hemlock Ravine and Shubie to support this monitoring effort.

Treatment timing and efficacy

It is estimated that treatments either by injection or basal bark spray will remain effective for roughly five years. It is important to strategically time treatment to strike a balance between tree decline and longevity of protection. That is, treating too early (i.e., before HWA is confirmed present in a park) could be a waste of resources, but treating too late will mean that even once protected, treated hemlocks will never be as vigorous and beautiful as they were before being infested by HWA. For this reason, many high priority sites for treatment listed in *Table 6* have

been chosen based on 1) confirmed presence of HWA or 2) proximity to confirmed presence of HWA.

Table 7 includes a schedule to direct monitoring and treatment efforts to ensure the highest priority hemlock forests in HRM are proactively protected.

Cultural sensitivity and practice

In alignment with the views and expertise shared by Indigenous Knowledge Holders, Youth, and Elders during the Gathering Circle, it is advised that all treatments are undertaken with cultural sensitivity in mind. Where possible, it would be ideal for an Indigenous Knowledge Holder or other similarly qualified Indigenous Expert to be invited to a hemlock stand prior to treatment to engage in cultural practise as deemed appropriate by that person. This is especially important for treatment events that might include members of the public to encourage cultural awareness and sensitivity and build connections between the diverse communities of the Halifax Region. If such an expert is invited to lead this practice, they should be fairly compensated with an honorarium in accordance with the payment advice suggested by HRM's Diversity and Inclusion Office. There should be a line in the approved *HWA Treatment and Management Plan Budget* to accommodate this.

Where inviting an Indigenous Expert is not feasible, those conducting the treatment are encouraged to make a land acknowledgement before beginning work for the day and again any time they enter a new site. Ta'n Weji-sqalia'tiek or the Mi'kmaw Place Names atlas is a good resource for identifying the original place names in areas throughout the Nova Scotia-extent of Mi'kma'ki and may be helpful in the crafting of a land acknowledgement. It is important that a land acknowledgement is representative of:

- the person one who is making it (i.e., recognizes their positionality and is not just a reproduction of an acknowledgement written by someone else),
- the place that is being acknowledged, and
- the people of the place that is being acknowledged.

It is also advisable to make an offering to the hemlock stand where the treatment is to occur. At Asitu'lisk where an injection-based treatment program was undertaken between 2023 and 2025, an offering of loose tobacco was made prior to the beginning of a treatment. Making similar plant offerings to stands treated in HRM is also advisable. If an offering is to be made it ought to be:

- sourced from a good place (i.e. a local Indigenous seller),
- plant-based and contain no non-biodegradable or dangerous materials (e.g., no plastic packaging)
- either:
    - native to Mi'kma'ki and contain no invasive plant material

- culturally significant in Mi'kma'ki (i.e., welima'qji'jewe'l (sweetgrass), qaskusi (cedar), kijelamusi (sage), or tmawey (tobacco) (C. Bernard, personal communication, June 12, 2024).[140]

Silvicultural treatments

Silviculture is an adaptive management approach that has been employed in some HWA treatment regimes in Nova Scotia. Jeremy's Bay Campground in Kejimkujik National Park is a good example.

Silviculture as an HWA management tactic uses tree thinning and sometimes re-planting to satisfy a pre-determined objective like recovery of canopy coverage and biodiversity in a degraded forest stand. Other objectives of silviculture treatment might be to transition a hemlock stand into a different forest type, specifically one dominated by long lived hardwood species that are more fire resistant than conifer-dominated forests or reducing pesticide use by intentionally leaving some hemlock trees untreated to serve as a seed source to help repopulate hemlock populations once biocontrol is established. Some also hypothesize that cutting down patches of hemlock can help slow HWA's spread, but this has not been well-supported by the literature or anecdotal reports. Whether silviculture is a feasible approach to be employed in HRM is still under consideration by staff in the Environment and Climate Change and Urban Forestry divisions. It will only be employed if an appropriate candidate stand is identified.

If silviculture becomes a part of HRM's treatment and management strategy, it will only be done selectively (i.e., on a tree-by-tree basis, no clearcuts) and only in woodland park areas where a portion of eastern hemlocks have been treated. In those cases, a portion of untreated trees would be left standing to slowly decline into standing snags/wildlife trees while others would be pre-emptively thinned. This would create a mosaic of healthy/treated trees, dead/wildlife trees, and gaps in the canopy. The latter will allow for regeneration, which could be supplemented by tree planting. However, if treated hemlocks are present underplanting is unlikely to be necessary due to natural regeneration.

As an example, *Figure 12* was taken at Pollards Falls, NS in 2024 after HWA had been present for approximately five years. The canopy is completely open, and most hemlocks pictured are dead apart from a few struggling trees. This site was partially chemically/medicinally treated but had been in varying stages of decline at the time of treatment. Though there is still active research underway on the regeneration of hemlock stands post-HWA disturbance, it is predicted that early successional hardwoods like red maple (*Acer rubrum*), trembling and large-tooth aspen (*Populus tremuloides* and *Populus grandidentata*), and white and grey birch (*Betula papyrifera* and *Betula populifolia***)** will have increased opportunities to regenerate, while later

[140] Reeder, M. 2020, Oct 9. Ask an expert: William Johnson on the importance of plants In Mi'kmaw culture. *Dal News.* https://www.dal.ca/news/2020/10/09/ask-an-expert--william-johnson-on-the-importance-of-plants-in-mi.html. [ax. 2025 Feb].

successional species like red spruce may be among the new pre-dominant species.[141] However, due to the timescale required for forest regeneration to occur, some initial observations suggest that shrubby species like native rhododendrons (e.g. *Rhododendron maximum)* are finding their home in areas where mass hemlock dieback has occurred.[142]

Figure 13: Hemlock stand post-HWA infestation. Taken by Heba Jarrar, 2024.

Figure 13 provides anecdotal evidence that red spruce and potentially also white pine may be candidates for re-populating former hemlock groves. In this example, silviculture could be employed to thin out dead standing trees, since a build up of coarse woody debris could become a fire risk (until the standing deadwood starts to decay). Silviculture could also be employed to thin out conifer regeneration to be replaced with broadleaf underplanting to build resilience to wildfire outbreaks and promote species diversity. Again, the science on long-term recovery of forest stands post-HWA outbreak is still young. It is likely that any stands slated for

[141] *Ibid.* LeBlanc, 2025.
[142] Mulroy, ML, Holzmueller, EJ, & Jenkins, MA. 2019. Woody regeneration response to overstory mortality caused by the hemlock woolly adelgid (Adelges tsugae) in the Southern Appalachian Mountains. *Forests, 10* (9) pp.1-21. DOI: 10.3390/f10090717. [ax. 2025, Jul].

silviculture treatment in HRM will be pilot projects (perhaps in collaboration with other organizations) intended to contribute to that growing cannon.

Biocontrol

As mentioned earlier in this report, chemical/medicinal treatment is intended to be a temporary measure to protect hemlocks while the longer-term solution of biocontrol is established in Nova Scotia. Two types of species are being introduced across North America in different regions affected by HWA. Each targets HWA at different life stages: two species of silver fly (*Leucotaraxis* spp.) prey on the eggs of both generations of HWA and one species of beetle (*Laricobius nigrinus*) feeds on the winter/spring generation of HWA.[143] These species are colloquially known as Leuc (pronounced “Luke”) and Lari (pronounced "Larry”).

HWA biocontrol research and introductions have been under development for decades, starting in the eastern United States. The Canadian program is led by the Canadian Forest Service and has resulted in the release of over 5,000 biocontrol agents in Nova Scotia in the last few years.

It is important to note that the biocontrol program will not eradicate HWA from Nova Scotia. If it did, the biocontrol agents would disappear due to the complete loss of their primary food source. This would mean eastern hemlocks would no longer be protected if HWA were ever re-introduced. Instead, the biocontrol program aims to mimic the same balanced relationship that exists between hemlocks, HWA, and HWA-targeting predators in HWA’s native range. For example, there is a population of HWA in western North America, that is theorized to have arrived there over 20,000 years ago and is thus considered to be native. Because of this long-lasting presence, predators have evolved to prey on HWA. This means that an HWA infestation of a western hemlock is unlikely to be fatal to that tree. The Canadian Forest Service and others are attempting to create the same relationship between eastern hemlocks, HWA and its natural predators.

Initially, biocontrol introductions in North America were done with predator insects collected in Asia. In more recent years, introductions into Nova Scotia have consisted of individuals collected from British Columbia. The travel and labour associated with collecting these species have driven local innovation. In 2025, Dr. Kirk Hillier, a biology professor at Acadia University, along with academic, provincial, and federal partners, received over $1 million in funding to pursue biocontrol research and develop a novel HWA biocontrol rearing facility to raise HWA predators for release across the province. It is anticipated that this will help to expedite the introduction process and therefore reduce the need for chemical/medicinal treatment approaches.[144]

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[143] Cornell University New York State Hemlock Initative. 2025. Leucotaraxis spp. Biocontrol Research. https://blogs.cornell.edu/nyshemlockinitiative/biocontrol-program/leucotaraxis-silver-flies/. (ax. 2025, May).
[144] Acadia University. 2025. Acadia to lead groundbreaking research to save Nova Scotia’s hemlocks, mitigate impacts of climate change. https://www2.acadiau.ca/about-acadia/newsroom/news-reader-page/research-to-save-nova-scotia-hemlocks-mitigate-climate-change.html. [ax. Mar, 2025].

Volunteer programming

Based on public engagement results, many residents of the Halifax region are interested in supporting HWA management and treatment HRM parks through volunteering. This interest combined with the 1) success of other volunteer treatment programs in the province, 2) growing scale of the HWA problem, and 3) possibility of increasing the longevity of HWA treatment due to decreased treatment costs indicates that a staff-led, volunteer program would be a significant benefit to HRM's HWA treatment strategy going forward.

Similar to HRM's LakeWatchers Program, the *Hemlock Healers* program would mobilize interested community members to take conservation action in local parks. This model would not only be more economical (since 2024 it is estimated that volunteer contributions to LakeWatchers saved the municipality more than $50,000) but would increase environmental literacy, provide Halifax residents an opportunity to actively participate in climate action, and align with goals set out in the *Parks Stewardship Program.*

The volunteer program would be modelled after a similar program established in the Mersey Tobeatic area by Medway Community Forest Cooperative. To participate, volunteers would be required to attend a training program with a certified pesticide applicator before attending any active treatment events. Unless a certified pesticide applicator, all volunteers would play a supportive role in treatments. That is, they would never actively handle pesticides but would instead assist with tasks like drilling injection sites and collecting empty cannisters.

The same treatment protocols outlined in *Appendices C* through *F* would be followed for volunteer treatments with an added educational element.

Supervisory Restrictions

Section 9 of Nova Scotia's provincial *Pesticide Regulations*, outlines "Supervisory Restrictions" and there are different rules for "private applicators" (e.g., residential property owners) compared to "commercial applicators" (e.g., contractor or HRM staff). The following applies to commercial applicators:

1. Notification of supervision

    - Subsection 2C indicates that "an Administrator is notified when the supervision of the non-certified applicator will occur."
    - Notification should be sent to the District Manager at Nova Scotia Environment & Climate Change via email who will then share it with appropriate regional staff.
    - Notification can be sent as a "batch" and should include:
        - Name of certified person who will be supervising,
        - Names of those being supervised, and
        - Approximate dates / timeline for treatments

2. Thirty-day supervisory period

- Section 9 (3) indicates that “A non-certified applicator may only be supervised by a commercial applicator under subsection (2) for one 30-day period.”
    - Nova Scotia Environment & Climate Change are currently in the process of interpreting the above restriction, including what it may mean for organizations undergoing HWA treatment that may engage the use non-certified staff or volunteers.

In discussion with the provincial regulator, it was confirmed that, the 30 days specified in the *Pesticide Regulation* days means days of pesticide application **only**. It does not refer to a continuous 30-day period.

Projected budget

As noted elsewhere in *the Plan,* it is anticipated that the long-term management strategy for HWA (i.e., biocontrol) will not be established in Nova Scotia for (optimistically) ten to (realistically) twenty years. It makes the best economic sense to plan to invest in HWA treatment in the long-term. While there *is* value in short-term treatment to avoid mass hemlock die-off all at once, economically and ecologically it would be best to begin protecting trees in 2025 and continuing to do so in 2030 when the initial treatment is no longer effective and beyond.

The budget reference table (included as *Table 8)*, for this program assumes that a cyclical treatment program of target parks will be adopted with the treatment cycle repeating every five years for the next twenty years.

Item	Cost	Type	Description/Justification
Contractor(s)	$150,000+	Repeat (every 5 yrs. for up to 20 yrs.)	Some practitioners caution against hiring contractors for the full-scale roll out of HWA treatment because compared to volunteer-led or staff-led programs, the costs of contractors may drain resources and limit the number of hemlock trees protected by the treatment program. Others attest that hiring contractors is an efficient way to increase treatment capacity. Hiring contractors to aid in the early stages of the HWA treatment program is likely to expedite the treatment process and ensure HRM’s treatment program is more preventative than reactive.
Staffing	$60,000~$80,000	Ongoing	The Nova Scotia Department of Natural Resources, the Town of Bridgewater, and others have approached their respective HWA treatment programs using a “strike team” model. This approach relies on dedicated staff to plan and implement HWA treatment. Medway Community Forest Cooperative

			has also established a volunteer treatment program that is complementary to the province's program to increase expediency of hemlock treatment (though this program is also supported by dedicated staff members). It is recommended that HRM hire at least one full-time Junior Environmental Professional to oversee the Hemlock Protection Program. It is anticipated that this position would be a permanent position to assist with ongoing monitoring, volunteer program management, and initiatives related to management of other invasive species.
Treatment equipment	$25,000	One-time	The cost of injection equipment and all associated accessories for staff-led and volunteer-powered treatments.
Communications and incidentals	$13,000~15,000	TBD	A one-time* fund to cover the cost of replacing broken (e.g., injection canisters) or depleted (e.g., cleaning supplies) equipment, fuel costs for travelling from site to site, communications like Canada Post mail-outs and sign production, and any additional unforeseen costs. **This amount may be spread out through the 5-year treatment cycle.*
Truck	$80,000* **This may be an in-kind cost if an existing HRM vehicle can be designated to the Hemlock Protection Program*	TBD	A designated vehicle for treatment would be a wothwhile investment to ensure pesticides are being safely distributed. Pesticide should never be transported in an enclosed area with a driver (i.e., an open-air box must always be used). Transporting chemicals and contaminated equipment in personal vehicles should not be encouraged. Having a designated truck where both pesticides and spill/safety kits can be transported together would help mitigate spill risk. In addition, it would help with maximizing the efficiency of the work. Because pesticide treatment depends heavily on weather, it can be tricky to schedule treatments on specific days. Having a vehicle available at all times will reduce delays.

Product: Xytect 2F (5%) (Backpack spraying)	$400/3.79 L (1 US Gallon)* Approx.$8.48/tree **This price is only available per gallon when 4+ gallons are ordered at a time*	Repeat	Approximate cost assuming approximately 50 ha of priority hemlock stand at a density of 100 hemlocks/ha with an average size of 40 cm. It is important to note: • The maximum allowable amount of Xytect 2F used annually is 1,900 mL/ha (or 456 g of active ingredient) this translates to 1,638 DBH/ha treatable per year. Assuming there are 100 hemlocks/ha with an average DBH of 40 cm, it will take 3 years to treat all the hemlocks in one hectare. • It is not possible to only treat by basal bark spray as spraying is prohibited within 7 m of a watercourse.
Product: IMA-Jet (10%) (Injection)	$650/L Approx. between $29.64 and $32.50/tree tree	Repeat	Approximate cost assuming approximately 50 ha of priority hemlock stand at a density of 100 hemlocks/ha with an average size of 40 cm.

Table 8: Budget reference table outlining projected costs of an HWA Treatment program in HRM

Budget notes

When inspecting the projected costs of HWA treatment outlined in *Table 8* there are several considerations to be made:

- The estimated contractor cost has been made as low as possible by assuming the smallest treatment team possible (i.e., two people versus the six people considered optimal for injection-based treatment as outlined in *Appendix E*). It is likely that the cost of hiring a contractor will go up each treatment cycle (i.e., every 5 years) due to inflation and other unknowns.
- The cost of hiring a contractor could be supplemented with volunteer programming. That is, volunteers, led by HRM staff, could complete tree assessments and marking to allow all contractor funding to be dedicated to actual chemical/medicinal treatment.
    - The value of pursing staff-led volunteer HWA treatment in at least a portion of HRM-owned hemlock forests would have great value beyond the protection of individual trees. This would give residents and property owners the opportunity to learn more about the treatment methodologies allowing them to make more informed decisions about whether/how to treat hemlocks on their own properties.
- There are plans to apply for additional funding to support the creation of a new staff position.

- Treating sites as a preventative measure too early can create additional costs. Waiting too long to treat stands can also result in significant cost increases as it would require the use of an additional, faster-acting product like Starkle or TreeAzin.[145]
- Product costs are recent as of April 2025. Because these products are typically produced and supplied by American companies, prices will fluctuate with changing exchange rates.

Jurisdictional comparison

To better frame the cost of operating a hemlock treatment program, a scan of government spending in other regions of Nova Scotia has been completed and a summary provided below.

In 2022 the Province of Nova Scotia dedicated $10 million to their HWA management program, which is focused on treating Crown lands and protected places in partnership with the Medway Community Forest Cooperative. The province operates its own “strike team” in addition to supporting the MCFC Hemlock Conservation team and volunteer program. This project is intended to protect the highest priority hemlock stands on provincial property.

The Town of Bridgewater allocated roughly $158,000 toward a park preservation project, designed to safeguard Bridgewater's parkland trees against HWA in both the 2024/2025[146] and 2025/2026 fiscal years[147], for a total of $316,000 dedicated to this work over two years.

In the 2025/2025 budget year, The Municipality of the District of Lunenberg increased the annual budget for “hemlock inoculation” from $50,000 in the previous year to $100,000, for a total of $150,000 dedicated to the goal of “[protecting] the species” to date.[148]

The Town of Kentville has allocated $20,000 in the 2025/2026 fiscal year for HWA treatment equipment and associated operational costs. Additional costs include staffing (i.e., one dedicated HWA-focused summer staff, seasonal park staff, and a program supervisor) and pesticides. The latter ranges in price year to year. Typically Kentville spends between $10,000 and $20,000 annually and a local community organization matches costs, bringing the total pesticide cost to approximately $40,000. Kentville is treating 100% of eligible hemlock trees with the goal of saving approximately 75%. Their program focuses on 171 hectares of heavily hemlocked parkland.

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[145] *Ibid.* Crossland et al., 2022.
[146] Town of Bridgewater. 2024. Town Council approves 2024-2025 budget; residential and commercial property tax rates unchanged. https://www.bridgewater.ca/news-events/latest-news/3372-town-council-approves-2024-2025-budget-residential-and-commercial-property-tax-rates-unchanged. [ax. 2025, Jul].
[147] Town of Bridgewater. 2025. Town Council approves 2025-2025 budget; residential and commercial property tax rates unchanged. https://www.bridgewater.ca/news-events/latest-news/3516-town-approves-2025-2025-operating-and-capital-budgets. [ax. 2025, Jul].
[148] The Municipality of the District of Lunenberg. 2025. *Approved Operating and Capital Budget 2025/26.* https://www.modl.ca/index.php?option=com_docman&view=list&slug=2025-2026&Itemid=335&layout=table. [ax. 2025, Jul].

Funding opportunities

Applying for additional funding may help to alleviate the cost of implementing a full-scale Hemlock Protection Program for Halifax. There are several possible funding opportunities available.

- Science Horizons (Clean Foundation): Employment subsidy
  - A one-year employment subsidy that would make hiring an HWA Treatment Coordinator possible.
- Mitacs: Research subsidy
  - Research-focused subsidy that would make onboarding a student possible who could help with program roll-out and monitoring
- Environment and Climate Change Canada: Environmental Damages Fund
  - Priority is given to projects that restore the natural environment and conserve wildlife.

Decision-making and conclusion

Currently, chemical/medicinal treatment is the only option available to protect hemlocks from the worst effects of HWA. Both reactive and prophylactic (i.e., preventative) treatment will be required to reduce the impact of HWA's continued spread. It is anticipated that the Hemlock Protection Program in Halifax will be undertaken by a combination of HRM staff, volunteers, and contractors with an average cost of between $150,000 and $200,000 per year for each 5-year treatment cycle.

To summarize the impacts and benefits of HWA treatment modalities and help to inform decision-making, a summary table has been provided (*Table 9*).

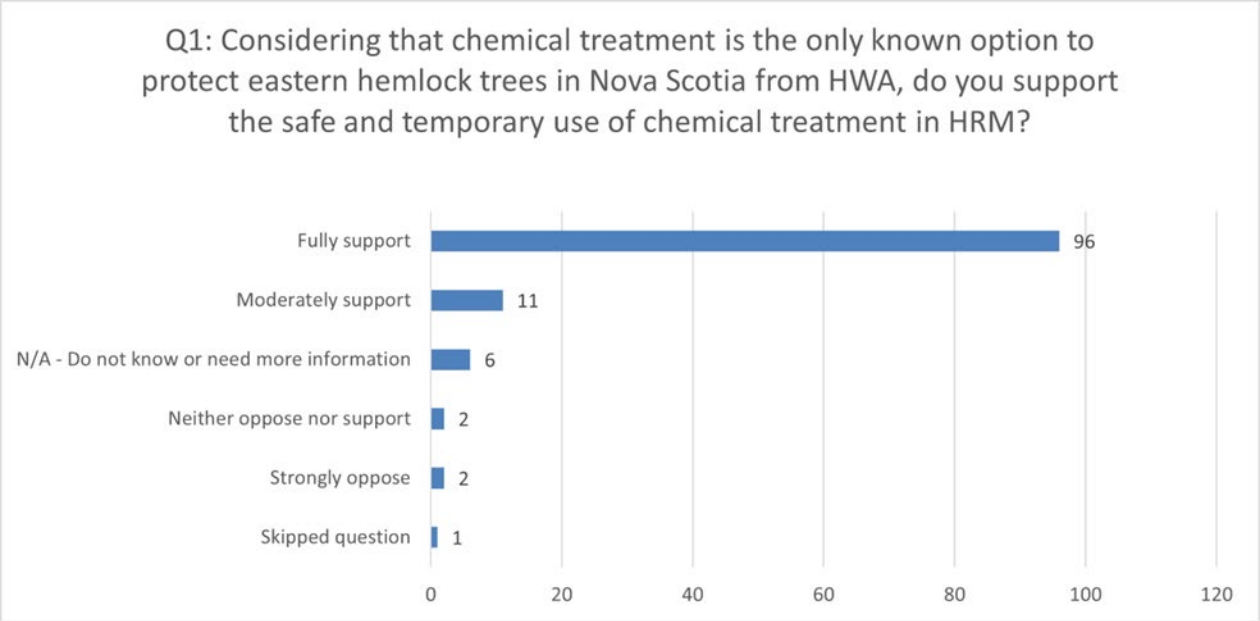
	Pro	Con
Basal Bark Spray	• No drill holes are need causing less damage to tree overtime • Cheaper (approximately $8.48 per average-sized hemlock tree) • Takes less time to treat trees • Requires less people compared to EcoJect system	• Unsupported (or not well enough understood to be supported) by many Mi'kmaq Elders and Knowledge Holders. • Application limits will require repeated re-entry into some treatment sites year-after-year. • Cannot be undertaken by volunteers.

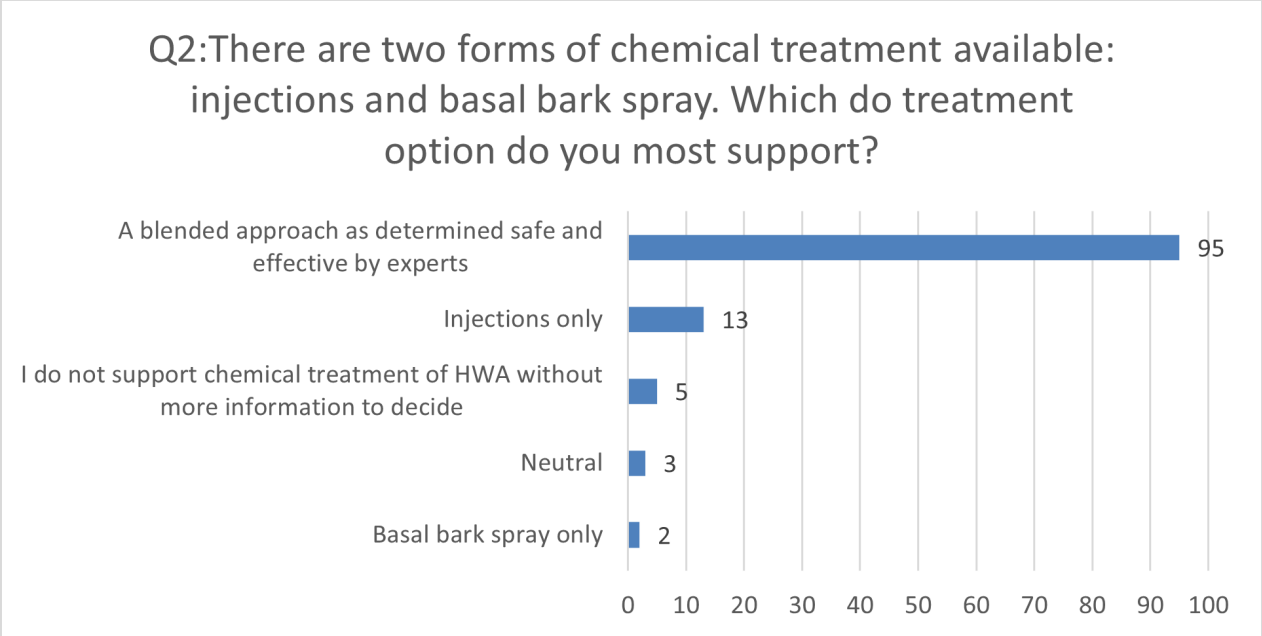
		• Parks will need to be closed for treatment which will be difficult to enforce • Non-target environmental impacts are more likely
Injection	• There is lower risk of non-target impacts (i.e., reduced risk of pesticide runoff) • No yearly restrictions, all trees can be treated in a 1 ha grid at once • Can be used near waterbodies, wet areas and ecologically sensitive sites • More flexibility with weather constraints • Less risk of heat-related illness by applicators • More volunteer friendly, offsetting the con of needing more people	• Cannot treat trees with a DBH ≤ 12.7cm as the drilled holes will cause too much damage.[149] • More expensive ($29.64-$32.50/tree) • Each tree takes longer to treat compared to basal bark spray

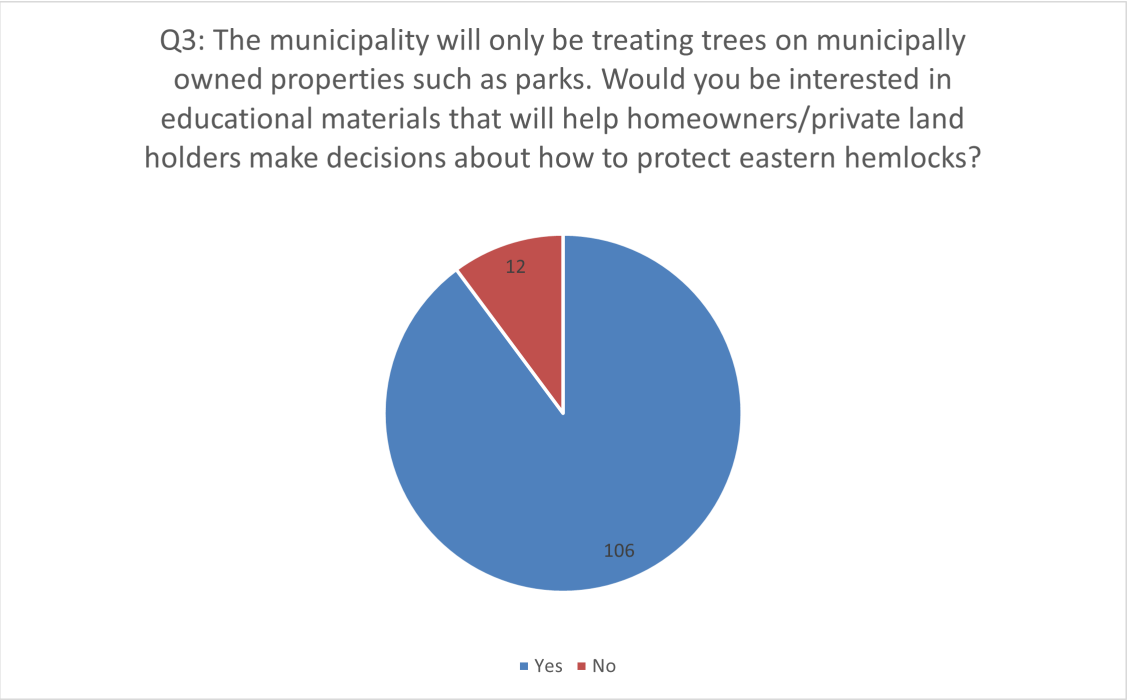
Table 9: Pros and cons to different of chemical/medicinal HWA treatment.

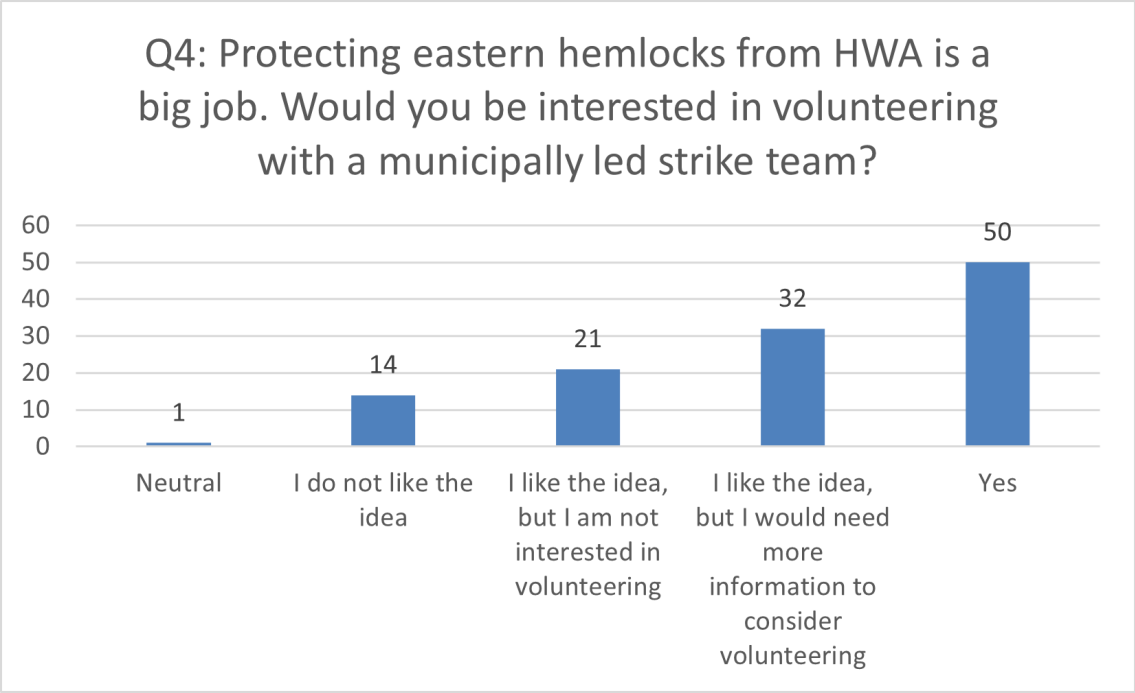
[149] *Ibid.* Crossland et al., 2022.

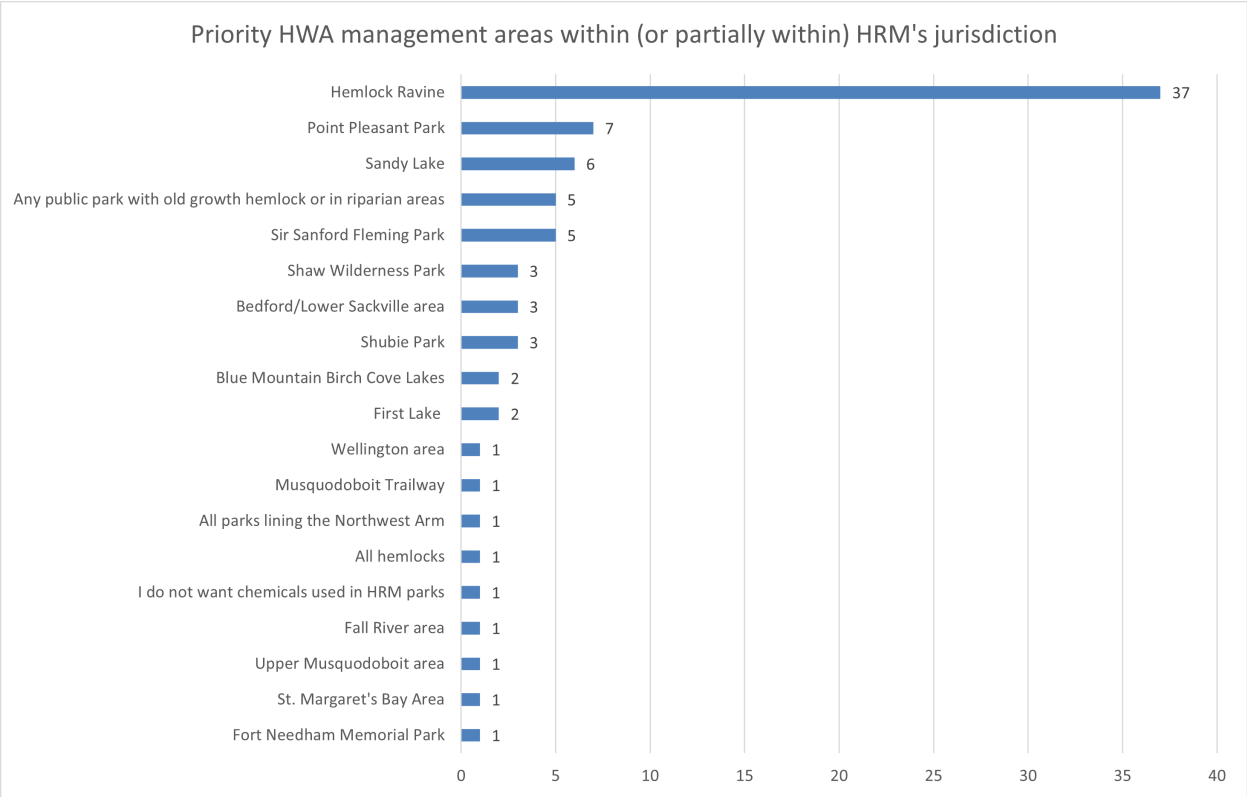
Appendix A: Survey results

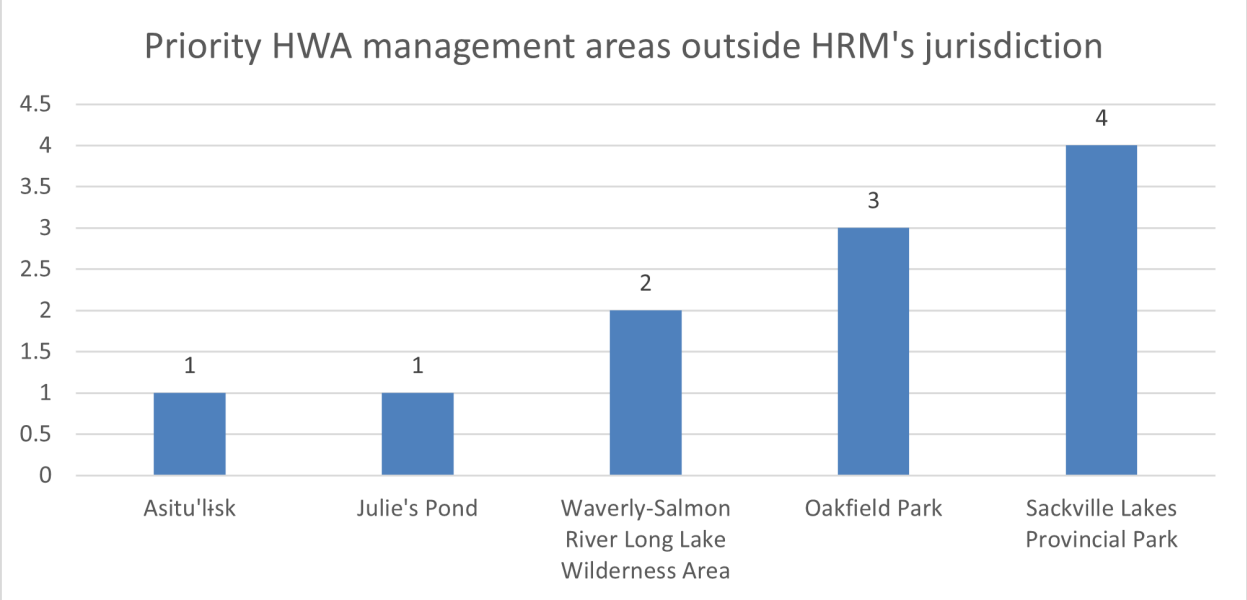





Q3: The municipality will only be treating trees on municipally owned properties such as parks. Would you be interested in educational materials that will help homeowners/private land holders make decisions about how to protect eastern hemlocks?
12
106
Yes
No


Q4: Protecting eastern hemlocks from HWA is a big job. Would you be interested in volunteering with a municipally led strike team?
60
50
40
30
20
10
0
1
14
21
32
50
Neutral
I do not like the idea
I like the idea, but I am not interested in volunteering
I like the idea, but I would need more information to consider volunteering
Yes


Priority HWA management areas within (or partially within) HRM's jurisdiction
Hemlock Ravine 37
Point Pleasant Park 7
Sandy Lake 6
Any public park with old growth hemlock or in riparian areas 5
Sir Sanford Fleming Park 5
Shaw Wilderness Park 3
Bedford/Lower Sackville area 3
Shubie Park 3
Blue Mountain Birch Cove Lakes 2
First Lake 2
Wellington area 1
Musquodoboit Trailway 1
All parks lining the Northwest Arm 1
All hemlocks 1
I do not want chemicals used in HRM parks 1
Fall River area 1
Upper Musquodoboit area 1
St. Margaret's Bay Area 1
Fort Needham Memorial Park 1
0 5 10 15 20 25 30 35 40


Priority HWA management areas outside HRM's jurisdiction
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
1
1
2
3
4
Asitu'lɨsk
Julie's Pond
Waverly-Salmon River Long Lake Wilderness Area
Oakfield Park
Sackville Lakes Provincial Park

Appendix B: Field checklists

In addition to the equipment listed, practitioners should ensure that they have everything they need to be ready for a day in the field such as weather appropriate clothing, appropriate footwear, water, snacks (Note – do not eat when actively treating to reduce risk of contamination), bug repellent, etc.

Assessment equipment checklist

- ☐ Fully charged field phone/tablet
- ☐ Offline Field map downloaded
- ☐ Survey 123 downloaded
- ☐ Field safety plan submitted
- ☐ First aid kit
- ☐ High visibility (vis) vests for all practitioners on site
- ☐ Diameter tapes or calipers
- ☐ Prism/angle gauge
- ☐ Hypsometer
- ☐ 20-meter tape
- ☐ Metal tags
- ☐ Nails
- ☐ Hammer or other tools for driving nails into trees
- ☐ Flagging
- ☐ Charged battery pack & cord

Tree marking equipment checklist

- ☐ Fully charged field phone/tablet
- ☐ Offline Field Map downloaded
- ☐ Survey 123 downloaded
- ☐ Field safety plan submitted to HRM
- ☐ First aid kit
- ☐ High vis vests for all practitioners on site
- ☐ Diameter tapes or calipers
- ☐ Tree tags for the corresponding year
- ☐ Nails
- ☐ Hammer/other tool for driving nails into trees
- ☐ All colours of flagging tape
- ☐ Permanent markers
- ☐ Charged battery pack & cord

Safety equipment checklist

Should always be on hand at pesticide storage facility and whenever handling or transporting pesticides

- ☐ Working communication equipment (e.g., fully charged cell phone with service)
- ☐ SDS
- ☐ Product Label
- ☐ Emergency contact numbers
- ☐ Pesticide applicators licence
- ☐ Spill kit
- ☐ Mixing berm
- ☐ Kitty litter or other absorbent
- ☐ Eye-wash station or eye-wash apparatus
    - Extra saline
- ☐ First-aid kit
- ☐ Personal protective equipment aligning with product label
    - Gloves
    - Respirator or masks (especially recommended for basal bark spraying)
        - Spare cartridges
    - Safety glasses or sealed safety goggles
        - Anti-fog cleaning spray
    - Face shield and/or mask (if working with pressurized system)
    - Long sleeved shirt and pants
        - Coveralls **or** Tyveck suit recommended for basal bark spraying
    - Chemical resistant boots
    - Surgical/ nitril gloves
    - High vis vests
    - Do not wear hat that cannot be washed daily.
- ☐ Lysol wipes
- ☐ Garbage bags
- ☐ Paper towel
- ☐ Isopropyl alcohol or other appropriate equipment cleaner
- ☐ Filled water tank/container
- ☐ Backpack(s)
- ☐ Lint roller
- ☐ Boot brush

Injection equipment checklist [Based on EcoJect system]

- ☐ Proper PPE and cleaning supplies [see *Safety equipment list* and double check the product label]
- ☐ Product (i.e., IMA-Jet 10%)
- ☐ Injection system [HRM recommends EcoJect]. Including:
    - Cannisters and nozzles

    - Multi-loader manifold
    - Loading gun repair kit
    - O-ring replacement kit
    - Tagwires
- ☐ Drill
    - Spare drill bits
    - Spare charged battery
- ☐ Air compressor
- ☐ Flagging tape
- ☐ Hammer
- ☐ Nozzle guard (i.e., hose fitting)
- ☐ Adjustable wrench
- ☐ Adjustable pliers
- ☐ Hex key set
- ☐ Electrical tape
- ☐ Plumbers tape
- ☐ 2 L graduated cylinder
- ☐ Sharpie marker

Mixing and basal bark spray equipment checklist

- ☐ Proper PPE and cleaning supplies [see Safety equipment list and double check the product label]
- ☐ Containment area: either chemical berm or large container
- ☐ Water (if not close to a water source for mixing)
    - Sieve (in case of collecting water from a natural source)
    - 2 L graduated cylinder
- ☐ Product (i.e., Xytect 2F)
- ☐ Backpack sprayer [[HRM recommends Husqvarna 4 Gallon]
- ☐ Appropriate nozzles
- ☐ Electrical tape
- ☐ Pipe fitting tape
- ☐ CF valves
- ☐ Shovel

Appendix C: Stand assessment using Field Maps and Survey123[150]

Assessment of a new park or other treatment area is required to determine the type and scale of treatment needed for hemlocks in that area.

Step 1: Navigation
Use Field Maps navigate to the target stand (i.e., grid). Note any issues for future access (washout, gate, etc.).

Step 2: Grid Selection
Once standing in the target grid, click on the corresponding grid in Field Maps. This should pull up the target grid and potentially other grids that surround it (see *Figure 14*). The selected grid will become highlighted in blue and the survey associated with that grid will pop up. Click on the HWA Assessment Survey link (see *Figure 15*) and proceed to the survey in Survey 123.

Once in the survey confirm that Survey 123 was opened through the Field Map grid (otherwise Survey123 will drop the survey in the incorrect location*) If this ever happens, notify the HRM GIS technician.

Step 3: Starting the survey
In the open survey, check that the area name matches up with the block name. If it does not, do not attempt to change the name manually. Simply exit out and repeat Step 2. The area names are set to correspond to the HWA GIS data base, if the name is not correct, the survey cannot be submitted. Go through the data entry options starting with plot number (See Figure 2,3 & 4).

Step 4: Plots
As informed by the provincial assessment protocol, the size of the hemlock stand will determine the number of assessment plots needed to inform treatment.

- 1 plot: Less than 5 ha
- 2 plots: 5 – 15 ha
- 3 plots: 15 – 30 ha
- 4 plots: More than 30 ha

For accuracy, assessment plots must be evenly distributed throughout the site and be representative of the hemlock stands under consideration for treatment. This means that when determining the number of assessment plots needed, the guidelines to follow are per ha of contiguous hemlock forest area (e.g. a Park may be 20 ha, but may only have two individually sized blocks of 3 ha and 2 ha stands of hemlock dominant forest, at that point you would complete 2 assessment plots, so 1 assessment plot per block). Plots should be spread out

[150] Adapted from NS Department of Natural Resources' HWA Strike Team resources

evenly through out the stand in representative areas. Take time to input points of interest in the block, such as wet areas, areas with the wrong species composition, or areas where regeneration can impede effective chemical/medicinal treatment. It may be necessary to readjust the boundaries of a polygon (i.e., expand the site if there are more hemlocks than expected, or decrease if the mapping is inaccurate). This will better inform how much product is needed. However, if the boundaries are being adjusted, it is important to check with muncipal GIS tech to ensure boundaries of municipal land are not overstepped.

Because so few parks identified for treatment in HRM have more than a hectare of total treatment area, as indicated in *Table 6*, it is anticipated that few parks in HRM will require more than one assessment plot.

Once the number of plots is determined, start a new plot by either choosing a tree as plot centre. Prepare a tag by marking it with the corresponding plot number (i.e., P1, Plot 1 or just 1). Nail the tag to the centre tree. It is best practice to have one person stand at the plot centre, while another person conducts individual tree assessments.

The person at plot center will use a prism/angle gauge to conduct the sweep (capturing trees) at north in a clockwise direction. Disregard the distance of the tree from the plot center. Assessment tree numbers should be in order of the tree captured by prism/angle gauge. Once a tree is captured as “in”, measure and record the required data (noted in Step 5 below) in Survey123. Each assessment tree should be tagged (i.e., Tree 1, T1, or just 1) and mark with blue flagging tape as shown in *Figure 14*. Repeat the process on the next tree.

Figure 14: Assessment tree. Photo by Riley Scanlan.

Step 5: Individual tree assessment
At each assessment plot the following must be completed for each tree:

- DBH measurement (See *Figure 15*)

    - Standing at the selected tree, use a diameter tape or calipers to determine the DBH. Industry standard is to collect this measurement at 1.3 m from ground level on the high side of the tree as illustrated in *Figure 16.* Measure above or below any deformities. If using a diameter tape, pull it taut to get the most accurate measurement. Trees forked below 1.3m should be counted and treated as 2 separate trees.
- Crown density (see *Figure 12*)
- New growth present
    - Note the presence of pale/lime green shoots at the end of branches
- Foliar health (1-5 scale)

    1: Mostly healthy, deep green, dense foliage, lush new growth

    2: Green, appears healthy but has reduced amount of new growth

    3: Chlorotic out of season, no new growth detectable, foliage may also be thinning

    4: Foliage noticeably thin, significant canopy openings, dead terminal shoots obvious

    5: Very sparse foliage, only tufts and/or branch tips remain

It is important to note that crown density and foliar health can be very subjective observations. Further, both can be caused by stressors other than HWA. Yet, they are some of the only indicators available for efficiently assessing a tree's health. Taking the whole tree into account when recording crown density can help make this measurement more accurate. Finally, the foliar health scale provided is a general guideline. Typically, stands that average a 3~5 ranking on this scale may not be the highest priority for HWA treatment. If this is the case, it is important to consult with the HWA treatment supervisor or other HWA experts to determine if treatment is appropriate. It is best practice to also check for presence of HWA when conducting an assessment survey.

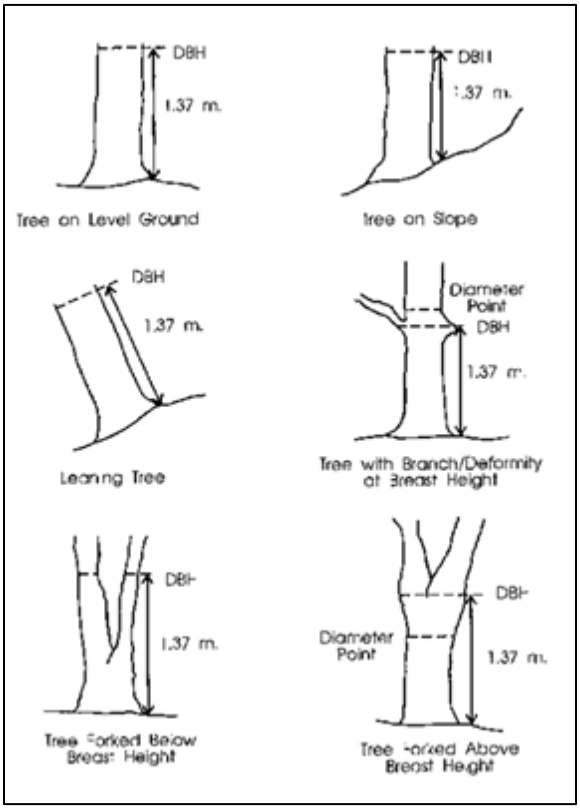


Figure 15: Where to collect DBH based on a variety of conditions.[151]

Step 6: Final data entry

After all trees within a plot are assessed and tagged, record the average height of trees within the plot. In the comment section enter the rough species composition and other notable features. Finally, if HWA is present in the vicinity of the plot, take a photo along with three additional photos from plot center:

- Facing north,
- Facing south, and
- Directly up at the canopy.

If HWA is not present, take note of its absence in the comments section.

Step 7: Submit survey

Once the survey is complete, hit the check mark at the bottom right-hand corner of the screen. It will provide three options: 1) Send now, 2) Continue this survey, or 3) Save in the outbox. If

[151] Miller, P, Stolte, K, Duriscoe, D, Pronos, J. 1996. Evaluating ozone air pollution effects on pines in the western United States. Forest Service General Technical Report. https://www.researchgate.net/figure/Proper-method-for-measurement-of-diameter-at-breast-height-DBH-of-the-tree-bole_fig11_255262269. [ax. 2025, Jul].

connected to the internet, the first option can be selected. If not, the third option should be selected. If there are problems with survey completion or submission, click the X in the top left corner of the screen and select “Save in drafts”. This will prevent the loss of any data. Contact the GIS Specialist to help if the problem persists.

It is best practice to save the survey every 5 trees to ensure no data is lost in the event of an app malfunction.

Appendix D: Tree marking and tagging using Field Maps and Survey123[152]

It may be advisable to complete Tree assessments and Tree marking concurrently to prevent multiple trips to the field.

Step 1: Navigation and starting location
Use Field Maps to navigate to the target stand (i.e., grid). Once arrived, determine the starting location for moving through the stand. It is generally easiest to start in a corner of the grid and work around the edge to establish the boundary and then move through the interior. This reduces the risk of straying outside the selected grid and provides a better overview of tree conditions within that grid.

Step 2: Grid Selection
Once standing in the target grid, click on the corresponding grid in Field Maps. This should pull up the target grid and potentially other grids that surround it (see *Figure 16*). The selected grid will become highlighted in blue and the survey associated with that grid will pop up. Click on the HWA Treatment Survey link (see *Figure 17*) and proceed to the survey in Survey 123.

After updating to the field map, confirm the treatment year is correct for the selected grid. This is especially important for re-entry areas where additional basal bark spray in subsequent years will be needed.

[152] Adapted from NS DNR HWA Strike Team resources

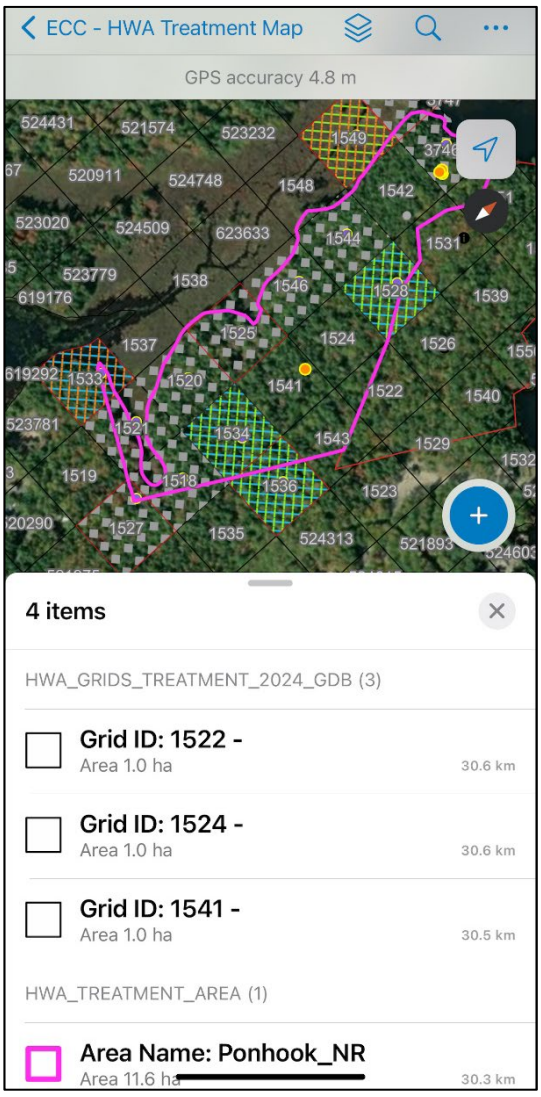


Figure 16: Grid selection. Shows an example of what might be displayed when trying to select a grid and why it is important to know the grid number.

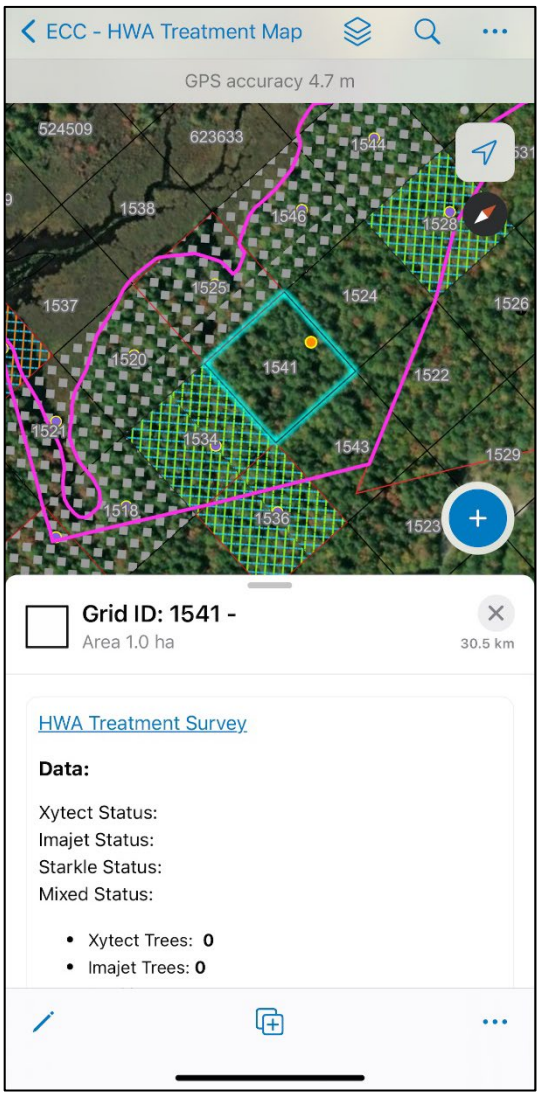


Figure 17: Survey selection. Shows where to find the survey associated with the selected grid.

Step 3: **Opening the survey**

Once in the survey confirm that: 1) Survey 123 was opened through the Field Map grid (otherwise Survey123 will drop the survey in the incorrect location*) and 2) the treatment grid ID is correct before proceeding to the second page to input survey data.

*If this ever happens, notify the HRM GIS technician.

Step 4: Tree selection

If basal bark spray is being used, not all trees in a grid can be treated due to annual product limits. It is also unlikely that every tree can be treated via injection due to the time and cost

required to treat each tree, so it is important to 1) be selective when choosing trees and 2) distribute product evenly throughout the grid. It is ideal to select trees that are evenly distributed by location and age class within each treatment block (hectare). Selecting only larger trees will result in less trees being treated overall. Alternatively, only choosing younger trees will greatly alter the canopy of the stand and may result in the loss of more mature trees that are of great ecological and genetic value. Tree condition must also be considered. Only selecting trees that are already in decline may mean that healthier trees are overlooked, while only choosing tree that appear healthy may mean declining trees will pass into a condition beyond saving before the next round of treatments occurs. Thus, a balanced approach must be taken in the tree marking phase. Please note that trees under 15 cm diameter and trees in decline for other reasons beyond HWA cannot be treated.

Step 5: Determine treatment type
If using an injection-only treatment approach, the treatment type will already be decided.

If using a mixed approach, stand at the base of the selected tree, place one arm on the trunk and extend it fully. Look up at the crown of the tree to determine the crown density (see *Figure 12*). Once the density is determined use that as a decision key for selecting treatment type. Treatment options are outlined in *Table 5.* It is important to note that the treatment recommendations made by tree markers may be reviewed as needed by the treatment supervisor who is responsible for finalizing treatment decisions.

Step 6: Measure tree diameter (DBH)
Follow DBH measurement steps indicated in Step 5 of *Appendix C.*

Step 7: Assessment tree determination
Assessment trees are the trees that were captured during the assessment plot step. They are typically marked with blue flagging tape and a metal tag that indicates their tree number as shown in *Figure 14*. Most trees are not assessment trees and as such, Survey123 has this field pre-set to “no”, If an assessment tree is encountered during tree tagging and marking, this field must be changed to “yes” and the assessment tree number must be entered.

Step 8: Mark the tree
Once steps 1-7 have been completed, Survey123 will provide the number of spray seconds for basal bark application, or the number of holes needed for injection. The survey will also count down the number of treatment centimeters remaining within the annual basal bark spray limit for that grid. This will help to track how many additional trees can be marked for treatment.

Using the corresponding flagging tape for the treatment type as outlined in *Table 6*, tie it around the tree 1.3 m from the ground (at breast height). The flagging tape should be knotted on the north side of the tree. Using a permanent marker, write the number of seconds (basal bark spray) or number of holes (injection) on the flagging tape near the knot so treatment practitioners can easily find it. A tag should be affixed to the tree just above the knot on the

north side of the tree. The tag should indicate the year of treatment and treatment type (also outlined in *Table 6*).

Step 9: Submit the survey
Follow Step 7 instructions from *Appendix C.*

Step 10: Update grid status
When tagging and marking is complete or the field day has ended update the grid status by selecting the grid in Field Maps and selecting the “Edit” option. Using the drop-down menu for each treatment type, select one of the following options: 1) Marking complete, 2) Marking partially complete, 3) Treatment complete, or 4) Treatment partially complete. Finally, enter “yes” or “no” for both “Re-entry” and “Is it treatable**”**. Finally, input any important information for people returning to the grid, such as terrain, infrastructure or dwellings near by.

Appendix E: Injection protocols[153]

Before beginning injection-based treatments, a "staging area" should be set up at the field site. This is where equipment and product will be prepared for injection. The staging area should include a flat surface (e.g., a folding table) with a portable spill berm set up underneath it to catch any dripped product. The staging area should be a minimum of 30 metres away from the nearest watercourse, waterbody, or wet area.

It is imperative when working with pesticides, that all applicators wear the proper PPE. Always read and follow the product label at minimum. It is important to always have at least one person with an up to date First-Aid certification on site during HWA treatment. See *Appendix B* of this report for suggested equipment.

EcoJect system

Step 1: Pressurizing air tanks

- Thoroughly read the manual of the air compression system.
- Thoroughly read the Safe Work Practice and Safe Operating Procedures
- Wear proper PPE.
- Place the air compressor on a stable flat surface.
- Plug in the air compressor.
- Pour product into pressure canister
- Connect the air output line of the air compressor to the pressurized air tank.
    - Ensure the main valve of the pressurized air tank is open and the output valve (valve with the pressure gauge) is closed.
- Turn on the air compressor and pressurize the air tank.
- Shut off the air compressor when the gauge reaches 150 pound per square inch (psi).
    - Do not fill the tank more than the recommended pressure.
    - Some air compressors can be set to turn off at specific psi, however, operator should follow the pressure gauge on the canister.
        - To be safe, the compressor can be set to shut off at 145 to 147 psi
- Close the input valve
    - The compressor can stay connected to the air tank if the input valve is closed
- Be sure to store the air tank safely by preventing the valve from being bumped

Step 2: Setting up the EcJect system

It is important to follow the guidance provided in equipment manuals first and foremost. These instructions are intended to be supplemental to the information shared by the manufacturer.

- Turn the output valve of the Ecoject system to the "On" position. It is now ready to fill canisters with product.
    - The nozzle used to fill canisters should always be pointed away from the operator (and any other person in the vicinity) to prevent accidental back spray

[153] Adapted from NS DNR HWA Strike Team resources

- A bucket should be placed under the canisters as they are filled to catch any dipping product

Step 3: Using the EcoJect System
Optimally, an EcoJect injection team will consist of 6 team members as illustrated in *Figure 18*. Position descriptions are as follows:

1. **Cannister filler**: Certified pesticide applicator who continuously fills canisters with product at the staging area. They will keep the staging area clean to make de-staging at the end of the day more efficient. The bartender will supervise as needed and provide logistical support to the rest of the injection team.
2. **Driller** and **Tapper** duo
    a. Driller: checks flagging tape, drills the specified number of injection sites, and removes flagging tape from each tree identified for treatment. Responsible for appropriate disposal of flagging tape.
    b. Tapper: carries the canister nozzles and taps the nozzles gently into each injection site with a hammer and a nozzle tapper (i.e., a brass hose fitting that prevents damage to nozzles)
3. **Runner** and **Trouble-shooter** duo:
    a. Runner: Takes product-filled canisters from bartender and plugs them onto the nozzles set up by the "Tapper". This person will run back to the bartender for more filled canisters as needed.
    b. Trouble-shooter: Collects empty canisters from trees. This person is also responsible for quality control, ensuring all canisters are emptying properly. If a canister does not seem to be releasing chemical/medicine, it might be that the injection site is just slow on the uptake, if this is the case the trouble-shooter will take note and return for the cannister later. If the product is not moving out of the canister at all, it can be helpful to gently tap it to get it moving. If this does not work, the canister will be moved to a different injection site on the same tree. If this still does not work, the canister may need repair or be faulty and should be set aside for maintenance. A new canister should be used to finish dosing the tree.
        - The Trouble-Shooter is best paired up with the Runner, as they can easily trade-off empty and full canisters
4. **Nozzle stripping**: Removes nozzles once the canisters are emptied and ferries them to the Driller and Tapper duo.

Some roles can be performed by one person if needed, but this is likely to significantly reduce productivity. For example, all canisters could be pre-filled at staging forgoing the need for a bartender; however, this means the number of filled canisters available are limited. Drilling and tapping could be done by one person or either the driller or the tapper could backtrack, and strip nozzles as needed. Just so, the injection team could be expanded to create two or three of each

the driller and tapper and runner and trouble-shooter duo. This would be ideal for volunteer-based treatments when many hands are available to make light work.

Canisters must be treated with care as they can sustain damage from dropping. This may cause leakage, back spraying, or failure to empty altogether. They must not be tossed into buckets or bags.

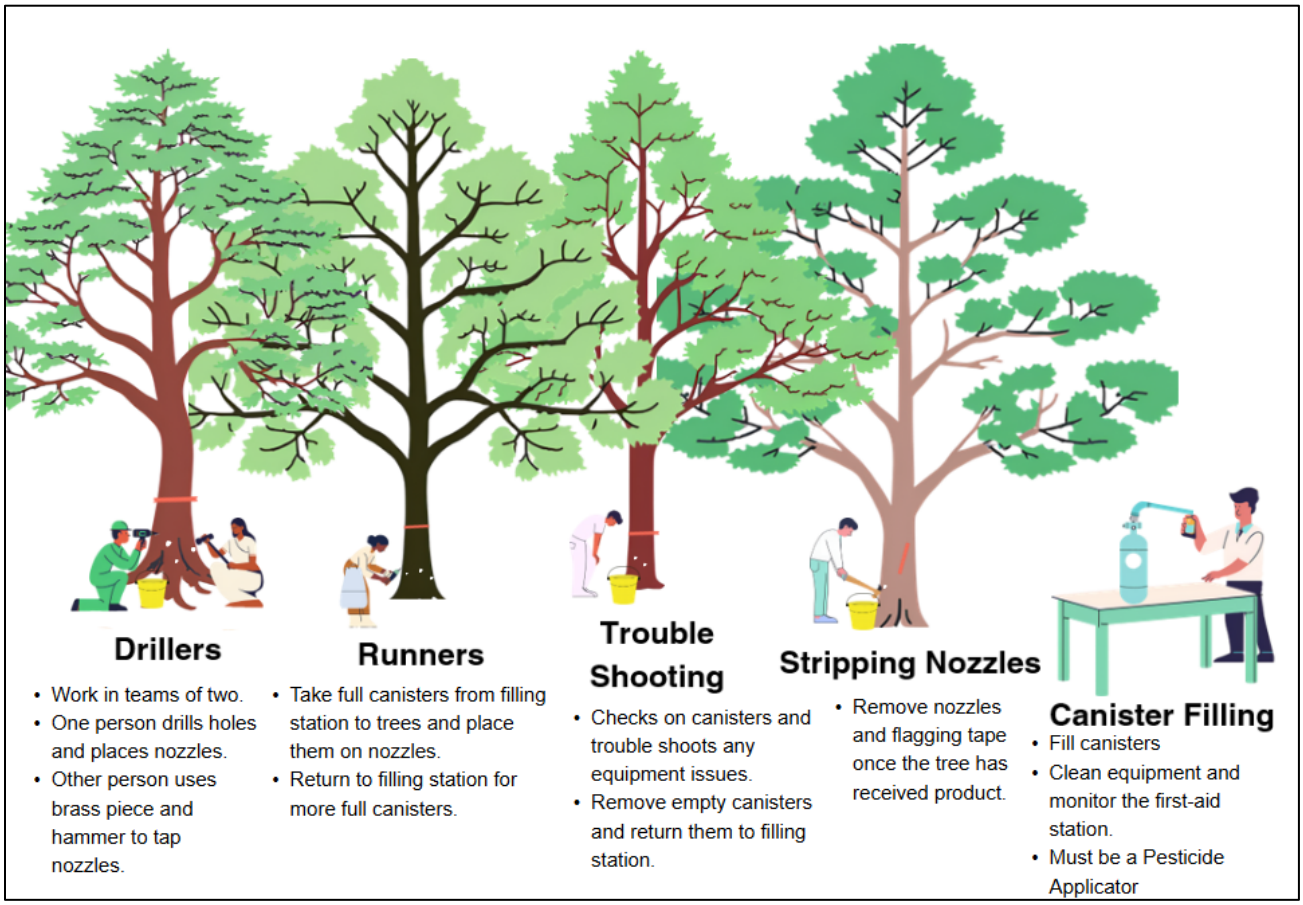


Figure 18: Optimal EcoJect injection team. Figure by Medway Community Forest Cooperative.

Step 4: Data entry
When treatment is complete, update Field Maps accordingly.

Step 5: Clean-up
Canisters and other field equipment must be thoroughly cleaned prior to leaving the site to prevent any contamination outside of the treatment area. Never use water to clean cannisters as this will cause the internal mechanism to rust. Instead use designated cleaner or isopropyl alcohol. Any garbage or disposed items of any kind must be removed from the site. Any empty pesticide containers are to be washed out and punctured as per proper disposal procedures.

Appendix F: Product mixing and basal bark spraying protocols

Unlike the product used in injection systems, the product applied using a backpack sprayer must be mixed with water. The mixing protocol outlined here assumes the use of Xytect 2F and Starkle 20SG (as described in *Table 5*), because at the time of writing, these are the products approved for use against HWA by the PMRA. It is imperative when working with pesticides, that all applicators wear the proper PPE. Always read and follow the product labels at minimum. See *Appendix B* of this report for suggested safety and application equipment. If any discrepancy between the mixing protocol outlined in this plan and the Xytect 2F product label, the product label should be taken as correct.

Teams of two or more is recommended for basal bark spray. During application, the applicator can choose to either time themselves or have someone time them. Regardless of who keeps time, there must be at least one person nearby who is not actively spraying, with a first aid kit and eye wash apparatus handy. Ideally this person will have an up to date First-Aid certification.

Preparing equipment

Prior to spraying equipment should be checked. It is important to start by familiarizing with the equipment manual. Next, while the backpack sprayer is empty, ensure the valve attached to the wand is clean and functioning properly (e.g. no chips/breaks). Attach all wand fittings with plumbers' tape and tighten and secure all other fittings in the backpack to prevent leaks. Fill the backpack with water, pressurize the system by working the hand pump, and test for any leaks. This is a critical step to prevent contamination to both the applicator and the environment. Double-check the bottom of the backpack, as it is an area that can be prone to leakage.

Once equipment is deemed safe it is time to calibrate. Add some water to the tank, use a sieve if obtaining water from a natural source like a nearby pond. Spray from a pressurized backpack into a graduated cylinder continuously for 15 seconds. Typically, the output flow rate should be 200 mL. However, the flow rate can vary depending on the type of valve being used, so it is important to confirm calibration time and dosage rates by inspecting the equipment manual and product labels.

Spray maintenance and calibration should be completed the day before a chemical application at minimum; however, it is recommended that it is done the morning of an application. To prevent confusion, backpack sprayers that have been calibrated can be marked with a "serviceable" tag.

Mixing

Mixing product within 30 m of a watercourse, waterbody, or wet area is strictly prohibited, so take care when choosing an acceptable site. When not actively being mixed or applied, pesticides must always be inside of a leakproof container with the lid closed. All mixing must be done inside a leakproof container or chemical berm. This includes the backpack sprayer which must also be inside the leakproof container.

A hose should never be used under any circumstances when working with pesticide. This is to prevent contamination to the hose. If water is needed, fill a container with water at a fill station and bring it to the loading station.

- Thoroughly read and follow the instructions outlined on the product label.
- Proper PPE must be worn throughout the mixing process.
- All mixing must be done in a large leak-proof containment area like a chemical berm or large container.
- Fill 1/4 ~ 1/3 of the back tank with water.
    - Fill through a fine sieve to filter out particles if using water from natural sources like a lake or pond.
- Pour the appropriate product amount (in accordance with the product label) into a measuring cup/graduated cylinder.
    - If using a mixed tank of Xytect and Starkle, both products should be added at this time in dosages that align with product label instructions.
- Pour the measured product into the back tank.
- Rinse the measuring cup/graduated cylinder with filtered water and pour into the back tank [repeat this step three times to ensure all product is rinsed from the measuring cup]
- Close the lid of the back tank while it is half full.
- Ensure the lid is secure and thoroughly shake the half-filled tank to mix.
- Fill the tank to the 15 litre(L) mark and secure the lid.
- Shake again to ensure the water and product are adequately mixed.

Spraying

Step 1: Strap in backpack
A mixed tank can be very heavy. Again, it is ideal to work in pairs so applicators can help each other lift the back tanks. Check that straps are adjusted properly and the applicator is showing no signs of fatigue or overt physical exertion.

Step 2: Begin treatment
Upon arrival at a marked tree, the applicator must:

- Read the time written on the flagging tape,
- Remove the tape and safely store it for appropriate disposal later (recommended to wrap it on the pump handle of the back tank,
- Pressurize the back tank with a few pumps.
- Start timing with the stopwatch and spraying at the same time, using the hand used for pumping to check the timer between pumps until the time is up.

Product should be evenly applied to bark around the entire circumference of the tree from the top of the root flare to breast height (1.3 m from ground). It is important to note that if using a mixed tank (i.e., Xytect 2F *and* Starkle 20SG) the tree can only be sprayed between breast height and 10 cm from the ground.

Some tips to prevent product drift during basal bark spray include:

- Spraying as close to the tree as possible without fanning spray off to the side of the tree.
- If the nozzle produces a flat fanning of spray, position the fan vertically so little to no spray will miss the tree.
- Be observant of any weather changes and stop spraying if the wind picks up.
- Avoid over-saturating the tree to prevent run off, circle the tree multiple times if needed.
- Do not spray a tree if the trunk is wet from precipitation as this may cause the trunk to become over-saturated and cause run-off
    - This should be easily avoided if the guidance outlined in the *Timing and weather considerations* section of this plan is followed.

Repeat this step at each tree until all marked trees in the hectare have been treated.

Step 3: Data entry
When treatment is complete, update Field Maps accordingly.

Step 4: Clean-up
Backpacks must be thoroughly cleaned prior to leaving the site to prevent any contamination outside of the treatment area. Any garbage or disposed items of any kind must be removed from the site. Any empty pesticide containers are to be washed out and punctured as per proper disposal procedures.