**Regional Prioritization of Hemlocks**





Published by the [New York State Hemlock Initiative](https://blogs.cornell.edu/nyshemlockinitiative/landowner-hemlock-prioritization-toolkit/) of [Cornell University](https://cals.cornell.edu/)

Authors: Caroline Marschner and Mark Whitmore

Contributions by:

* Brad Mudrzynski of CC Environment and Planning
* Jonathan Rosenthal and Radke Wildova of the Ecological Research Institute
* Jason Denham and Bryan Ellis of the NYS Department of Environmental Conservation
* Matt Brincka and Nick Marcet of the New York State Office of Parks, Recreation and Historic Places

 

Funding provided by the New York State Department of Conservation and the Great Lakes Restoration Initiative of the U.S. Forest Service, U.S. Department of Agriculture.



Introduction

Conservation of hemlocks is critical to the long-term health of New York’s forests. New York has more hemlock trees than any other state in the US; it will be impossible to conserve all of our hemlocks. As hemlock woolly adelgid (HWA) moves through the state, landowners, managers, and regional planners need to prioritize which hemlocks to focus on for survey, conservation and management. This regional prioritization tool is a decision tree and weighting tool to help landowners and land managers decide which hemlock stands are the most important to conserve across multiple properties. If you have only one property or a couple properties that are close to each other, you might consider using our landowner tool, which is more streamlined for use on one or just a few properties.

Depending on the scale at which you are work, different qualities of hemlock stands become more of a priority. From a regional perspective, it makes sense to focus efforts on hemlocks in high-quality ecosystems and in watersheds, protect trout populations, or are in an iconic viewshed. A land trust or county park system with heavy public use or an educational mission may have greater concern for hazard trees around trail systems. Properties outside the known HWA infestation area will have a very different management response than those in long-infested regions. Extremely valuable habitat such as old growth remnants also deserve a separate consideration apart other stands. Some very important stand qualities are described early in the decision tree; after that, stands can be put through the weighting tool to help landowners and land managers decide where to focus their attention and funds.

This tool can be used at different scales, and for different purposes. For example, a land trust could use it to determine which stands across their properties require management. An agency or group planning to apply for funds that focus on a specific service or area (aquatic protection, riparian habitats, etc.) could run only stands that meet the criteria of the grant through the tool, to determine which stands should be managed to meet the goals of the granting agency.

Different groups have different missions, and therefore will weight various components of hemlocks’ importance differently. The Excel file that accompanies this tool has weighted the various components of hemlock prioritization to conserve the ecological services of hemlock on the landscape. These weights can be edited by the user to better fit the uses/needs of the properties under consideration.

To use this decision tool, you will first answer the yes/no special case questions; if any of your hemlock stands meets one of these criteria, we recommend that you follow the recommendations within the special cases section and not put that stand through the rest of the tool. Remaining stands are scored with as many of the various metrics that you have data for and believe to be relevant to your properties.

Within the scoring tool, each stand receives a score of 0-3 for a wide range of stand traits. Some are easy to determine by visiting the stands (how big is the stand, how dense, how healthy); others might require some repeat visits or extra help (are there rare species on or near the stands, for example). We recommend that you do the best you can with the information you can gather within your organization and with initial site visits or institutional knowledge, and fill in the blanks later if that information will help you manage your hemlocks more effectively.

As mentioned above, each stand trait (stand size, quality of habitat, deer pressure, etc.) is weighted to reflect its relative importance, and these weights can be adjusted by the user. Weighting is done in the spreadsheet, in the row just below the stand trait names. The score you gave each stand is multiplied by the number in this cell, and added to the total score at the end of the weighting table. The higher the number (from one to four), the more impact the stand trait (stand health, hazard trees, supporting trout fisheries, etc.) will have on the stand’s final score. This number can be edited by the user to anything from 1 to 4, in order to better fit the uses/needs of their property. If you don’t have data for or choose not to use a trait, just leave it blank in for all of your stands. The Excel file that accompanies this tool has weighted each stand trait to conserve the ecological benefits of hemlock across the landscape; as you work through the tool, you can adjust the weights according to your priorities for your organization. For example, if you manage a property with frequent public access and extensive trails, you may wish to weight hazard trees more heavily in your metric.

When you are done filling out the spreadsheet each stand will have final score, which is the sum of all the weighted traits you recorded for that stand. The most important stands will have the highest values, while the least important will be lowest. (The number values don’t have a specific meaning; they are just a way to compare stands to each other. This is particularly true if your organization changes the weights, and the results will not be comparable to another user’s values.) We encourage you to think about what traits led to the higher and lower scores and compare that with your organization’s land management goals. If the scores agree with your goals, focus conservation on the highest scoring stands first. Everyone has limited time and resources; we hope this tool will help you better understand your property and hemlocks so you can make informed decisions about managing your forests’ hemlocks.

Higher priority stands should be monitored for HWA arrival at least every couple of years – ideally twice a year, in spring and fall. Lower priority stands can be monitored less frequently. Once HWA arrives, higher priority stands should be the ones targeted for management. How far down your priority list you choose to actively manage for HWA is up to you, and will probably depend on your finances, interest, and the risks the stands pose to people and property. Stands you don’t intend to manage can be targeted for replanting of beneficial species as the hemlocks decline, or just monitored to make sure the succession of species is one that benefits your property. It’s a good idea to monitor for invasive species invading declining hemlock stands, since disturbance sets the stage for such problems.

Included in this packet is some information on hemlock woolly adelgid (HWA) identification and reporting, a map of the winter 2020 extent of HWA in New York, and suggestions on management of HWA on your property. If you are outside the current range of HWA, especially in the Adirondacks, Tug Hill, or western New York, we hope you will report any HWA sightings to DEC, either directly or through iMap Invasives. If you have any questions, please feel free to reach out to the NYS Hemlock Initiative at [nyshemlockinitiative@cornell.edu](mailto:nyshemlockinitiative@cornell.edu).

This work was funded by the NYS Department of Conservation, the US Forest Service, and the Great Lakes Restoration Initiative. Special thanks to [CC Environment & Planning](https://www.ccenvironment.com/) of Rochester who built the original metric from which this tool was built, and to the [Ecological Research Institute](http://www.monitoringash.org/author/rwjr/) who provided substantial editing and revisioning for this tool. The final version was built in cooperation with the NYS Department of Conservation and the NYS Office of Parks, Recreation, and Historic Places.

Special Cases

1. Is the stand at the leading edge of HWA infestation, or isolated from other infested areas? In 2019, the northern edge of HWA infestation is of particular importance, as only one infestation has been found in the Adirondacks so far and the most dense populations of hemlocks in New York are in the Adirondacks and the Tug Hill region. Any infestation in these areas, or in other regions where HWA is considered and early detection/rapid response species, should be treated aggressively regardless of other considerations in order to slow the spread of HWA into new regions.
2. Is the hemlock stand in an old growth remnant? If so, treatment and conservation should be considered, as these are exceedingly rare ecosystems. Old-growth hemlock stands support up to four times more understory species than second growth stands (D’Amato 2009).
3. Stand protection: Stands that will be removed in the near future should not be treated, since their survival is not an option.

If you have stands on your properties do not meet any of these special cases, the following are the items that the NYS Hemlock Initiative and our partners suggest you consider when prioritizing hemlocks for HWA management. Their suggested weight is listed below the description; these weights were determined in a collaborative process including the New York State Hemlock Initiative (NYSHI), NYS Department of Conservation (DEC), and NYS Office of Parks Recreation and Historic Places (OPRHP). Resources to help you determine your stands’ ranking are offered when they are available.

Stand Traits

* **Current stand health:** Do the trees currently have healthy canopy all the way down the tree, or dense, green, fairly long canopies in pure hemlock stands? Are the trees producing new growth (lime green) in the early summer? Do you see any other hemlock pests (elongate hemlock scale, hemlock borer, hemlock rust, sirrococus tip blight)?

Suggested Weight**: High** (3)

This metric can be thought of differently by different organizations, depending on how infested their properties are and how far their resources will go to cover impacted stands. A land trust with no infestations would be looking at stand health before HWA arrives, and in this instance it might make sense to rank the healthiest stands as the highest priority. For a manager facing a lot of HWA impact already and limited funding, it would make more sense to take a triage approach, treating declining stands first so that they can start to recover. Generally, trees with less than 30% of their canopy remaining are not considered a good investment for treatment unless they are especially valuable. Some New York managers have treated some important trees that were below that threshold hoping to get lucky, and they have gotten lucky and gotten recovery in some of those trees. As a general rule, though, stands below that 30% threshold should probably be ranked as low priority for treatment whether you are using the pre-infestation or triage health approach.

Many of our partners around the state are using the NYSHI 5-point hemlock health scale (link listed as a resource below):

5: 80-100% canopy cover, foliage healthy, bright shiny green

4: 61-80% canopy cover, foliage starting to thin, most of canopy in good color

3: 40-60% canopy cover, foliage thinning, lower branches are bare

2: 21-40% canopy cover, foliage thin and grey

1: 1-20% canopy cover, foliage thin and sparse

If you are ranking the healthiest stands highest, we would suggest translating those scores a follows:

5 – higher priority (3)

4 & 3 – medium priority (2)

2 & 1 – low priority (1)

If you are using a triage approach we would suggest translating the scores as follows:

3 & 2 – higher priority (3)

4 – medium priority (2)

1 & 5 – low priority (1)

Resource:[NYSHI stand survey](https://cpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/f/7151/files/2018/11/Volunteer_Tree-Health-Survey_Protocol-1ntzurc.pdf)  
(<https://cpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/f/7151/files/2018/11/Volunteer_Tree-Health-Survey_Protocol-1ntzurc.pdf>)

* **Environmental stressors**: Is the stand in an area where it gets ample water? Is there construction or development close enough to impact roots? Is it in on an exposed slope rather than partially shaded by topography? Is the stand on a steep slope? Trees in stressful growing conditions like these tend to decline more rapidly once HWA arrives. While in some cases this might make the stand less favorable for conservation, in cases where a stand is important for other reasons it may suggest higher prioritization, as the trees are likely to need earlier intervention than those in a less stressed stand.

Suggested Weight: Medium (2)

* **Stand size:** How large is the hemlock population? The larger and denser the stand, the more impact it has on your local environment, and the more disruption its loss will cause.

Suggested Weight**:** Medium (2)

Resource: <https://orthos.dhses.ny.gov/> for downloadable GIS leaf-off aerial imagery, or a walking survey of your property. Unfortunately, both Google maps and Bing maps now use leaf-on imagery, so without GIS capabilities your options for are limited. If you download Google Earth Pro, the 2013 imagery is from spring and may help you pick our conifers.

* **Hemlock density: % basal area** (>50%)\* - How dense is the hemlock stand? The denser the stand, the more impact it has on your local environment, and the more disruption its loss will cause. Percent basal area is the percent of the total tree diameter in a given area that is hemlock. 50% basal area is sometimes used as a cutoff to call a population dense enough to be considered a hemlock ‘stand’, or dense enough to focus on for conservation. It’s worth noting that HWA spreads faster in dense hemlock, which can lead to hemlocks declining more quickly. (Morin et al. 2009).

Suggested Weight: Medium (2)

Resource: On the ground measurement or regional-level remote sensing. This can be an estimate – rather than a technical basal area, it’s fine to walk through a hemlock area or look at aerial imagery and make a guess about whether less than a quarter of the tree canopy is hemlock, or less than half, or more than half. Remember, this tool is all about comparing stands, so as long as you use the same method on all of your stands it will give you the relative density information you need.

* **Proximity to HWA:** How close is HWA to the site/stand? Properties closer to the nearest HWA infestation are likely to become infested first. This suggests more focus on these properties for careful prioritization and monitoring. But because HWA is also spread long-distance by weather and wildlife (especially birds), infestations are notoriously patchy; new infestations have arisen forty miles from the nearest known infestation (Prospect Mountain, Adirondacks) – so it’se important to check high-priority properties and stands for HWA regularly, wherever they are.

Weight: For detection, stands closer to HWA infestations are likely (although not always!) to be infested first. For treatment, though, the farther your infestation is from other infestations, the more early intervention is likely to slow the spread of HWA through your property and the larger landscape. If you have and infestation that is very isolated from other HWA, you may have an early detection/rapid response situation; in that case, return to the first special case exception from the weighting process.

Suggested weight for survey/detection: low (1)

Suggested weight for treatment: Medium (2), as what treatment you choose will vary based on how isolated your infestation is. If an infestation is the first in an area (>10 miles, or closer to the Adirondacks/Tug Hill region than other infestations if you’re near those areas), it actually falls under the early detection/rapid response “special case” scenario, and should not even go through the ranking tool. If you’re surrounded by HWA, you are simply managing that stands’ health rather than trying to slow the spread of HWA in a new region.

Resource: [iMap Invasives map of HWA](https://imapinvasives.natureserve.org/imap/services/page/map.html?x=-75.6401&y=42.4049&z=9&dpnl=legend&lgrp=ALL&bm=topo&toc=mainDataTOC;0;0=1;40|aoiTOC;0;0=0;40|statesTOC;0;0=0;0|countiesTOC;0;0=0;0|waterbodiesTOC;0;0=0;40|conservationLandsTOC;0;0=0;40|usgsTopoTOC;0;0=0;0|ismaTOC;0;0=0;0|hydrobasinTOC;0;0=0;0|countryTOC;0;0=0;0|tncIPMMS;0;0=0;40&fobs=&fhbtt=&fspec=374&fstyp=n&fkdom=&fgens=&fbdte=&fadte=&fproj=&forg=&fjur=&felim=) – this link should lead to a map focused on New York, where the “Filter Records” option has been selected for hemlock woolly adelgid. The little yellow hexagons are positive records of HWA; zoom in further to see specific points.

* **Proximity to water body** (for early detection work only): HWA often (not always!) arrives near water when entering a new area. It’s good to check all areas, but monitoring hemlocks near water more closely may be a good idea.

Suggested Weight: low (1)  
  
Resource: The Eastern Brook Trout Joint Venture has a great interactive map that has a lot of information that is useful to this prioritization process. The map is here: <http://bit.ly/1FLvq5m>, and the useful piece for this metric is the streams and waterbodies layers. To view these, click on the link above. This opens a map; zoom in to about the county level and click on “streams” and “waterbodies” in the legend to bring up streams and waterbodies.

* **Genetic diversity:** We believe it’s important to conserve the widest genetic diversity possible to maintain eastern hemlock as a viable species into the future. Our region is an area of relatively high genetic diversity for hemlocks, although overall hemlocks are not a very genetically diverse tree. Since genetic diversity isn’t something that’s easy to measure or see, capturing the diversity of hemlock on your property can be done by conserving the diversity of hemlock habitats on your property. Isolated stands, high and low elevation stands, wet and dry stands, north-facing vs south-facing stands, stands on steep slopes vs stands in lowlands; ensuring that examples of different kinds of hemlock sites will help conserve any hemlock genes that are best suited to different habitats. From a state perspective, old growth stands, hemlock in primary forest tracts, and rich hemlock hardwood swamps are the most unusual hemlock habitats and are worthy of extra consideration if they exist on your property.

**Weight:** at the property level, low (1). Across multiple properties, a region, or a state, **high (3).**

* **Stand isolation:** How close is the nearest hemlock population to the one you’re looking at? Isolation could mean that your hemlocks are vital for local animal populations. It also could mean that they have a lower chance of becoming infested as HWA moves across the landscape, although it’s likely to arrive eventually.

Suggested Weight**:** low (1)

Resource: <https://orthos.dhses.ny.gov/> and the aerial imagery there is probably the best bet for this, combined with some ground truthing to pinpoint the nearest hemlock rather than pine, spruce or fir.

Aquatic Ecosystem Services

* **Supports cool-water fish habitat:** Cold-water fish assemblages rely on consistently cold water to survive. Hemlocks help cool streams and stabilize stream flows. In the Delaware Water Gap, brook trout are 3x more common in watersheds with hemlocks than in ones with predominantly hardwood forest. Prioritizing hemlocks that directly shade or are in the watershed of streams with cold-water fish like trout will help conserve those fish habitats (Ross et al. 2003). Moreover, with warming climate, shading can become more important (optimal temp. for brook trout 11°-16° C). Stands most important for this service would occur in riparian locations that are not shaded by surrounding slopes, and in streams where groundwater isn’t providing temperature stabilization. These shading services would be most important in streams that host brook trout (Siderhurst et al. 2010).

Potential additional effects of hemlock loss near a stream on aquatic habitat quality, either cool or warm water:

* More light reaching stream bed increases stream bed algae and other aquatic vegetation
* Hardwood litter is more easily digestible, higher quality for detritivores, alters aquatic food chains, including fish species composition
* Increased debris from dying/dead hemlock causes structural habitat changes, likely effecting aquatic communities.

**If your stand/property is in a watershed with cold-** water fish habitat, please use the “direct shade” and “upland snow” items in the tool. If not, please use the “direct shade” item, and skip the “upland snow” item.

**Suggested weight:** if in a cool-water fish watershed, the weight for both items is medium (2). If the watershed is of another stream type, direct shade can be low or medium, depending on the priority of the landowner.

Resource: To determine if your stand is in a cool-water fish watershed, please use the Eastern Brook Trout Joint Venture [website](https://easternbrooktrout.org/resources/state-maps-of-wild-brook-trout-patch-distribution/map-of-new-york-wild-brook-trout-wild-brook-trout-patches/view) and [data](https://easternbrooktrout.org/assessment-data/brook-trout-assessment-data).

* **Upland snow persistence in high priority watershed:** Hemlocks in the cachement of cold water streams/waterbodies hold snow on the ground later into the spring due to their dense evergreen shade. This helps keep the water entering the streams cooler later into the spring. If you have cold-water fish habitat in or downstream from your hemlock stand, score it higher whether it’s near the stream or not.
* **Direct shade of cold water stream:** see explanation of fish habitat quality. Site Assessment **:** the Eastern Brook Trout Joint Venture [website](https://easternbrooktrout.org/resources/state-maps-of-wild-brook-trout-patch-distribution/map-of-new-york-wild-brook-trout-wild-brook-trout-patches/view) and [data](https://easternbrooktrout.org/assessment-data/brook-trout-assessment-data) provide locations for trout, which would be a good proxy for water temperature.
* **At-risk water quality**: Are your hemlocks in a watershed whose water quality is at risk? Hemlock loss, especially in the riparian corridor, may alter nutrient cycling, which could exacerbate challenges in an at-risk watershed. Hemlock stand provides slow, tight biogeochemical cycling because of their thick, acidic, low-quality litter in cool microenvironments (Finzi et al. 1998). Replacement of hemlock by other common native shade-loving species is likely to increase nitrogen leaching to nearby water (Lovett & Mitchell 2004).

Weight: Medium

Resource: The NYS Environmental resource map, <https://gisservices.dec.ny.gov/gis/erm/>, has information on stream quality. A stream classified as “1” is good for drinking, swimming, and fishing; a “2” is good for swimming and fishing but not drinking, and a “3” is not for human contact but OK for fishing. I have been unable to find any creek, even in highly polluted areas, that was not a “3”, so this is clearly a blunt instrument for measuring water quality – but in the absence of good information for your watershed it’s a start. Theoretically there is also water body information in here, but at the time of publication it’s not functioning. The New York State GIS Gateway has a shapefile titled “water Inventory/Priority Waterbodies” which was updated March 2020: <http://gis.ny.gov/gisdata/inventories/details.cfm?DSID=1117>; this doesn’t capture ecological benefit/quality, but it’s a place to start. If your property is in the watershed of a body of water with a landowner association, watershed association, or active water monitoring, reaching out to those local contacts for better information would yield better results for this question.

* **Stream flashiness:** Hemlocks pull water from the ecosystem mainly in the spring and fall, when water is abundant, and minimally during the summer when hardwoods are active. Their loss can increase drying of streams in the summer, and increase spring flooding risk (Catovsky et al. 2002; Hadley et al. 2008, Brantley et al. 2013). Maintaining hemlock on the landscape may help buffer expected hydrologic changes in the future, and HWA infested areas already are experiencing more flashy hydrologic behaviors, (Singh et al 2020). If your property’s streams are prone to problematic fluctuations in streamflow, hemlock loss may exacerbate that issue.

Suggested Weight**:** Low (1)

**Resource: none at present**

* **Drinking water:** Many New York watersheds provide drinking water from surface waterbodies to human populations (Skaneateles Lake and Syracuse, the Catskills and New York City, etc). Losing hemlocks along the lake or its tributaries may alter nutrient cycling in the watershed, which could cause problems. A temporary increase in nitrogen is probable as hemlocks decline and new vegetation is unable to keep up with nitrogen release (Orwig et al. 2008, Jenkins et al. 1999), but whether nutrient cycling will change long term depends on what species replace the hemlock (sugar maple and birch would both increase nitrogen leaching long-term (Crowley et al. 2016).

Suggested Weight**:** Low (1)

**Resource:** [NYS AA/AAA Watershed map](https://blogs.cornell.edu/nyshemlockinitiative/surface-drinking-water-of-ny-map/)

Terrestrial Ecological Value

* **Primary forest:** Primary growth stands have been in continuous forest cover through European settlement, and have never been plowed, although they may have been selectively logged. These often have pit-and-mound topography and are fairly rare; if your property has one of these stands, this would be a strong argument for protection/management.

**Suggested Weight: Very high (4)**

Data resource: Site survey; look for [pit-and-mound topography](https://en.wikipedia.org/wiki/Pit-and-mound_topography#:~:text=Pit%20and%20mounds%20are%20small,soil%20matrix%20used%20to%20be.) and/or trees older than the normal secondary forests in our region.

* **Rarity of ecosystem:** There are a few hemlock ecosystems that are quite rare: hemlock swamps and especially a specific subset of these swamps called rich hemlock hardwood peat swamps. If your property/stand contains one of these ecosystems, it is a priority for management and conservation.

**Suggested Weight: High (3)**

Data resource: Site survey

* **Proximity to related rare species:** This can be restricted to species that would be negatively impacted by hemlock loss; if you have a listed grassland bird nearby, the transition from hemlock to some other forest cover is unlikely to impact it (unless you have site-specific reasons for impact).

**Suggested Weight: High (3)**

Data resource: There are 39 rare plants associated with hemlock communities, about half of which are also dependent on hemlock. A few are also federally or globally threatened or rare. In the Excel tool associated with this document there is a tab to the right of the prioritization tables called “rare species”. This contains a table of these plants with links to their NY Natural Heritage Program profiles, along with comments on their distribution for those dependent on hemlock. The best way to make see if you have rare species is to check if your habitat is appropriate for these species, and to survey the property for them at the appropriate time of year. Take a look and see if any might be on your property.

Another useful tool is the NY Natural Heritage Program’s Environmental Resource Mapper, <https://gisservices.dec.ny.gov/gis/erm/>. In addition to information on basic water quality, it also has the general locations of rare plants and animals. To see this layer, open the mapper, zoom in until the layer text in the legend turns black, and then check the box next to the text; orange blobs should pop up on the map. If your property is in an orange zone, reach out to the program to see if the species near you might be using hemlock habitat. Technical tips: popups need to be enabled for this tool to work well, according to the main website. When you arrive, the layers are all greyed out – you need to zoom in pretty far before they turn black and can be visualized. Just click on the layers you want once you get in that far. When you click on the map, it’ll give you a popup window with basic information; if there’s more than one object near your click, it will say “1 of [however many]” with arrows to tab through them in the upper right-hand corner.

* **High-quality habitat:** Hemlocks in a high functioning ecosystem with strong biodiversity will be more important from an ecological perspective than hemlocks in a suburban matrix, for example.

Suggested Weight**:** Medium (2)

Data resource: Site survey. This is another relative trait; as you inventory your hemlock stands, feel free to rank your lowest quality stands as 1 and your highest quality as 3, rather than leaving room for, say, urban street tress when all you have on your properties are forest hemlock.

* **Presence of hemlock-dependent species**: Blackburnian warbler, blue-headed vireo, black-throated green warbler, and Acadian flycatcher all make heavy use of hemlock stands. Porcupine rely on hemlock as a staple winter food source. If a stand is known to be in use by these species, it may be worth ranking higher for preservation. Populations of the salamanders listed below, or of four-toed or longtail salamanders, would also suggest conservation. Other species that often use hemlock habitat are northern goshawk, white-tailed deer, hermit thrush, red-breasted nuthatch, and Magnolia warblers. Hemlocks near high-quality streams may provide important habitat for red-backed salamanders, Allegheny mountain dusky salamanders, and red efts.

Suggested Weight**:** Medium (2)

Data resource: Site survey or Lab of Ornithology data – better links to those data will be available in the final tool. As with other more difficult traits, if you aren’t sure what you have on your properties, it’s okay to skip it and fill it in later if you can.

* **Steep slopes:** While there is little research on the subject of hemlock loss on steep slopes, we are concerned that despite the slow decline of hemlocks in New York, slow decomposition of dead hemlocks and their roots, and regrowth of other species to replace hemlock, very steep slopes may be an issue. Treatment can be challenging on steep slopes because accessing trees on steep slopes can be difficult and expensive. How you incorporate slopes into your metric depends on your goals for the property. If you choose to let hemlocks on steep slopes near water decline, it may be worth watching to make sure sufficient strong-rooted vegetation is developing on these sites to maintain the slope. Restoration planting may be a good idea in situations where stands are not treated.

Suggested Weight: Low (1)

Resource: Property survey or GIS slope layer. This is another easily estimated value you can rate while walking your property; when you visit a stand, decide whether the stand is mainly on flat, sloped, very sloped-but-still-walkable, or too steep to walk. If the terrain is very sloped or too steep to walk on, especially if it’s near water, it might be worth managing that stand – either to maintain hemlock, or to replant so that you know what will come in after hemlock. That way you can make sure something with a strong root system is established once the dead hemlock finally fall.

Cultural Value

* **Political viability:** Does the landowner permit access, and are they supportive of necessary treatment? Does the site have a group that is strongly invested in it, and is interested in championing and supporting treatment, like a “friends of” group?

**Weight:** High

* **Hazard Trees:** Trees near roads, power lines and structures should be considered for treatment or removal once an infestation is noted. Planning for this will help minimize costs down the road.

**Suggested Weight: High (3)**

* **Natural/Cultural resources:** Is there a historic event associated with the site? Do the hemlocks form part of a highly visited public location? This can mean whatever is relevant to the people doing the prioritization, including protection of viewsheds from iconic scenic overlooks.

Suggested Weight**:** Medium (2)

* **Use/outreach potential:** Is the stand one that is used often (picnicking, hunting, etc.)? Deciding whether or not to preserve the hemlocks should include consideration of how to replace their function for the land users. A highly visited site will also provide opportunity for education and outreach on hemlocks, invasive species, and management.

Suggested Weight**:** Medium (1)

Sustainability

* **Protection/investment risk:** How likely is it that your conservation efforts will result in a preserved stand of hemlocks? If the site is not protected from development or repurposing, it may not be as high a priority as a site that is committed to remain as a natural area. If the hemlocks are likely to be lost to other factors, this would also make them less of a priority. Full protection would be inclusion in a park, DEC protected property, etc. Light legal protection would include a conservation easement, forest plan, or other binding legal protection on private property. Social protection would include verbal agreement or memorandum of understanding on private property.

**Weight:** High

**Data resources:** landowner records

* **Feasibility of treatment/type of treatment:** Can the trees be treated? If the land owner or manager is unwilling to treat, management may not be a possibility. If all other things are equal and two stands have vastly different costs or difficulties associated with treatment, the easier/less expensive one will allow more hemlocks to be treated. Some things that impact treatment potential and cost are road access, (less expensive), access to a water source if the site is not near a road (less expensive), and extreme slopes (more expensive).

**Suggested Weight: High**

**Data resources:** site map, slope layer, site visit

* **Climate resilience:** Trees that are situated where their needs will continue to be met into the future will be higher priority than those that may be lost as the climate changes. This is of high importance, but we don’t have a specific set of recommendations for hemlock; as a result, we are cautious about dismissing otherwise high priority stands based on an assumption of climate change response. New York is in the middle of the eastern hemlock’s range, but hemlocks tend to grow at higher elevations in the more southern portions of its range. Generally, we would suggest that stands that are already suffering from summer drought or flooding risk will become even more stressed, as New York is predicted to have about the same amount of rainfall but in more intense rain events, leaving longer stretches of dry weather between rains. Beyond that, we just don’t have the information yet to provide more detailed suggestions.
* Weight: Despite its importance, given the currently lack of strong information for hemlocks we currently rank this low (1). As more information is developed in this area, we will update the tool as appropriate. If you’re not sure how to address this trait, feel free to not score it – the tool will still work just fine.

Resource: For climate resilience, The Nature Conservancy has a climate resilience map for the northeast, described [here](http://maps.tnc.org/resilientland/). <http://maps.tnc.org/resilientland/>

* **Deer pressure:** Stands in areas with high deer pressure are more likely to have invasive species problems after hemlock loss. If you have otherwise equal stands with varying deer pressure, it may make sense to treat the stands in higher deer pressure areas, or put substantial effort into managing post-HWA forest composition.

**Weight:** Low (1)

Further Reading & References

New York State Hemlock Initiative website: [www.nyshemlockinitiative.info](https://blogs.cornell.edu/nyshemlockinitiative/). Provides information on HWA identification, reporting, and management in New York State.

iMap Invasives: New York (<https://www.nyimapinvasives.org/>). Real-time information on the spread of HWA and other invasives through New York State. Report your invasive species finds here, so that researchers and landowners all over the state can make better informed decisions on invasive species management.

New York State Department of Conservation’s Hemlock Woolly Adelgid website (<https://www.dec.ny.gov/animals/7250.html>). The latest information on HWA in New York, including the [current infestation map](https://www.dec.ny.gov/docs/lands_forests_pdf/hwadistribution1.10.20.pdf).

D’Amato A W, D A Orwig, D R Foster, 2009. Understory vegetation in old-growth and second-growth Tsuga canadensis forests in western Massachusetts. Forest Ecology and Management 257 (2009) 1043–1052.

McAvoy, T. J., J. Regniere, R. St-Amant, N. F. Schneeberger, and S. M. Salom. 2017. Mortality and recovery of hemlock woolly adelgid (Adelges tsugae) in response to winter temperatures and predictions for the future. Forests 8:497.

Letheren, A., Hill, S., Salie, J., Parkman, J. and Chen, J., 2017. A Little Bug with a Big Bite: Impact of Hemlock Woolly Adelgid Infestations on Forest Ecosystems in the Eastern USA and Potential Control Strategies. International Journal of Environmental Research and Public Health, 14(4), p.438.

Rosenthal, J. and Wildova R. 2017. Relating eastern hemlock (*Tsuga canadensis*) ecosystem services to stand attributes in the Catskills, pp. 37. (<http://adkinvasives.com/wp-content/uploads/2018/12/Fall-2018-ADK-PRISM-Report.pdf>)

Ross, R. M., R. M. Bennett, C. D. Snyder, J. A. Young, D. R. Smith, and D. P. Lemarie. 2003. Influence of eastern hemlock (*Tsuga canadensis*) on fish community structure and function in headwater streams of the Delaware River basin. Ecology of Freshwater Fish, 12:60–65.

Siderhurst, L A, H. P. Griscoma, M. Hudya, Z. J. Bortolot, 2010. Changes in light levels and stream temperatures with loss of eastern hemlock (*Tsuga canadensis*) at a southern Appalachian stream: Implications for brook trout. Forest Ecology and Management 260, 1677–1688

Singh K, J. Knighton, M. Whitmore, M.T. Walter, J.P. Lassoie, 2020. Simulation and statistical modelling approaches to investigate hydrologic regime transformations following Eastern hemlock decline. Hydrological Processes 2020, 1–15.