 

***Forest Management Plan***

Submitted to the Massachusetts Department of Conservation and Recreation for enrollment in CH61/61A/61B and/or Forest Stewardship Program

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | ***CHECK-OFFS*** | | | | | | ***Administrative Box*** | | | |
| CH61 |  | CH61A | CH61B | STEWARDSHIP | | Cost Share | Case No. | 234-000 | Orig. Case No. |  |
| cert | | cert | cert | new | | EEA | Owner ID | 0000100 | Add. Case No. |  |
| recert | | recert | recert | renew | | Other | Date Rec’d |  |  |  |
| amend | | amend | amend | Climate | | Birds | Plan Period | 2023-32 |  |  |
|  | | | | Conservation Rest. | | | Rare Spp. Hab. | No |  |  |
| Plan Change to | | | | CR Holder |  | |  | |  |  |

***OWNER, PROPERTY, and PREPARER INFORMATION***

Property Owner(s) Sample Family

Mailing Address Main Road 2, Ashfield, MA 01330 Phone 413-200-0000

Email Address

Property Location Town(s) Ashfield Road(s) Main Road

**Plan Preparer** Millie QuercusMass Forester License # 1000

Mailing Address Main Road, Plainfield, MA 01070 Phone 413-300-9999

***RECORDS***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Assessor’s Map No. | Lot/Parcel No. | Deed  Book | Deed  Page | Total  Acres | Ch61/61A  61B  *Excluded*  Acres | Ch61/61A  61B  **Certified**  Acres | Stewshp  *Excluded*  Acres | Stewshp  Acres |
| 10 | 20 | 1500 | 200 | 105 | 5 |  | 5 | 100 |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  |  |  | **TOTALS** | 105 | 5 |  | 5 | 100 |

**Excluded Area Description(s) (if additional space is needed, continue on separate paper)**

House, yard and surrounding open areas.

***HISTORY*** Year acquired 1972 Year Management began 2023

Are boundaries marked: Yes  blazed/painted/flagged/signs posted (circle all that apply) No  Partially

What treatments have been prescribed, but not carried out (last 10 years if plan is a recert.)?

stand no. treatment reason

(If additional space is needed, continue on separate page)

Previous Management Practices (last 10 years)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Stand # | Cutting Plan # | Treatment | Yield | Acres | Date |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

Remarks: (if additional space is needed, continue on separate page)

Page 1 of 47

**Plan Summary**

Your woodland is an important place for your family, both recreationally and ecologically. It is already helping to act as a natural climate solution and is supporting your family’s and community’s well-being. Climate change and forest health threats such as hemlock woolly adelgid (*Adelges tsugae*), have impacted your woods over the past several decades. Several key management strategies have been identified which prioritize your family’s goals of maintaining the beauty of your woodland, promoting carbon sequestration and storage, addressing forest health threats, and supporting your forest’s resilience to climate change. Removing threatened trees through harvest practices to provide space for future-adapted young trees is an important method to meet those goals. Management recommendations will assure compliance with your property tax reduction (Chapter 61) while also providing your community with valuable local wood products.

**The impacts of climate change are contributing to and will intensify the following ways in which your forest is most vulnerable:**

* Eastern hemlock (*Tsuga canadensis*) decline associated with the intensifying impacts of hemlock woolly adelgid (HWA) and hemlock scale (*Fiorinia externa*)
  + The five-acre hemlock-dominated stand (ST-3) represents the highest-risk portion of your property. The stand has been designated as highly vulnerable (see figure one) because of both these forest health threats as well as the long-term impacts of climate change on Eastern hemlock.
* A lack of tree species diversity, combined with high rates of deer browse and invasive species in your Eastern white pine (*Pinus strobus*) stand (ST-1)
  + Existing forest health threats and the risk that moisture extremes (too wet or too dry conditions) can pose to pine stands threaten the ability of the stand to sustain itself long term. This is a moderate-high risk stand (see Figure 1).
* Drought risk on the upper slopes of your Northern Hardwood stand (ST-4) in combination with American beech (*Fagus grandifolia)* that is declining as a result of beech bark disease (*Neonectria faginata*)
  + Drought-prone areas of this stand are comparably small, resulting in a moderate risk (yellow icon in figure 1) to the stand. Risks in this stand are over the long-term. Monitoring can help identify if and when more intensive intervention may be needed.

Figure 1: Stand Vulnerability Indicator



The management practices that are described in this plan have been tailored to the goals of the Sample family and are designed to work with nature. The Massachusetts Department of Conservation and Recreation (DCR) provides helpful information about how foresters are able to support nature in ways that address challenges and support resilience (See *Caring for Your Woods:* [*Working with Nature*](https://www.mass.gov/doc/caring-for-your-woods-working-with-nature-private-lands-forestry/download)*).* Many of the Sample Family’s goals focus on biodiversity and climate. Climate goals include both climate mitigation (supporting forests’ ability to soak up and store greenhouse gases that cause climate change) and adaptation (helping forests cope with the impacts of climate change). Less intensive harvests, protections against herbivory (deer eating very young trees as they sprout), and enrichment plantings (understory tree planting) directly support these goals while also promoting an aesthetically pleasing forest. A particular emphasis has also been placed on promoting forest health and invasive plant species management, two key goals of the Sample family. Forestry best management practices (BMPs) have been recommended to protect the property during management activities. These protections will reduce machine impacts and slow the movement of water and soil. Implementing more robust BMPs will assure that the property’s trails, recreational destinations, soils, and water quality are protected.

**A suite of management practices has been selected for your property to address your goals and concerns. These Practices are designed to work together over time, though there is often a need to prioritize. Two key management focuses include (see ‘Management Recommendations’ for additional information):**

* Assisting the transition of ST-1 while promoting diverse regeneration
  + A regeneration harvest (p. 41) has been recommended to promote the establishment of a diversity of native tree seedlings while assisting the regeneration of climate-adapted species through planting (p. 39), invasive species treatment (p. 34), and herbivory reduction (p. 40).
* Reducing risks associated with hemlock woolly adelgid and hemlock scale
  + A thinning (p. 44) has been recommended in ST-2 to promote the resilience of diverse native trees, including healthy eastern hemlock.
  + A regeneration harvest (p. 43) has been recommended in ST-3 to facilitate the transition of the stand from infested eastern hemlock to a stand that is more complex and resilient.

Selecting goals for your property was the first step towards improving your woodlot. This plan provides a roadmap of your options to address how a changing climate will affect the health of your forest and the trees growing there. Once you've had a chance to absorb key information about each area of your property, you can move ahead to implement the management recommendations that are most pressing and of highest importance to you. You don’t have to make the decision alone; as a next step we can work together to develop an operational plan and identify funding sources (if needed) to implement your priorities in an ecologically sound manner.

# Landowner Goals

Please **check** the column that best reflects the importance of the following goals:

*(goals may change over time and this table may be updated to reflect any changes)*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Goal** | **Importance to Me** | | | |
| HIGH | MED | LOW | N/A, Don’t Know |
| Improve access for walking/skiing/recreation | x |  |  |  |
| Improve hunting or fishing |  |  | x |  |
| Maintain or enhance privacy |  | x |  |  |
| Preserve or improve scenic beauty | x |  |  |  |
| Protect special features, including those of historical or person significance |  |  | x |  |
| Enhance the quality and/or quantity of forest products**\*** | x |  |  |  |
| Practice agroforestry |  |  |  | x |
| Produce income from timber products, or other products and services |  | x |  |  |
| Produce firewood for personal use |  | x |  |  |
| Enhance habitat for birds |  |  | x |  |
| Enhance aquatic habitat in streams, ponds, and other wetlands |  |  | x |  |
| Enhance habitat for wildlife |  |  | x |  |
| Promote diversity of plant species and habitat types |  | x |  |  |
| Increase forest resiliency | x |  |  |  |
| Minimize damage from forest pests | x |  |  |  |
| Protect water quality | x |  |  |  |
| Sequester and/or store carbon to mitigate climate change | x |  |  |  |
| Suppress or eradicate invasive plants | x |  |  |  |
| Lower property taxes |  | x |  |  |
| Protect land from development |  | x |  |  |

**\* This goal must be checked "HIGH" if you are interested in classifying your land under Chapter 61/61A.**

*In your own words please describe your goals for the property:*

We want to make sure our property is healthy for our kids. We want to protect our forests from climate

changewhile helping demonstrate to our children that each of us can play a role in the climate solution.

Our trails are alsoimportant to us and we want to be able to continue to use our property for recreation.

#### Stewardship Purpose

By enrolling in the Forest Stewardship Program and following a Stewardship Plan, I understand that I will be joining with many other landowners across the state in a program that promotes ecologically responsible resource management through the following actions and values:

1. Managing for long-term forest health, productivity, diversity, and quality.
2. Conserving or enhancing water quality, wetlands, soil productivity, biodiversity, cultural, historical and aesthetic resources.
3. Following a strategy guided by well-founded silvicultural principles to improve timber quality and quantity when wood products are a goal.
4. Setting high standards for foresters, loggers and other operators as practices are implemented; and minimizing negative impacts.
5. Learning how woodlands benefit and affect surrounding communities, and cooperation with neighboring owners to accomplish mutual goals when practical.

**Signature(s): Sample Family Date: 2/21/23**

**Property Overview, Regional Significance, and Management Summary**



**Property Overview and Goals**

The Sample property, located in Western Massachusetts, lies within the Western New England Upland region. This area is ecologically significant given its diverse terrain and its geographic connection to the Green Mountains of Vermont. The Sample property contain 105 acres of land, the majority of which (100 acres) are forested. The property has variable terrain with the highest and most diverse terrain in ST-4 (elevation 1200 feet) and the lowest elevation in ST-1 (800 feet). The property is located within the Deerfield River watershed and has an intermittent stream flowing through the center of the property. Low-lying sections along the stream, in the eastern portion of ST-2, are poorly drained, creating wetland conditions that support a diversity of wetland-dependent vegetation and wildlife.

The Sample property is broken up into four different stands (Figure 2) which represent different forest types. While the prevalence of seedlings and saplings varies across each of the stands, the property as a whole has limited tree regeneration, or in other words, is not producing very many baby trees. Deer browse and a lack of available sunlight are preventing adequate regeneration. These are manageable challenges that harvest, planting, hunting, and protection from deer can help to address. Beyond these property-level issues, each forested stand is associated with different forest health and climate vulnerabilities, which are described in the ‘Stand Descriptions’.

This property supports a diversity of plant and animal species. Harvest has helped to improve the structural and species diversity of this forest, particularly in the portion of ST-2 south of the stream where firewood harvests have occurred over the past two decades. These harvests have thinned the canopy, enhanced tree health and vigor, while supporting your property’s carbon sequestration and timber production. Harvests recommended in this plan build from this approach, but with a focus on climate resilience.

The Natural Heritage and Endangered Species Program (NHESP) identifies approximate areas of threatened and endangered species. According to MA GIS maps, this property does not contain any vernal pools or Priority Habitat for endangered species at this time. However, it is important to check updated NHESP maps (available through the MA MassMapper website) prior to any timber harvesting – properties with the above-mentioned habitats typically have modified operating restrictions. This information will also be assessed by MA DCR any time a Forest Cutting Plan is submitted for the property.

**Diagram, engineering drawing

Description automatically generated**

ST-1 White Pine

ST-2 Oak Hardwood

ST-3 Hemlock Hardwood

ST-4 Beech Birch Maple

Figure 2. Stands in the Sample Family Forest.

**History**

It is important to acknowledge that prior to colonization the land we now know as northwestern Massachusetts was inhabited by several Indigenous nations including the Mohican Stockbridge Munsee, Nipmuc, Pocumtuck, and Abenaki. Native peoples continue to live in and steward northwestern Massachusetts forest land without access to most of their historical lands. Land uses both before and after European colonization have influenced and shaped today’s forests.

Colonization led to widespread forest clearing for agriculture. A 20th century decline in agriculture followed and led to the resurgence of many forests. Stone walls persist as a cultural feature in a few sections of the Sample property (ST-1), documenting this cultural legacy. The gradual abandonment of farm fields is reflected in the current forest stands on the property. The areas farthest from the homestead and steepest were abandoned first, and now contain tree species characteristic of mature forests such as Eastern hemlock and a variety of northern hardwoods. The middle of the property likely reverted to forest more recently, and being more accessible, has seen the most harvesting in recent decades. This oak-hardwood stand has a range of species including early successional species such as black cherry (*Prunus serotina*) and big tooth aspen (*Populus grandidentata*), mid-successional species like red oak (*Quercus rubra*) and black birch (*Betula lenta*)*,* along with scattered hemlocks and northern hardwoods. The white pines that dominate the flatter areas nearest the home established in the mid-twentieth century when the final fields were abandoned.

The legacy of land clearing and farm abandonment has led to relatively homogenous forest stands, and overall, less resilient forests across the region. The Sample family has helped to improve the condition of the forest by responsibly harvesting firewood. However, structural and age class diversity is still limited across much of the property. Recreational trails and forest viewing areas have been created and enjoyed by the family over many years.

**Climate Change**

The climate of Massachusetts is changing, and this impacts our forests in a number of ways. At the same time, because the cause of climate change is increasing carbon dioxide concentrations in the atmosphere and trees are the best technology we have for removing carbon dioxide from the atmosphere, forests are a powerful nature-based climate solution. This section will provide an overview of how climate change is impacting the Sample family forest, and the actions you can take to adapt your forest to climate change. These actions are balanced to maintain the ability for your forest to continue to absorb carbon from the atmosphere and store it in trees, soils, and all other parts of the forest for decades and centuries to come. For more general information on climate change effects on forests and actions to adapt forests to climate change, please review the *Caring for Your Woods:* [*Adapting to Changing Conditions*](https://www.mass.gov/doc/caring-for-your-woods-adapting-to-changing-conditions/download) booklet. The *Caring for Your Woods:* [*Managing for Forest Carbon*](https://www.mass.gov/doc/caring-for-your-woods-managing-for-forest-carbon/download) booklet provides additional information on forest carbon and considerations for management.

Broadly speaking, based on available climate models, we know that:

* Temperatures will increase throughout all seasons in the Northeast region over the next century, annual temperature projected to increase by 3 to 10°F.
* Future precipitation rates are uncertain but are, and will continue to change. Total annual precipitation is generally expected to increase over the next 100 years.
* The greatest precipitation increases are expected to occur during the winter months, where warmer temperatures will result in more precipitation falling as rain instead of snow.
* Even with moderate increases in rainfall, there will likely be more frequent droughts in the summer and/ or fall because higher temperatures will lead to greater water loss from evaporation and transpiration.
* Strong storms will occur more frequently.

*Climate Impacts & Vulnerabilities*

While changes in climate generally occur over long-time scales, we are already seeing noticeable changes that impact our forests and how we manage them. Even minor, incremental changes in temperature and precipitation can have significant impacts on a forest. Climate change and interacting factors not only affect the health and vitality of the trees currently living in the forest, but also influence which young trees can get established to create the future forest, and our ability to respond to these changes through management. Table 1 summarizes climate vulnerabilities of the Sample Forest.

**Table 1: Sample Family Forest Vulnerabilities**

|  |  |  |
| --- | --- | --- |
| **Climate Change Impact** | **Vulnerability** | **Climate Related Challenges/Opportunities to Meeting Goals** |
| **Increased Risk of Summer Drought** | * Drought poses the greatest risk as elevation increases in ST-4. Shallow soils and drought susceptible species, including American Beech that has already been impacted by beech bark disease, increase the level of risk associated with drought in this stand. * Mortality risks are increased in Eastern hemlock trees, ST-3 is particularly vulnerable in dryer locations with high levels of hemlock woolly adelgid and scale. | * **Challenge:** Increased mortality risk associated with drought will make it more difficult to sustain carbon storage levels. * **Opportunity:** Dry periods during the summer months could help to reduce the severity of fungal pathogens. * **Opportunity:** Dry soils may provide opportunities to harvest that minimize impact on recreational areas. |
| **More frequent and severe ice and wind storms** | * More structurally homogenous areas are subject to greater risks from wind and ice storms. * Limited established regeneration in much of the property make the system more vulnerable to disturbance. | * **Challenge:** Increased barriers to tree regeneration will make storm recovery more difficult. * **Opportunity:** An increase in mild-moderate disturbances could increase long-term forest resilience. |
| **Increase in forest insect pest and pathogen outbreaks** | * Hemlock woolly adelgid and hemlock scale represents two of the most urgent threats to the property. * The prevalence of white ash increases long-term risk as emerald ash borer is expected to continue its spread. * Eastern white pine is subject to a variety of fungal pathogens that can lead to tree decline, particularly during moisture extremes. The presence of White Pine Needle Damage (WPND) in ST-1 elevates the need for management. | * **Challenge:** Warmer winters will make it harder to address forest health threats. * **Challenge:** Increased success of deer and invasive species will make it more difficult to improve species diversity, particularly in ST-1. * **Opportunity:** Many areas in ST-2 are good candidates for forest reserves where a diverse mix of native tree species minimizes pest impacts of climate change. |
| **Increased success of invasive plants** | * Dense patches of invasive species in ST-1 reduces the stand’s ability to respond to disturbance and to have decreased species diversity. | * **Challenge:** Warmer temperatures will increase vigor of invasive species. * **Opportunity:** Longer growing seasons can also support the success of native species. |

In addition to the climate vulnerabilities described above in Table 1, changes in temperature and precipitation will increasingly favor tree species that have a more southerly distribution and/or are more resilient to occasional drought, such as red oak, black cherry, and maples (*Acer spp.*). In contrast, more northerly species like Eastern white pine or Eastern hemlock are expected to fare increasingly poorly as climate change continues. Other species, like white ash (*Fraxinus americana*) and American beech (*Fagus grandifolia*), which would otherwise fare well in a warmer climate, are susceptible to pests and pathogens that are causing their decline in our forests now. The Sample family forest contains a mix of northerly and southerly trees, which are expected to decline or prosper over timescales of several decades. Additionally, some tree species that are present are being affected by pests and diseases that are affecting the overall forest’s health now.

Table 2 provides a summary of climate and forest health risks for the tree species growing in the Sample family forest. This table summarizes how favorable habitat conditions are expected to be for these species at the end of the century (from climate models), how susceptible the species are to physical disturbances from storms or drought, whether pests or diseases are expected to impact forest health in the near term, and whether regeneration of the species requires specific attention. Management actions can help shape the species composition of the forest, aim to make individual trees less vulnerable to physical disturbance, pests, and diseases, and encourage regeneration of future adapted species. See the ‘Stand Descriptions’ for a more detailed information on forest conditions and vulnerabilities of specific forest stands, and the ‘Management Recommendations’ for actions to improve the forest’s resilience to climate impacts and to promote your goals for your forest.

Table 2. Forest health and climate risks for tree species present in the Sample Forest.

****

\* Tree species vulnerability to long term climate risks (habitat conditions) and near-term stressors determined from the UDSA Forest Service Climate Change Tree Atlas data, modified by site conditions at the Sample property. The Tree Atlas uses modeled climate at the end of the century to project whether tree species will gain or lose suitable habitat by then. Also included in the Tree Atlas are an assessment of “modifying factors” that may alter how tree species respond to climate change. This table uses these modifying factors to describe how vulnerable the tree species present on the Sample property are to risks from storms, drought, and pests or disease, and the level of concern about the regeneration of the species given observed levels of competing invasive plant species and deer browse.

*Responding to Climate Change*

When selecting management practices that address the vulnerabilities of the site there are three primary climate-adaptive management responses: resistance, resilience, and transition. There are locations on the Sample property where each strategy is appropriate, but a resilience strategy is most appropriate overall.

Each of these climate-adaptive strategies aims to maintain healthy forests over the long term and enabling the establishment of new young trees to replace the trees that die is key to doing this. Currently, competition from invasive plants, over-browsing by deer, and insufficient light hitting the forest floor are preventing some species, such as oaks, that would be best suited to future climate conditions from regenerating in this forest. Addressing these challenges to growing new trees can be incorporated into each of the adaptation strategies described below.

Resistance is most effective when most or all of the species present are well matched with the future climate expected for the site (an example in Massachusetts would be an oak-hickory forest), in places where the microclimate is more determined by local topography than broader climate trends (like a cold hollow), or something other than climate is the main determinant of the ecosystem type. The mix of open marsh and pockets of red maple swamp, where water-level determines the species growing there, is a good example of this last type of site appropriate for a resistance strategy on the Sample property. In the forested wetlands that make up part of ST-2, keeping invasive plants to a minimal level and monitoring for any changes is likely all that is needed.

Across most of the Sample family forest, a combination of both resilience and transition is needed. Resilience strategies are designed to allow for the forest on the property to experience some changes with the goal of retaining existing species and habitat characteristics to the extent possible. This will be particularly important in ST-2 and ST-4 where conditions are good overall, but where sections of each stand are at greater risk. Tree species that are expected to do well with climate change make up a majority of the basal area on the Sample property, including red oak (14% composition), red maple (14% composition), sugar maple (*Acer saccharum*) *(*15% composition), black cherry (5% composition), and white oak (*Quercus alba*) (2% composition). Resilience strategies will favor these climate-adapted species, while also seeking to maintain species that are less well adapted to future conditions in locations where they have the best chance to thrive, so as not to sacrifice biodiversity. For example, Eastern hemlock in the southern portion of ST-2 has not been impacted by HWA and scale to the same extent as the northern portion of the stand or in ST-3. This section of the stand is on moist soils with favorable topography (north facing slopes), which reduce its vulnerability to climate change and may allow it to cope better with forest health challenges.

Transition strategies are designed to facilitate change within a forest in order to create conditions that are better suited to the changing climate. Transition makes the most sense in areas where we know the forest is already declining and is unlikely to recover. The decline and likely mortality of Eastern hemlock in ST-3 and parts of ST-2, as well as eastern white pine in ST-1 means these areas are unlikely to be able to provide the climate, aesthetic, and recreational benefits the Sample family expects as climate change progresses. While these forests will naturally transition from one type to another over time, active management practices can make this transition smoother and faster, while making use of the wood in trees that would die anyway. To the extent that harvested wood ends up in long-lived wood products, the carbon contained in it will continue to be stored for years and decades to come.

Management strategies in this plan consider the current presence of species that are expected to do well with climate change, site conditions that buffer more vulnerable species from the worst impacts of climate change, and past management efforts that have helped to support the site’s resilience to date. Thinning of the canopy from harvesting firewood over the past decades has improved the structural complexity and has incidentally initiated some regeneration in the southern half of ST-2. Additional harvest practices will expand on this good work to help strengthen the diversity of the Sample property and promote resilience to climate change risks such as more extreme storms, drought, and tree pests.

*Carbon Storage and Sequestration*

Forests help to both soak up harmful greenhouse gasses from the air (carbon sequestration) and lock them away for long periods of time (carbon storage). Young forests are best at sequestering carbon since young trees rapidly take up carbon dioxide as they establish. Older forests and trees continue to take up carbon dioxide but at slower rates. Their biggest climate benefit is continuing to hold onto all the carbon that they have accumulated over time, serving as a sort of “carbon savings account.” The ideal forest for carbon benefits has a mix of healthy and vigorous young and old trees that both absorb carbon dioxide at a high rate from the atmosphere and store that carbon away securely for a long time.

The Sample’s forest has a small amount of young forest, limited to a few patches created through recent firewood harvests. As a result, the property’s overall sequestration potential is declining. However, the Sample’s forest is still a powerful natural climate solution and is currently storing roughly 49 tons of carbon per acre (t/ac) for a total of approximately 4,900 tons. In other words, this forest stores the equivalent amount of carbon that driving 3,512 cars for a year would release into the atmosphere (according to EPA estimates). On average, these forest lands are storing as much or more carbon than 50-60 percent of similar forests in western Massachusetts. As the forest continues to mature, the natural cycle of tree loss and regeneration will continue to play out. These processes will lead to movement of carbon between various pools. Trees that die will continue to store some carbon for many decades in the form of dead and decaying wood. As trees decay, carbon will also move into forest soils and be lost back to the atmosphere. Overall, as the forest matures the amount of carbon stored will continue to grow unless there are extreme disturbances within the system.

Promoting the Sample family’s goal of mitigating climate change will require a balance between reducing the risk of rapid carbon loss, increasing sequestration rates, and selecting strategies that promote long-term carbon storage. Carbon is lost back to the atmosphere (exacerbating climate change) when disturbances cause tree mortality. The climate change impacts (e.g., drought) and associated stressors (e.g., invasive plants) described earlier can lead to greater carbon loss due to tree mortality from disturbances and a slower rebound in the ability of forests to sequester carbon. Forest carbon is also lost during harvests, but harvests designed to promote climate-adaptation reduce the risk of rapid carbon loss in the future and increase the rate of sequestration. The white pine and hemlock that make up most of the trees recommended to be harvested from this forest can be used for building, locking the carbon contained in them for many decades and thereby benefiting the climate. This means that while some loss of stored carbon will occur, the risk of more extreme carbon losses will be reduced. Additionally, the thinnings and regeneration harvests prescribed in this plan (see ‘Management Recommendations’) are expected to lead to more carbon stored compared to no management over the course of a few decades from increased growth rates on residual trees and new young trees. While that may seem like a long time, greenhouse gasses persist in the atmosphere for hundreds of years and forests are slow moving ecosystems, so natural climate solutions have to consider the short and long term.

Ensuring vigorous young trees are present in the Sample’s forest will be key to promoting both carbon sequestration and storage over the long term. Planting climate-adapted tree seedlings adds to the climate mitigation potential of the site. Additional protections associated with reducing herbivory and treating invasive species will support forest regeneration, enhance biodiversity, and lead to carbon gains while reducing risk.

**Wildlife**

The Sample’s forest provides important habitat for many wildlife species, particularly those that rely on mature forest cover, such as wild turkey, white-tail deer, owls, black bear, moose, fox, coyote, fisher, bobcat, raptors, and song birds such as wood thrush, scarlet tanager, and wood warblers. Management recommendations described below would maintain the overall mature forest while adding new elements of structural diversity – downed wood, snags, and patches of younger forest that will benefit the existing wildlife species. These elements would provide perching, feeding, and nesting sites for many bird species and the dense vegetation that will develop in the young forest patches may attract additional species. Bird species that would benefit from young forest patches include American woodcock, ruffed grouse, brown thrasher, chestnut-sided warbler, eastern towhee, mourning warbler, and white-throated sparrow.

**Management Summary**

Meeting the Sample family’s primary goals for their forest of providing recreational access and scenic beauty, while maintaining a healthy forest that has diverse native species, is resilient to climate change, protects water resources, and sequesters and stores carbon to help mitigate climate change will require an active management approach across most of the property. **Two key management objectives will be making sure that the forest is both as resilient as possible to disturbance while also being able to renew itself through the establishment and growth of a diversity of climate-adapted native tree species.** The management practices recommended here all support these two objectives. Maintaining a vigorous and resilient forest is the first step in realizing carbon sequestration and storage benefits from the forest. While the harvests prescribed are designed to primarily increase the resilience of the forest to climate change, implementing these practices will also fulfill the landowner’s responsibility under their Chapter 61 enrollment to manage for forest products.

Diagram

Description automatically generatedThis plan recommends implementing nine forest management practices over the next ten years to meet the Sample family goals. Five of these focus on native young tree establishment and growth to ensure the future forest is healthy and well adapted to climate change. Improving conditions for native tree establishment will also increase forest biodiversity. Other practices focus more on the increasing the vigor of existing trees, enhancing forest structure, and protecting carbon stocks and water quality. The locations where practices are recommended for are shown in Figure 3.

* Patch cuts, thinning, invasive removal, planting, fencing
* Crop tree release
* Reserve/ deferred harvest
* Beech brush treatment, (planting)
* Timber stand improvement, (planting)

Figure 3. Locations for recommended management practices.

There is a natural order for practices to be implemented. An important first step is to remove invasive plants (ST-1, ST-2, and ST-3) and beech sprouts of diseased trees (ST-4) that compete with native vegetation. These practices by themselves will help encourage native tree establishment, but more importantly will set the stage for additional management practices to be successful.

The next step will be to implement a variety of harvest practices while also designating locations that will not be harvested during this management cycle (deferred harvest or temporary reserves) around the forested wetlands and stream (ST-2), as well as on the steep slopes (ST-4). In the white pine stand (ST-1), a regeneration harvest will increase light availability to allow a diversity of native tree seedlings to establish. A thinning in the oak hardwood and northern hardwood stands (ST-2 and ST-4) and a single tree/small group selection harvest in the hemlock hardwood stand (ST-3) will enhance the vigor of a diversity of healthy canopy trees while encouraging the development of a more robust understory composed primarily shade-tolerant native tree species in the understory. This will make the forest more resilient to disturbance while accelerating the development of old-growth characteristics.

Additional treatment of invasive plants may be necessary after harvest, followed by planting climate-adapted tree seedlings to supplement the naturally established tree seedlings to add diversity to the stand (primarily in ST-1 with addition planting possible in ST-3 and ST-4), and protect both planted and naturally established seedlings from deer browse through cages (ST-3 and ST-4), fencing (ST-1), and potentially more hunting (all stands). During the implementation of all management practices, but especially during harvests, best management practices will be followed to minimize the impacts of machinery on soils and water to protect water quality and soil carbon stocks. Finally, monitoring the property should be done throughout the management period and in all stands to track forest health threats such as beech bark disease, hemlock wooly adelgid, emerald ash borer, invasive plant populations, and deer browse, as well as the effects of strong storms. Monitoring will ensure a quick management response if conditions deteriorate so that forest health can be maintained as much as possible.

**Stand Summary**

For the purposes of this report a forest stand is an easily defined area that is relatively uniform in composition and structure.

Table 3. Summary of the Forest Stands on your property

| **Stand** | **Acres** | **Forest Type** | **Important Observations** | **Climate Risk** | **Carbon/Acre** |
| --- | --- | --- | --- | --- | --- |
| 1 | 20.00 | White Pine (WP) | White pine established after farm field abandonment in mid-twentieth century  Invasive shrubs dense around stand edges and in gaps where white pine mortality has occurred  Overstocked, trees with small canopies and little light reaching understory  White pine is dominant and has poor adaptive capacity, WPND present  Small area of white pine closest to the residence is relatively healthy | Moderate to High - due to dominance of a single species and barriers to tree regeneration | 62 ton/ac  85th -Percentile |
| 2 | 45.00 | Oak Hardwood (OH) | Northern red oak dominated canopy, but little oak regeneration  Oaks provide hard mast for wildlife. Good coarse and fine woody debris, and leaf litter  Conifers - an important habitat feature, hemlock stands favored by black-throated green warbler. Some soft mast species  Hemlock woolly adelgid and hemlock scale are less prevalent and oaks are relatively dominant  Stream and associated wetlands create valuable riparian habitats  Greater structural diversity and healthier tree canopies in south part of stand due to past firewood thinning | Low to moderate: A diversity of tree species and moist soils buffer much of this stand | 44 ton/ ac  45th – Percentile |
| 3 | 5.00 | Hemlock Hardwood (HH) | Hemlock woolly adelgid and hemlock scale present at high levels  High levels of hemlock mortality  Black birch seedlings common in understory gaps  Woods road is rutted and located on moist, sensitive soil | High: declining hemlock health and dominance of single species elevate risk | 67 ton/ac  90th – Percentile |
| 4 | 30.00 | Northern Hardwood (BB) | High tree species diversity with red and sugar maples forming matrix provide good resilience to climate change  Moderate to steep slopes limit access for management  Elevation/moisture gradient with seeps near lower boundary transitioning to upland soils vulnerable to drought at higher elevations  American beech thickets in upland areas are limiting regeneration  White ash near bottom of slope is vulnerable to emerald ash borer, but currently healthy | Moderate- Ash and beech component is more vulnerable to climate change but other climate adapted species help to reduce risk. | 44 ton/ ac  45th – Percentile |

**Stand 1, White Pine**

**Table 4: Summary of Average Field Conditions Across Stand 1**



**Stand Narrative**

Stand one (20 acres) is located in the eastern portion of the property, nearest the home. The dense, small crowned white pine making up the majority of the stand became established after farm field abandonment in the mid-twentieth century. As detailed in Table 3, above, the stand is overstocked with limited light reaching the forest floor. The dense shade inhibits seedling growth within the stand. Invasive shrubs and vines such as buckthorn (*Rhamnus* spp.), bittersweet (C*elastrus orbiculatus*) and honeysuckle (*Lonicera* spp.) further limit native regeneration in areas with sufficient light, as along the edge of the stand and in gaps created by white pine mortality. Dense clusters of invasives cover roughly 20% of the stand. The stand’s density, and small tree crowns (low live crown ratio) increases the risk of white pine needle damage (WPND).

White pine makes up 82% of the stand, with striped maple (*Acer pensylvanicum*) and black cherry being the next most common species making up 10% and 6% of the stand, respectively. Striped maple is not generally an overstory species but, along with birch species (*Betula spp.*), has survived competition with invasive shrubs in the stand’s gaps and edges. About half of the trees are unacceptable growing stock, limiting forest product potential. Some small sections of the stand are in better condition with less dense stocking and a combination of birch and maple species. These areas are largely the areas closest to the home.

**Terrain & Soils**

Stand 1 is gently sloped with greatest inclines in the northern portion of the stand. The soils are a well-drained Charlton fine sandy loam. The more recent legacy of farming here may have compacted these soils, which can limit drainage and productivity in certain areas. Best management practices during harvests can help limit further impact.

**Management History**

The stand has not been recently managed. There are legacy impacts from forest clearing and farming.

**Habitat**

White pine is a valuable wildlife species, supporting a variety of small and large mammals as well as a number of bird and insect species. However, the small tree crowns and dense shading limits this stand’s value to wildlife. Invasive fruits also have deleterious effects on wildlife species. The many standing dead trees and proximity to stream habitat are beneficial to wildlife and should be retained during harvest activities when possible.

**Climate Change & Adaptation**

Stand one is vulnerable to climate change in the near-term. The relationship between moisture extremes, increased springtime precipitation, and the presence of fungal pathogens that are exacerbated by these changes are the greatest contributor to vulnerability. The adaptive capacity of the system (its ability to adjust to changing conditions) is limited largely as a result of a lack of diversity, regeneration failure, and invasive species prevalence. The dominance of trees that are at-risk to climate change both in the near and long-term suggests an opportunity to promote resilience by shifting species composition towards more climate-adapted species while also promoting species diversity.

**Table 5: Stand 1 Climate Vulnerabilities by Forest Component**

|  |  |
| --- | --- |
| **Stand Vulnerability Rating** | **Vulnerability Time Horizon** |
| **Moderate** | **Short-Term:** White pine is already being impacted by the moisture extremes of climate change. |
| **Long-Term:** White pine’s vulnerability will increase with time. Manage for biodiversity and monitor over time. |
| **Forest Strata** | **Climate Vulnerability and Adaptation Options** |
| **\* Canopy** | **Vulnerabilities:** Low species diversity, uniform distribution lacking structural diversity, WPND. |
| **Carbon:** High carbon storage, but vulnerable to mortality and limited sequestration. Carbon benefits not likely to be sustained. |
| **Adaptation:** Reduce density, increase live crown ratio, promote diverse structure and distribution. |
| **\* Midstory** | **Vulnerabilities:** Midstory not currently present. |
| **Carbon:** Limited vertical distribution reduces potential of stand. |
| **Adaptation:** Reducing canopy density will allow for midstory development. |
| **\* Regeneration** | **Vulnerabilities:** Regeneration is not occurring; stand is not self-sustaining. |
| **Carbon:** Regeneration failure limits carbon sequestration as well as long-term storage potential. |
| **Adaptation:** Increase light availability, reduce competition from invasive species, promote climate adapted species. |

**Desired Future Condition**

The current condition of the stand is not meeting the goals of the Sample family for a resilient forest that sequesters carbon and stores it for the future. Tree mortality, dense stocking, and invasives limit the aesthetic and recreational value of the stand as well. While the stand currently holds high levels of carbon, white pine decline is leading to reduced carbon sequestration and threatens the loss of that stored carbon from living trees. With minimal native tree seedlings to pick up the slack as the pines decline, sequestration rates will not be sustained. Invasive species (particularly in proximity to the property’s streams) can also negatively impact hydrology and water quality over time.

Management interventions can create a more desirable future condition, including a forest that is more resilient to current and future threats, has greater carbon sequestration rates, and stores that carbon more securely for decades to come. Management should focus on creating an uneven-aged stand that has a high percentage of future adapted species including maples, oaks, black cherry, and poplar, while retaining the best formed white pines to continue storing carbon for decades and possibly centuries to come. Actions to achieve this goal include a harvest to reduce the density of white pine and encourage native regeneration, removing invasive shrubs and vines, planting future-adapted native tree seedlings, and protecting seedlings and saplings from deer herbivory. More details on these actions can be found in the ‘Management Recommendations’ section of this report.

**Stand 2, Oak Hardwood**

**Table 5: Summary of Average Field Conditions Across Stand 2**



**Stand Narrative**

Stand two is the property’s largest stand, totaling 45 acres, and is fairly heterogenous. A stream running from west to east bisects the stand, and an old woods road parallels the stream in the southern part of the stand. This trail is the primary point of access for the Sample family’s recreational use of the property. Easy access has also meant firewood harvests have been focused in this area over the years, and a commercial thinning in the southern part of this stand occurred about 10 years ago. These management activities have contributed to the variability in trees species and ages of the stand.

Red oak (30%), sugar (20%) and red maple (18%), and eastern hemlock (17%) are the dominant species, although a variety of others, including black (2%) and yellow birch (*Betula alleghaniensis*) (2%), black cherry (7%), white oak (*Quercus alba*) (4%) and occasional white pine and big tooth aspen (*Populus grandidentata*) also occur. Large red oaks are dominant in much of the canopy, with hemlock more common in the understory and midstory. Due to past harvests, the southern portion of the stand has a richer diversity of tree species and ages, including noteworthy development of both the understory and midstory, which have benefited from increased light where canopy trees were removed. The northern portion of the stand is more uniform with a single dense canopy layer and less regeneration. The majority (80%) of the growing stock is acceptable growing stock, and the stand has continued potential to manage for income.

Forest health risks include a small patch of barberry (*Berberis thunbergii*) along a portion of the stream, deer browse limiting regeneration, and forest pests. Eastern hemlock is relatively healthy in this stand though hemlock woolly adelgid is present at low levels. Red oak in the overstory is healthy and vigorous, and to date, has not been impacted by the recent spongy moth (*Lymantria dispar*) outbreak that has occurred in other areas of Massachusetts. About 50-60% of seedlings belong to at-risk species and oak regeneration is very limited.

**Terrain & Soils**

The property’s stream runs through the center of the stand at the base of a gradual depression. The southern portion of the stand is a moderate, north facing slope favoring hemlocks, especially near the stream. The northern proportion of the stand is a moderate, south facing slope. The most dominant soil complex is Marlowe-Peru, which is a rich, loamy soil complex that is well drained. Wetland areas adjacent to sections of the stream are largely composed of the Wonsqueak series which are deep, very poorly drained soils.

**Management History**

The southern portion of the stand underwent a thinning for firewood approximately 10 years ago and has been routinely harvested for firewood over several decades. The northern portion of the stand has not been recently harvested.

**Habitat**

The species diversity of the stand lends itself to productive wildlife habitat. Streamside Eastern hemlocks are important for a variety of aquatic species and support a unique microclimate in the stand’s understory. Denser sections of stand can serve as areas of refuge for wildlife, buffering them from temperature and wind extremes. Downed logs and other woody debris help to support a variety of small mammals and amphibians.

**Climate Change & Adaptation**

**Table 6: Stand 2 Climate Vulnerabilities by Forest Component**

|  |  |
| --- | --- |
| **Stand Vulnerability Rating** | **Vulnerability Time Horizon** |
| **Moderate** | **Short-Term:** Hemlock in the northern portion of the stand is more vulnerable, given drier and warmer south facing slopes; currently healthy. |
| **Long-Term:** Hemlock is likely to become more vulnerable in the long-term. Monitoring will be important. This property may serve as a refuge for hemlock on moist, north facing slopes. |
| **Forest Strata** | **Climate Vulnerability and Adaptation Options** |
| **\* Canopy** | **Vulnerabilities:** Good diversity, favorable soils and climate-adapted species means lower risk. Denser, less diverse conditions and southerly aspect in the northern portion of the stand can elevate hemlock and oak vulnerability (spongy moth and drought). |
| **Carbon:** Carbon storage is likely below potential. Reserves can promote additional storage. |
| **Adaptation:** Crop tree release to increase vigor of canopy trees, carbon sequestration, and forest structure. |
| **\* Midstory** | **Vulnerabilities:** Many climate-adapted species in the mid-story are suppressed and are less likely to survive in the absence of disturbance. |
| **Carbon:** Potential to balance sequestration and storage using crop tree release. |
| **Adaptation:** Reducing canopy density will allow for midstory development. |
| **\* Regeneration** | **Vulnerabilities:** Regeneration is less prevalent in the northern portion of the stand. Lack of oak seedlings throughout. |
| **Carbon:** Deer pressure reduces sequestration potential by suppressing regeneration. |
| **Adaptation:** Hunting could be considered on the property. Good oak seed sources enable management for oak regeneration. |

Stand two has low-moderate vulnerability to climate change. The southern portion of the stand is likely to be well buffered against the impacts of climate change due to a cooler, moister microclimate due to its north-facing slope, and because of its greater diversity of tree species and ages. This area could be managed as a refugia for existing northerly species, either through establishing forest reserves or thinning that creates better growing conditions for future legacy trees. The northern portion of the stand has a diverse mix of species in the overstory, but regeneration is lacking and southerly aspect means greater impacts from warming and drought. Supporting regeneration of young trees, and promoting climate adapted species such as oaks, can help to promote resilience within the stand.

**Desired Future Condition**

Stand two has supported the Sample family’s firewood needs and is the primary location for the family’s recreational activities. Given the relative health of much of the stand, there is an array of options for future management, ranging from the designation of forest reserves in some sections, to harvests focused in other areas. The target future condition of the stand should balance high carbon storage with supporting regeneration of climate-adapted species and diversifying the canopy through thinning that focuses growth on healthy, vigorous trees. Forest viewing areas should be protected to support recreational opportunities. Adaptive measures can promote forest health, and monitoring will be essential for early detection of threats associated with eastern hemlock and red oak. Increasing the amount of white oak on the property could be considered as a way of supporting climate-resilient biodiversity.

**Stand 3, Hemlock Hardwood**

**Table 7: Summary of Average Field Conditions Across Stand 3**



**Stand Narrative**

Stand 3 is comprised of 5 acres of Eastern hemlock forest, with few other tree species. Hemlock woolly adelgid and hemlock scale are present and have started to cause thin discolored canopies and mortality. Hemlocks on more northerly aspects have fuller canopies than those on slopes with more southerly aspects. Little regeneration is occurring in denser parts of the stand, while low levels of black birch seedlings have established in areas with canopy mortality.

The stand is composed of 92% eastern hemlock, 5% white ash, 2% black birch and 1% yellow birch in the overstory. The dominance of Eastern hemlock in the overstory and the lack of regeneration indicates a species composition that is at-risk to climate change. Without management, expect to see increasing hemlock mortality over the next decade with an increase in black birch seedlings.

**Terrain & Soils**

The stand sits at the confluence of several intermittent streams that form the headwaters of the stream. Terrain is varied with a diversity of aspects, gradual slopes, and a number of depressions. The dominant soil complex is Pillsbury fine sandy loam, which is poorly drained and vulnerable to rutting.

**Management History**

No recent management has taken place in this stand.

**Habitat**

A number of songbirds depend on Eastern hemlock, many of which show a preference for the habitat that is provided in pure hemlock stands during breeding season. Snowshoe hare, bobcats, and fishers are also supported by Eastern hemlock.

**Climate Change & Adaptation**

**Table 8: Stand Three Climate Vulnerabilities by Forest Component**

|  |  |
| --- | --- |
| **Stand Vulnerability Rating** | **Vulnerability Time Horizon** |
| **Moderate** | **Short-Term:** Hemlock trees are in decline and the impacts of climate change are already decreasing the viability of this stand. |
| **Long-Term:** Hemlock-dominated stands are unlikely to do well with climate change and will likely significantly change their composition (transition to a different forest type). |
| **Forest Strata** | **Climate Vulnerability and Adaptation Options** |
| **\* Canopy** | **Vulnerabilities:** Having a singular dominant species in the overstory limits the forest's ability to “respond” to climate change. |
| **Carbon:** Current carbon storage is extremely high, but is likely to decline with expected mortality over time. Carbon sequestration rates are already declining. |
| **Adaptation:** Reducing hemlock density will help to reduce susceptibility to disease. |
| **\* Midstory** | **Vulnerabilities:** Midstory not currently present. |
| **Carbon:** Limited vertical distribution reduces potential of stand. |
| **Adaptation:** Encourage development of a diverse cohort of midstory trees. |
| **\* Regeneration** | **Vulnerabilities:** Regeneration is inadequate. |
| **Carbon:** Sequestration potential is low. |
| **Adaptation:** Species diversity can be promoted by facilitating regeneration. |

Climate change is likely to lead to transition in this stand, as species composition shifts to a new dominant forest type over the long-term. Without intervention, black birch is likely to become the dominant species, but facilitating this transition in the short-medium term through removal of dying hemlocks can help assure the more rapid establishment of diverse and climate-adapted trees. A harvest would result in short-term carbon losses in this stand, but trees removed could become long-lived timber products, storing carbon for decades to come. Transitioning the stand to a condition that would help sustain the system long-term by creating more resilient forest conditions and increasing carbon sequestration would support the Sample family’s goals.

**Desired Future Condition**

The future condition of the stand should be focused on building resilience by reducing the density of at-risk species, primarily Eastern hemlock, and promoting diverse regeneration to encourage an uneven-aged forest with old growth characteristics over time. The small component of white ash can be retained, despite its forest health concerns, to promote biodiversity. While no invasive plants were found in this stand, barberry could enter along the stream corridor as the deep shade of the current canopy degrades. Monitoring for encroachment by invasive plants is important.

**Stand 4, Northern Hardwood (Beech-Birch-Maple)**

**Table 9: Summary of Average Field Conditions Across Stand 4**

****

**Stand Narrative**

Stand four is comprised of 30 acres of northern hardwood forest, on an elevational gradient extending from a break in slope above stands 2 and 3 to the property line on a ridge. The lower elevations are moister and somewhat enriched, supporting some white ash, along with sugar maple and yellow birch. Higher elevations are drier and rockier, with American beech being more common. Stand stocking and canopy cover are adequate with an average canopy cover of 60-70%, though canopy cover is lower at upper elevations where beech thickets are preventing other trees from reaching the canopy.  Beech bark disease has impacted most of the American beech, killing canopy stems and creating beech stump sprout thickets. The stand’s white ash are growing vigorously, though a few sections of white ash seem to be doing poorly. Emerald ash borer (*Agrilus planipennis*) has not yet been found in the immediate vicinity, but is considered a medium-term threat to the property’s white ash. The stand’s at-risk trees include American beech, white ash, black birch, and yellow birch.

The stand is composed of sugar maple (25%), red maple (24%), American beech (18%), white ash (18%), yellow birch (8%), red oak (5%), and black birch (2%), in the overstory.  The composition of the stand’s regeneration favors birch and American beech and has been impacted by deer browse. Barberry can be found in limited quantities near seeps at the stand’s lower boundary but doesn’t currently represent a major threat. Approximately 65% of the stand’s growing stock is considered acceptable.

**Terrain & Soils**

The terrain is steep in this stand, rapidly gaining elevation and reaching a rocky ridgeline that is the property’s highest elevation. Higher portions of the stand have rocky, dry soils largely comprise of the Westminster soil series. Westminster soils are somewhat excessively drained, shallow soils. These soils are more vulnerable to drought. At lower elevations, Ashfield soils that are deep and moderately- to well-drained lend some resilience to at-risk species, like ash. There are numerous seeps near the lower boundary of the stand.

**Management History**

No recent management has taken place in this stand.

**Habitat**

 The seeds of white ash, maples, oaks, and beech trees are food sources for many species, including squirrels, mice, and turkeys. White ash is also known to support porcupines and bats. Maintaining white ash on the landscape, to the extent possible, is valuable for wildlife. Protecting and promoting the few healthy beech trees remaining – those capable of producing beech nuts – would also benefit wildlife.

**Climate Change & Adaptation**

The maples that make up about half of the trees in this stand (as well as the small red oak component) shouldcontinue to support a healthy stand even with climate change. American beech and white ash are also expected to do fine with climate change but face short-term disease and pest risks that make their long-term viability in the stand doubtful. The loss of these species as canopy trees means that a climate-adapted seedling layer is important for continued stand resilience and carbon sequestration and storage. At higher elevations, drought-prone soils elevate the risk of hotter and more intense summer droughts driven by climate change. Beech thickets suppressing regeneration of other species limits biodiversity and the number of pathways through which the stand can “respond” to climate change. Removing diseased beech and planting climate-adapted species, such as oaks or possibly disease-resistant American chestnuts, would help mitigate this threat. The loss of white ash from emerald ash borer would increase vulnerability to Japanese barberry spread (and future native tree regeneration), which is currently held in check by the deep shade of a closed canopy. Monitoring both the condition of ash and the barberry populations is important.

**Table 10: Stand 4 Climate Vulnerabilities by Forest Component**

|  |  |
| --- | --- |
| **Stand Vulnerability Rating** | **Vulnerability Time Horizon** |
| **Moderate** | **Short-Term:** Beech bark disease is suppressing regeneration; combined with drought prone soils, this puts higher elevations at risk. Emerald ash borer threatens ash at lower elevations. |
| **Long-Term:** The trajectory of summer drought will alter stand vulnerability. |
| **Forest Strata** | **Climate Vulnerability and Adaptation Options** |
| **\* Canopy** | **Vulnerabilities:** Loss of canopy trees associated with beech thickets and emerald ash borer elevate the risk of this stand. |
| **Carbon:** Carbon storage is below its likely potential. |
| **Adaptation:** Reduce dominance of diseased American beech and support drought resistant species. |
| **\* Midstory** | **Vulnerabilities:** Birch species do well in the mid-story but are vulnerable to the impacts of climate change in the longer term. |
| **Carbon:** Continued development of midstory will increase carbon storage and sequestration, except where dominated by beech. |
| **Adaptation:** Monitor for signs of birch decline. |
| **\* Regeneration** | **Vulnerabilities:** Drought resilient species are not regenerating adequately, particularly in competition with beech. |
| **Carbon:** American beech has limited mitigation potential given its decline. |
| **Adaptation:** Facilitating regeneration in dense beech thickets, including oaks and potentially disease-resistant American chestnuts. |

**Desired Future Condition**

The American beech thickets at higher elevations are the most immediate threat to the Sample family’s goals of promoting resilience, carbon storage, and recreational opportunities. The decline of American beech and the exclusion of other regeneration represent a loss of biodiversity and carbon sequestration and storage potential. The thickets have also impacted aesthetics and made it difficult to reach a property overlook that has been a frequent destination of the Sample’s recreational outings.  The future condition of the stand should remedy those concerns by reducing diseased American beech density, while protecting healthy beech and promoting other climate-adapted species. White ash is a valuable part of the stands composition but may need to be managed to mitigate risk.

**Management Recommendations**

For the purposes of this report, management practices with an object code of ‘CH61’ are required to be accomplished as a commitment to the Massachusetts Current Use Program. Practices with object codes of ‘STEW’ are voluntary and are provided as suggestions of activities that can help you achieve your woodland objectives.

| **Stand(s)** | **Obj Code** | **Goal** | **Practice** | **Timing** | **Climate Benefits** | | **Value/Cost/Cost Share** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Resilience** | **Carbon** |
| 1 (2,3) | STEW | Suppress or eradicate invasive plants | Remove invasive vegetation | 2023 - 2025 | Improves regeneration capacity of forest | Increase carbon sequestration in native trees | Cost  Potential NRCS cost-share |
| 4 | STEW | Minimize damage from forest pests | Beech brush treatment | 2023 | Reduce competition for healthy native trees | Increase carbon sequestration of healthy native trees and stability of carbon stocks | Cost  Potential NRCS cost-share |
| 2,4 | STEW | Sequester and/or store carbon to mitigate climate change | Establish forest reserves | 2023 | Develop old-growth characteristics in healthy sections of stands | Maintain high carbon storage in areas with low vulnerability to climate and other stressors | Minimal cost associated with marking areas  Lost income through not harvesting |
| 1 | CH61 | Enhance the quality and/or quantity of forest products / Minimize damage from forest pests | Facilitate forest transition to better match future conditions (Transition) | 2025 - 2027 | Create conditions for establishment of diverse climate-adapted native tree regeneration | Convert dying trees into long-lived forest products to capture stored carbon / Enhance carbon sequestration in regenerating stands | Value of harvested trees |
| 3 | STEW | Minimize damage from forest pests | Facilitate forest transition to better match future conditions (Transition) | 2025 - 2027 | Create conditions for establishment of diverse climate-adapted native tree regeneration | Enhance carbon sequestration in regenerating stands | Cost  Potential NRCS cost-share |
| 2 | CH61 | Enhance the quality and/or quantity of forest products / Increase forest resiliency | Enhance adaptive capacity in forests (Resilience) | 2025 - 2027 | Enhance growing conditions for most vigorous trees of all species while enhancing structural complexity | Increase sequestration rate and long-term carbon storage potential | Value of harvested trees |
| 1 (3,4) | STEW | Promote diversity of plant species and habitat types | Plant trees to increase forest stocking / Protect seedlings and saplings from deer browse (tree tubes) | 2026 -2028 | Ensure a diversity of climate adapted trees establish in regeneration stands and enhance diversity in vulnerable areas | Increase long-term carbon sequestration and stability of carbon storage | Cost  Potential NRCS cost-share |
| 1 | STEW | Promote diversity of plant species and habitat types | Protect seedlings and saplings from deer browse (exclosure) | 2025 - 2028 | Ensure a diversity of climate adapted trees establish in regeneration stands and enhance diversity in vulnerable areas | Increase long-term carbon sequestration and stability of carbon storage | Cost  Potential NRCS cost-share |
| All | STEW | Protect water quality / Improve access for walking/skiing/ recreation | Climate-informed forest access and forestry operations | 2023-2032 | Protect soils, water resources, and residual stand during management practices to ensure forest vigor | Protect soil carbon stores | Cost  Potential NRCS cost share  Ensured through strong harvest contract conditions |
| All | STEW | Minimize damage from forest pests / Increase forest resiliency | Respond to disturbance | 2023 – 2032 | Monitor forest health threats and forest condition to ensure prompt response to disturbance to maintain resilience | Maintain carbon stores and sequestration potential | No/minimal cost  Time investment of landowner |

**Practice: Remove Invasive Vegetation**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Objective** | **STD #** | **Goal** | **Manag. Practice** | **Extent** | **Climate Benefits** |
| **STEW** | **1,2,4** | **Suppress or eradicate invasive plants** | **Remove Invasive Vegetation** | **Most dense and widespread in ST-1, scattered barberry along stream and seeps in ST-2 and ST-4** | **-Greater regeneration potential reduces disturbance impacts**  **-Treatment improves sequestration potential**  **-Reduced impacts on hydrology protect the system’s ability to accommodate extreme weather events** |

**Practice Summary:** A combination of mechanical and chemical treatments will be used to address dense concentrations of bittersweet, honeysuckle, buckthorn, and barberry as needed. More isolated occurrences that are likely to spread following harvest will also be treated.

**Practice Timing:**  Treatment of invasive species should take place prior to harvest and as a follow-up to harvest as needed. Multiple treatments are likely to be needed and will take place across 2023-2025. Consider reaching out to your forester when you are ready to move forward with your project.

**Practice Specifications:**  Invasive species are not only ecologically and aesthetically harmful, but they also have the potential to reduce the effectiveness of the other management practices recommended in this plan. Often, eradication of these species is not possible (which is certainly the case in ST-1), but suppression helps to limit their impacts and ensure that complimentary practices, including those designed to promote regeneration, achieve the desired outcomes. Treatments will help to promote tree regeneration, biodiversity, and forest aesthetics while protecting the system’s ability to cope with climate extremes.

Treatment will be concentrated in ST-1 where invasive species density will need to be reduced to below 10% of the stand’s composition and be maintained at that level for several years with chemical control. ST-1 treatments will help to ensure a successful transition of the stand. Less intensive, spot treatments of barberry can effectively prevent the spread (or potentially eradicate) its presence in ST-2 and ST-4. While not currently present in ST-3, invasive plants could move along the stream corridor to this stand and should be monitored.

**Operational Considerations:**  Herbicides should be applied by a licensed applicator. A combination of hack and squirt (the plants stem is cut and sprayed with herbicide) and cut stump (the plant is cut to the ground and herbicide is applied to the stump) treatments can help to reduce the amount of chemical needed and isolate its impacts to the treated plants. Monitoring following a harvest can help to identify the extent to which a follow-up treatment is needed.

Barberry populations in ST-2 and ST-4 could likely be treated mechanically, but manual treatment can be both expensive and time consuming. Small chemical applications can reduce those inputs. Special consideration should be given to protecting soil and water quality in the wetland soils of ST-2, where the current barberry population is. Approved chemicals from the Massachusetts Sensitive Areas Materials List (<https://www.mass.gov/service-details/rights-of-way-sensitive-area-materials-list>) are safe for applications in these areas.

**Practice: Beech Brush Treatment**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Objective** | **STD #** | **Goal** | **Manag. Practice** | **Extent** | **Climate Benefits** |
| **STEW** | **4** | **Minimize damage from forest pests** | **Beech brush treatment** | **Dispersed treatment of beech thickets across ~5-10 acres** | **-Promotes the system’s resilience by favoring healthy species**  **-Supports diverse regeneration, improving resilience**  **-Reduces carbon losses associated with BBD** |

**Practice Summary:** Girdling and/or chemical treatments can be used to reduce the density of beech brush thickets. These practices will lead to the mortality of diseased beech and promote a more diverse forested stand.

**Practice Timing:** Beech bark disease (BBD) is less severe than some of the other forest health and climate threats to the site; if funds are limited the landowner may choose to prioritize other practices. However, early treatment (2023 suggested) is likely to reduce future costs and will support the landowner’s climate, diversity, and forest health goals.

**Practice Specifications:** American beech creates clones of itself, particularly when stressed. Through this clonal process, BBD is spread throughout the thicket. As a result, beech thickets may degrade the stands condition by reducing biodiversity and preventing the regeneration of healthy trees and its ability to recover from more severe, climate-driven disturbances. Chemical treatment is typically the most effective way of treating beech thickets, particularly in harder to access areas. In this instance, the Sample family may choose to combine a chemical treatment with girdling of larger diameter beech trees. Girdling will promote wildlife habitat and can increase the length of time that carbon is stored in the system, while plantings become established.

**Operational Considerations:** Herbicides should be applied by a licensed applicator. The stand’s beech thickets can be hard to access which is likely to increase the cost of treatment. Thickets that are more accessible can be prioritized for treatment.

**Practice: Establish Forest Reserves / Deferred Harvest**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Objective** | **STD #** | **Goal** | **Manag. Practice** | **Extent** | **Climate Benefits** |
| **STEW** | **2, 4** | **Sequester and/or store carbon to mitigate climate change** | **Establish forest reserves** | **-Designate 10 ac of ST-2 and 10 ac of ST-4 as reserves** | **-Allow for the establishment of old-growth conditions over the long term, maximizing carbon benefits**  **-Maintain soil carbon in steep/wet areas that would be difficult to protect from forest operations** |

**Practice Summary:** Identifying and marking no harvest areas.

**Practice Timing:** Areas should be clearly marked prior to any harvests occurring (before 2025).

**Practice Specifications:** Forest reserves are areas that are designated where active management is not needed; this may be temporary or permanent. Temporary reserves are areas where harvest activities will not take place during the current management cycle (the 10-year life of this forest stewardship plan) and can be re-evaluated when the plan is renewed. Temporary reserves can also be designated for the length of ownership of the current owner. Limited temporary reserves are generally permitted for properties under Ch 61. The DCR Service Forester for your region can provide guidance on how designating reserves may impact your Ch 61 agreement. Permanent reserves are designed to exist in perpetuity and are often enforced through a mechanism such as a forever wild conservation restriction held by another party such as a land trust. Permanent reserves may impact Ch 61 eligibility. For the purposes of this plan, temporary reserves are recommended.

In reserves, monitoring, intervention in the event of extreme disturbances (see ‘Respond to Disturbance’ practice), and as needed invasive species treatment are the best strategies for management. This approach, while hands off, will still allow for the establishment of the Sample family’s desired future condition because the productive, low vulnerability areas of ST-2 and ST-4 are expected to continue to be self-sustaining. It should be noted that this practice does remove the potential of timber revenue generation from these locations.

Several locations in ST-2 are likely to provide Eastern hemlock with valuable protection from the worst impacts of climate change. North facing slopes with moist soils should be a priority for reserves as they are more likely to maintain the eastern hemlock component the forest over the longer term. Steep areas as well as wetlands in both ST-2 and ST-4 are also good candidates for reserves. These areas are also likely to have greater impacts associated with forest operations. Limiting operation in these reserves will help to protect water quality and wetland communities that have higher levels of soil carbon storage.

**Operational Considerations:** Reserve areas should be clearly marked to avoid accidental incursion during a timber harvest. For temporary reserves, flagging and/or paint is sufficient. For permanent reserves boundary tags may be preferred.

**Practice: Plant trees to increase forest stocking &**   
**Protect seedlings and saplings from deer browse (tree tubes)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Objective** | **STD #** | **Goal** | **Manag. Practice** | **Extent** | **Climate Benefits** |
| **STEW** | **1, 3, 4** | **Promote diversity of plant species and habitat types** | **Plant trees to increase forest stocking &**  **Protect seedlings and saplings from deer browse** | **-Dispersed planting across 55 acres.** | **-Ensure the establishment of a diverse forested system and promote successful regeneration**  **-Increase long-term carbon sequestration and stability of carbon storage** |

**Practice Summary:** Planting climate adapted tree species and protecting them from deer herbivory helps to both facilitate transition to a better adapted forest type as well as to more rapidly increase carbon sequestration and storage.

**Practice Timing:** Planting should occur following harvest and any necessary follow-up invasive species treatment (2026-2028). Planting should occur in spring or fall in order to improve survival rates.

**Practice Specifications:** Transitioning stands (ST-1 and ST-3) should be prioritized for planting. Red and white oak should be planted, potentially with a mix of other climate-adapted species, to assist the transition to a more climate-adapted forest type. Plantings should be clustered in areas of high light availability, optimal spacing will be site-specific.

The Sample family may also consider planting in ST-4 following beech treatments. The planting can be designed to promote not only more climate-adapted species but species that are competitive enough to limit the reestablishment of beech, including species such as red maple and various native shrubs.

Tree tubes will be needed to protect planting from herbivory. Tree tubes should be 5’ in height and staked on both sides to improve durability. Mesh tree tubes and bamboo stakes should be avoided.

**Operational Considerations:**  The selection of appropriate tree stock is important. Stock should either be sourced from a nursery that prioritizes genetic diversity and/or sourced from multiple nurseries. Stock should be sourced from either a local source or a source that is matched to near-term projections of local climate.Larger stock with a good root-shoot ratio should be used for its improved tolerance of drought and wind.

Plantings and tree protection are optimized with maintenance which can be performed by the Sample family. Considering the accessibility of planting locations will be important if the family intends to maintain the plantings. Plantings that are within deer exclosures in ST-1 will not need tree tubes, but should be monitored for exclusion by competing vegetation and small-herbivore damage.

Some soil preparation may be needed in ST-3 given the thickness of the duff layer (decaying matter on the ground below trees) associated with Eastern hemlock-dominated stands. Hand preparation of the planting area is time intensive but can minimize soil carbon losses.

**Practice: Protect seedlings and saplings from deer browse (exclosure)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Objective** | **STD #** | **Goal** | **Manag. Practice** | **Extent** | **Climate Benefits** |
| **STEW** | **1** | **Promote diversity of plant species and habitat types** | **Protect seedlings and saplings from deer browse (exclosure)** | **-Extent will depend on landowner preferences.**  **-Fencing should be located around all/portions of harvested patches.** | **-Reduced herbivory will allow for a more rapid increase in carbon sequestration**  **-Fencing some harvested sections will help to create more diverse stand conditions, improving resilience** |

**Practice Summary:** Fencing (exclosures) will be used to exclude deer from harvested patches. This will promote the regeneration of a greater number of species over a shorter period of time.

**Practice Timing:** Fencing should be erected soon after the harvest in ST-1 takes place when conditions allow. Recommended 2025-2028 depending on harvest timing.

**Practice Specifications:** Either high tensile fencing or plastic mesh fencing will be placed around all or portions of created patches. Harvests located in areas of the stand that show the most signs of deer pressure should be prioritized for fencing. Fencing large areas tends to be more economical with a greater rate of return, larger two-acre patches may be a priority for fencing with smaller patches left unprotected.

**Operational Considerations:** Monitoring and maintenance of fencing either by the landowner, forester, or other contractor. ST-1 is relatively accessible, but the most accessible patches could still be prioritized for ease.

Additional brush clearing around the fence perimeter may be necessary. Fence must be installed with sufficient height; 7 ft is recommended but typically increases the costs over a more typical 5 ft installation.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| OBJ | STD NO | TYPE | SILVICULTURAL PRESCRIPTION | AC | TO BE REMOVED | TIMING |
| CH61 | 1 | WP | Group Selection (Patch cuts) with Commercial Thinning | 15 | 193 sq ft/ac (Patches) 60 sq ft/ac (thinning) 85 MBF | 2025-27 |

**Practice: Facilitate forest transition to better match future conditions (transition)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Objective** | **STD #** | **Goal** | **Manag. Practice** | **Extent** | **Climate Benefits** |
| **CH61** | **1** | **Enhance the quality and/or quantity of forest products/**  **Increase Forest Resilience** | **Facilitate forest transition to better match future conditions (Transition)** | **-Distributed across ~15 acres with a 5-acre buffer around residence**  **- Target basal area of ~130 sq.ft./acre**  **-<30% of stocking removed** | **-Increased tree diversity will buffer against the impacts of climate change**  **-Regeneration harvest can help to better prepare a stand for extreme disturbances.**  **-Promoting large, more vigorous trees will enable greater levels of carbon storage in the long term** |

**Practice Summary:**  A transition harvest will be conducted to promote regeneration of a diversity of tree species and reduce the prevalence of unhealthy white pine. A combination of variable sized patch cuts with thinning from below in between will help to create diverse forest conditions for regeneration and planting.

**Practice Timing:** Harvest in ST-1 should be prioritized to address vulnerability (2025-2027). Sufficient invasive species treatment must be completed prior to harvest and follow-up treatment will be required. Consider reaching out to your forester when you’re ready to move forward.

**Practice Specifications:** The combination of patch cuts and thinning from below will create a diverse matrix across the stand. Harvest will need to be intensive enough to allow for the removal of significant numbers of unhealthy trees while enabling regeneration of climate-adapted tree species that require more light. This will lead to near-term carbon storage losses, but will improve carbon sequestration rates and improve carbon storage in the long-term. To the extent possible, patches (small areas where 100% of trees will be removed) should be placed on south and west facing slopes (to favor oak regeneration) in areas where the greatest number of poorly formed/unhealthy white pines are located. Patches will vary in size from .5 acres to 2 acres with a total harvest area of 5-7 acres. Adequate establishment of climate-adapted species is likely to require planting in ST-1 (see plant trees to increase forest stocking description).

Thinning in between patches can help to promote healthy white pine and release suppressed hardwoods. Black cherry, a climate-adapted species, should be kept whenever possible. Thinning should be concentrated around well formed, healthy white pine and existing climate-adapted species. The mean stand diameter of 13 inches should be maintained or only slightly decreased to sustain carbon stocks and promote large diameter trees. Stocking in the thinned portion of the stand should be kept above the b-line with a target residual basal area of approximately 130 sq. ft.

**Operational Considerations:** ST-1 is relatively easy to access but soil protection will be important given the legacy of soil compaction from farming. Preventing additional compaction can help to prevent harmful alterations in hydrology or regeneration potential that could make the site less resilient.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| OBJ | STD NO | TYPE | SILVICULTURAL PRESCRIPTION | AC | TO BE REMOVED | TIMING |
| STEW | 3 | HH | Single Tree and Group Selection | 5 | 20 sq ft/ac  0.5 cords 5 MBP | 2025-27 |

**Practice: Facilitate forest transition to better match future conditions (transition)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Objective** | **STD #** | **Goal** | **Manag. Practice** | **Extent** | **Climate Benefits** |
| **STEW** | **3** | **Enhance the quality and/or quantity of forest products/**  **Increase Forest Resilience** | **Facilitate forest transition to better match future conditions (Transition)** | **-Dispersed across 5-acres**  **- Single tree and small group selection with no more than 10% removal** | **-Increased tree diversity will buffer against the impacts of climate change**  **-Promoting large, more vigorous trees will enable greater levels of carbon storage in the long term** |

**Practice Summary:** Non-commercial, single tree and small group selections will help to assist the transition of this stand. Most felled trees will be left behind to reduce herbivory and protect plantings.

**Practice Timing:** Harvest in ST-1 should be prioritized to address vulnerability (2025-2027) and partnered with tree planting to take advantage of felled trees.

**Practice Specifications:** ST-3 is relatively small and difficult to operate in, yet the vulnerability of the stand and its importance to the Sample family warrants intervention. Low intensity, non-commercial single tree selections that target the poorest quality Eastern hemlock will be used to assist the stand’s transition and reduce the dominance of Eastern hemlock. Thinning around occurrences of healthy black cherry and maple trees including the removal of birch and Eastern hemlock will also be used to help promote resilience within the stand and support tree vigor. Most downed trees will be left behind to deter herbivory and protect plantings that will help to bolster species diversity. The marking of trees to be cut should consider operating conditions while removing diseased Eastern hemlock.

This low-intensity harvest will have limited impacts on carbon storage which are likely to be recovered relatively quickly. It will also decrease the risk of rapid carbon loss associated with the stand’s vulnerability to climate and forest health impacts.

**Operational Considerations:** Soils in ST-3 are particularly fragile. Small scale, sensitive operations like this are best done without the use of large machinery. Appropriate siting can also help to protect the highest risk soils. Where feasible, without crossing sensitive soils, felled trees may be removed in conjunction with the commercial thinning in ST-2. However, most felled trees should be left behind rather than removed for sale to protect the sensitive soils from damage.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| OBJ | STD NO | TYPE | SILVICULTURAL PRESCRIPTION | AC | TO BE REMOVED | TIMING |
| CH61 | 1 | OH | Crop Tree Management | 35 | 20 sq ft/ac  27 MBF | 2025-27 |

**Practice: Enhance adaptive capacity in forests (resilience)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Objective** | **STD #** | **Goal** | **Manag. Practice** | **Extent** | **Climate Benefits** |
| **CH61** | **2** | **Enhance the quality and/or quantity of forest products/**  **Increase Forest Resilience** | **Enhance adaptive capacity in forests (Resilience)** | **-Distributed across northern and southeastern portions of stand (~35 acres)**  **- Target basal area of ~115 sq.ft/acre**  **-10-15% of stocking removed** | **-Promote structural diversity and storm resilience**  **-Promote vigor and resilience for individual focal trees**  **-Sustain regeneration while minimizing carbon losses** |

**Practice Summary:** A resilience harvest will be conducted to reduce competition among large-diameter trees and to reduce the risk associated with pests and pathogen threats in the stand. A variation of a crop tree release (thinning around priority trees to promote their health and vigor) will be used with some commercial timber removal.

**Practice Timing:**  ST-2 is a lower vulnerability stand; however, reducing forest health threats to Eastern hemlock and oak species on your property will help to assure your forest health and carbon goals are met. Consider reaching out to your forester once you are ready to proceed and discuss the prioritization of projects.

**Practice Specifications:** A crop tree release will be concentrated in the northern portion of ST-2 that has not been recently harvested. The harvest will be designed to reduce the more homogenous conditions that are found in the northern portion of the stand. The crop tree release will be a low-intensity harvest that reduces the stands stocking by 10-15%. A diversity of healthy, well-formed trees will be promoted as crop trees to maintain biodiversity with the prioritization of oak and Eastern hemlock. Harvest of pole-sized trees will focus on reducing the dominance of at-risk species in the lower strata, including birch species with some removal of eastern hemlock being acceptable. Reducing the dominance of at-risk trees helps to assure the stand’s next generation of trees are more likely to cope better with climate change. Pole and sawtimber sized maples, oaks, and black cherry will be harvested on a more limited basis but as appropriate to promote the health and vigor of focal trees.

This low-intensity harvest will have limited impacts on carbon storage, which are likely to be recovered relatively quickly and will improve carbon sequestration rates in the near-term. It will also decrease the risk of rapid carbon loss associated with the stand’s vulnerability to climate and forest health impacts while locking away carbon in wood products.

**Operational Considerations:**  Equipment will need to cross the stand’s stream and protections will need to be installed (see ‘Climate Informed Access’ practice description). Entering further west, towards ST-3, will require equipment to travel a further distance, but will help to avoid the stand’s wetland communities as well as areas that are likely to be designated as reserves. This entry point will also help to minimize the risk of spreading invasive barberry.

The intensity of thinning should be higher in the immediate proximity of oak trees in order to effectively promote resilience against spongy moth, while less intensive thinning will be needed in the immediate proximity of Eastern hemlock.

**Practice: Climate-informed forest access and forestry operations**

**Practice Summary:** Climate-informed forest access and forestry operations are enhanced best management practices that help to protect soil and water quality during and after forest operations. Best management practices (BMPs) are climate-informed when they consider the increasing impacts of climate change on a site and design practices to meet those challenges.

**Practice Timing:**  Best management practices are a continual consideration when stewarding forests. By law, BMPs must be implemented during any harvest, and are especially important when any forest work involves large machinery that can move or damage soils, wetlands, and water bodies. This begins with planning the layout for harvests and other practices and ends with the closeout of work to ameliorate any impacts. Some BMPs, such as waterbars, need regular maintenance after closeout, and monitoring of forest infrastructure should be done on an annual basis.

**Practice Specifications:**  The next step towards implementation of your stewardship plan will be an operational plan. Operational planning will allow for the careful siting of each management practice to reduce impacts and address vulnerabilities. Specific best management practices will be detailed during that process. These will include the location and layout of a log landing and forest access roads (skid trails) to minimize impact on soils and water resources, the locations for the installation of waterbars, timber mats and stream crossings, and a plan for maintaining and closing out BMPs. A temporary bridge will be used to cross the stream to access the northern section of ST-2. Timber mats will be used in areas with persistently wet soils. Waterbars will be installed to direct water off skid trails, following specifications in the Massachusetts [BMP](chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https:/www.mass.gov/doc/massachusetts-forestry-best-management-practices-manual-0/download) manual.

The existing forest road through the Sample property should be used for access to complete the recommended management practices and for transporting any logs to be removed. Repair of this road where existing erosion issues occur (see Figure 2 map) will be necessary before use. It is recommended to retire the section of the road through and beyond ST-3 to vehicle traffic. This area has wet and unstable soils, and there are several points where the road has been washed out, capturing small intermittent stream channels and redirecting storm water down the road. The planned harvest and BMP implementation would provide an opportunity to repair the hydrology of this area, which would have benefits for water quality.

**Operational Considerations:**  BMP implementation must follow specifications in the Massachusetts Forestry Best Management Practices Manual. This includes following all required BMPs (designated by ‘R’ in the manual) and should also include additional guidelines (designated by ‘G’ in the manual). NRCS programs can often be used to help fund BMPs and have additional guidelines. Other state programs may also provide funding and have additional requirements. An operational plan will describe practice specifications, costs, funding sources, and funding program requirements.

**Practice: Responding to Disturbance**

**Practice Summary:** Monitoring your property regularly is key for identifying and responding to disturbances that threaten your forest. Responding to high intensity disturbances by using one or more resilience or adaptation practices to aid in post-disturbance recovery can assure that forests are kept as forests, that climate adaptation is facilitated, and that carbon losses are mitigated by increasing carbon sequestration and reducing the amount of time the system will take to build up carbon storage (such as through planting and herbivory reduction).

**Practice Timing:**  Aim to visit all areas of your property at least annually and visit locations more vulnerable to disturbance as soon as possible after a disturbance event.

**Practice Specifications:** Small-moderate disturbances are a natural and important part of the forest cycle. In stands that are healthy, have low vulnerability, and are self-sustaining (particularly those set aside as reserves) no response is necessary. However, responding to extreme disturbance will allow the Sample family to protect ecosystem services that promote their goals under circumstances where forest conditions have been highly degraded.To effectively respond to disturbance, ongoing monitoring is needed. Disturbances to pay attention to include extreme weather, such as heavy precipitation that can cause erosion, high winds and ice and snow loading that can break limbs and topple trees, forest pests and pathogens that can diminish tree vigor and kill trees, intrusions by invasive plants that compete with native plants, and increases in browsing by deer or other animals that decrease tree seedling and sapling survival.

**Operational Considerations:**  Anticipating forest threats and actively managing your forest to prevent these threats from harming forest health is the best way to avoid needing to respond to disturbance later. A healthy forest will be able to absorb most of the typical natural disturbances in our region without major impacts to forest processes. This stewardship plan identifies many of the vulnerabilities to climate change and other stressors the Sample forest is currently facing. Following the recommendations will help you proactively avoid the worst effects of major disturbances. However, some disturbances will still require a quick response. Routine monitoring of your forestland will help you notice when disturbance impacts occur. Contact your forester when you see something that concerns you to so that they can evaluate and plan for a response as necessary.