Allen-Whitney Memorial Forest, Maine

Climate Change Adaptation Plan

Manomet Center for Conservation Sciences

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May 2013

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Suggested citation: Wilkerson, E., Sartoris, J., 2013. Climate Change Adaptation Plan for Allen Whitney Forest, Maine. Manomet Center for Conservation Sciences, Plymouth, MA.

Support for this project was provided by The Kresge Foundation and Dorr Foundation.

This report is available for download at: http://www.manomet.org/climate_solutions/Allen_Whitney.pdf


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Site Description and History

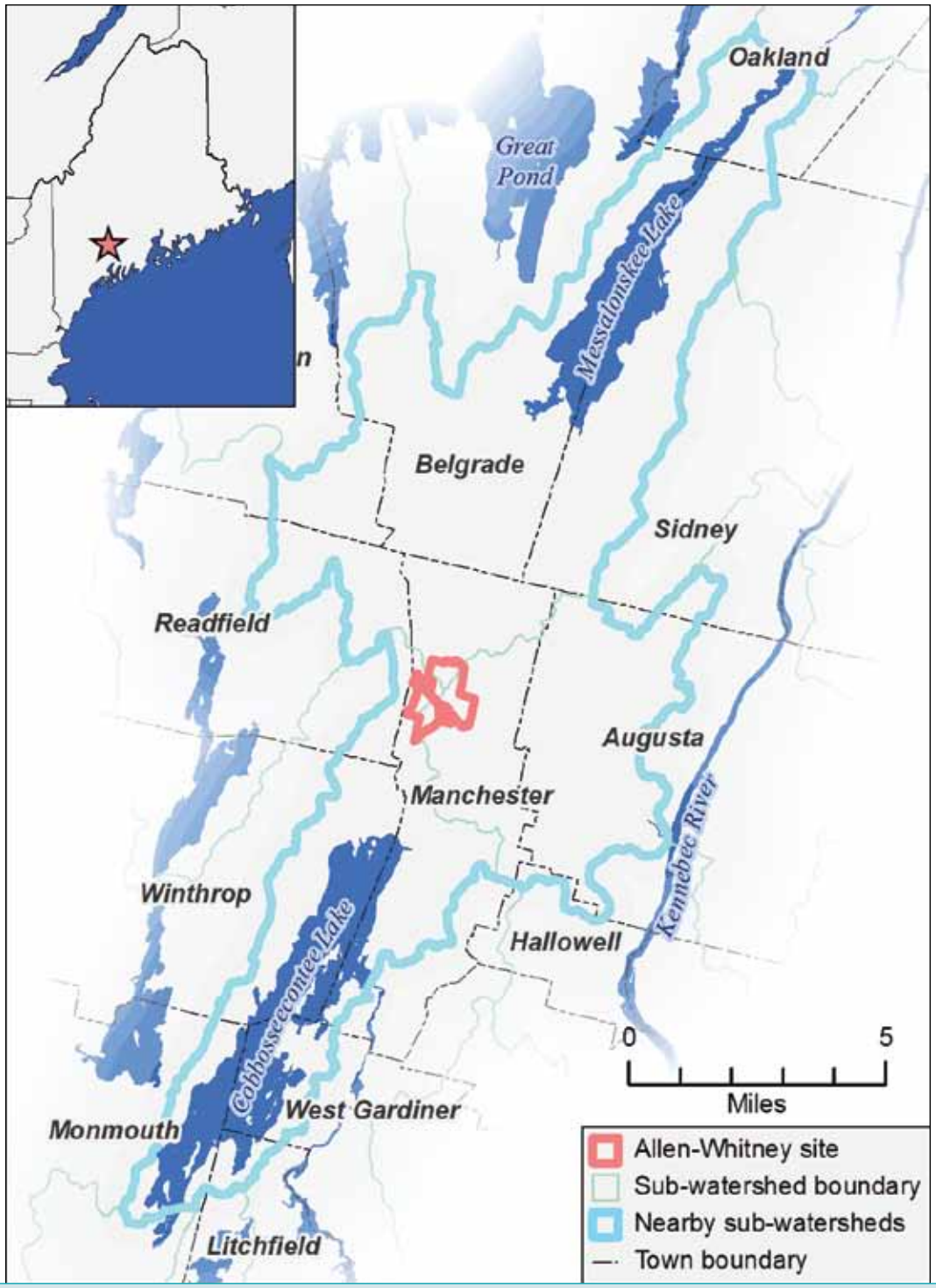
Allen-Whitney Memorial Forest (AWF) is a 700 acre parcel in Manchester, Maine owned by the New England Forestry Foundation (Map 1). Since being donated by Edward Allen-Whitney 60 years ago, the land has been sustainably managed for timber products including lumber, wood pulp, and as a biomass energy source. The Forest also provides important wildlife habitat, public recreation opportunities, and a setting for NEEF to run educational and stewardship programs regarding forests and forest management. Allen-Whitney Memorial Forest property is protected from future development, and will remain forest into the foreseeable future.

The composition and topography of the Allen-Whitney Forest is typical of central Maine, with rolling terrain rising from 250 feet to 640 feet in elevation at its highest point. The predominant forest type is a mix of hardwoods and softwoods comprising 277 acres. Hardwood stands (i.e., sugar maple, beech, ash, red oak) occupy 171 acres and softwoods (i.e., white pine, hemlock, spruce, fir) make up approximately 187 acres. The property also contains approximately 66 acres of pine plantations, planted in the 1950's and 1960's under the federal government's Soil Bank Program. The Forest has a large proportion of mid-sized trees (40% pole size; 31% saw log size); a small proportion of smaller, younger trees (17%), and very few large, old trees (6%).

The Allen-Whitney property also includes the eastern shore of Shed Pond, a 50-acre shallow pond with an undeveloped shoreline. There are small complexes of forested wetlands associated with Shed Pond and approximately four acres of non-forested wetland on the property. As there are only a few small drainages, stream habitat is limited; although Shed Pond flows south through Mears Brook and eventually reaches Cobbossee Lake.

These different systems provides habitat for forest generalist species, and the Pond's shores are also home to a plant species of special concern, broad beech fern. Several non-native invasive plant species grow on the parcel including Japanese barberry, multifloral rose, and shrub honeysuckle. These species are concentrated along old roads that transect the property but barberry has expanded beyond road beds into a recently-harvested stand.

The Forest also holds value for the Town of Manchester and its community. In 2004, the Town adopted an open space plan that identifies a suite of properties around and including the Allen-Whitney Forest as priorities for the conservation and public access trails. Additionally, the Kennebec Land Trust acquired parcels adjacent to the Forest to help conserve and connect the woodland and wetland habitat and further preserve the water quality of Shed Pond. The community itself is also involved in operations of the Forest, for example volunteer stewards handle daily oversight and management of the property; and the local snowmobile club is responsible for trail maintenance and safety. Allen-Whitney permits public access during all four seasons to a trail network encompassing all of the properties.



MAP 1

Map 1. Location of the Allen-Whitney site and the surrounding sub-watersheds in southern Maine.

Management Goals

Forestry is a traditional land use in Maine weathering many economic shifts in the past. Forest cover has increased in Maine over the past 50 years, as former agricultural lands have gone fallow and converted back to forest. Climate change brings challenges and opportunities for NEFF to help lead future practices in sustainable forestry's climate change adaptation.

The New England Forestry Foundation is dedicated to preserving New England's working forests through conservation and ecologically sound forest management. NEFF manages 130 demonstration forests (23,000 acres) and holds 125 conservation easements (1,138,000 acres). The Foundation's specific management goals outlined below reflect the desired future condition of the property over the next 100 years; and were the focus when selecting climate change adaptation strategies in this document.

- Protect and Maintain Natural Resources: Allen-Whitney Forest provides a mix of native trees and associated wildlife habitat, contributes to clean air and water, and other ecosystem services delivered by its systems. The site also provides habitat for wildlife, including deer, moose, loons, and diverse assemblages of migratory birds; and 15 percent of the Forest is considered Deer Wintering Area (DWA), designated as Significant Wildlife Habitat by the Maine Department of Inland Fisheries and Wildlife (IFW).
- Continue to Manage the Forest as a Source of Timber Products: NEFF manages the property for forest products production, and employs sustainable timber harvesting practices approved by the Forest Stewardship Council (FSC) and American Tree Farm (ATF). These organizations provide third party verification that harvesting operations are conducted in a manner consistent with maintaining the current and future biological, economic, and societal benefits of healthy forests.
- Provide Education and Recreation Opportunities: Recreation and public education are central to NEFF's mission. Passive recreation (e.g., wildlife viewing, hiking, snowshoeing, skiing) and hunting (e.g., deer, waterfowl, small mammal) are allowed. For example, there are trails for hiking, cross-country skiing, snowshoeing and snowmobiling. Educational opportunities include NEFF sponsored educational walks covering timber management, forest ecology, and birding.

Climate Change Vulnerabilities and Allen-Whitney Memorial Forest

Changes in climate will have significant implications for forests and how forests are managed in Maine. As detailed below, alterations in temperature and precipitation patterns may:

- Shift distributions of tree species and wildlife habitats northward or upslope – Changing temperature and precipitation may shift the distributions of species at both global and local scales.[1] Forest types in the Northeast are predicted to significantly change in the next 100 years under every atmospheric emissions scenario.[2] Habitat for several important species in Maine are projected to decline including: sugar maple, red maple, black cherry, balsam fir, red spruce, yellow birch, paper birch, quaking aspen, eastern hemlock, American beech, and white ash.[3] A few "southern" species are expected to extend their ranges northward and upslope, including both red and white oak.[4] The distribution of white pine is expected to contract across New England primarily in the southern portion of the range.[5] Maine is at the northern edge of the current distribution and white pine will likely grow and thrive for at least the next 100 years.

- **Increase the frequency and magnitude of disturbance events** – The distribution of forest habitats is expected to change slowly in response to climate change because canopy trees are long lived, slow to extend or contract their ranges, and can tolerate environmental stress. However, more rapid transformations could occur due to changes in disturbance regimes.[6 7] This includes the frequency and magnitude of storms, periods of extreme heat, droughts, fires, insect or disease outbreaks that may increase under a changing climate.[8 9] These disturbance events can damage canopy trees resulting in their injury or death and loss of economic value. For instance, in the United States each year ice and wind storms damage 4.5 million acres of forests and costs landowners $860 million dollars.[10 11 12 13] As the frequency and intensity of disturbance events increases, the number of acres impacted and financial costs will also rise dramatically.

- **Introduce new invasive species and/or intensify the impacts of invasive and non-native plant and pest species** – Non-native plants, pests, and pathogens are a significant threat to the ecology and financial stability of forests. It is estimated introduced pests and pathogens result in the loss of $2.1 billion dollars of forest products per year in the United States.[14] Climate change is predicted to introduce new and/or intensify negative effects of existing non-native plants, pests, and pathogens.[15 16 17] For example, the frequency of extreme weather events can stress native plants and favor establishment and growth of invasive species,[18] increased temperatures will expand the geographic range of non-native species that were previously limited by climatic conditions,[19 20] and non-native species can out-compete native seedlings and saplings and quickly colonize areas more easily following timber harvests or natural disturbances.[21] These threats can result in direct mortality of trees and plants, and reductions in growth and fitness, putting forests across Maine at risk of wide-spread disturbances in forest cover and associated alterations in plant community composition, reduced quality and quantity of wildlife habitat, and loss of timber revenue.

- **Alter the economic contributions of forests to the economy** – The most immediate financial impact of climate change are reductions in the number of days with frozen ground, reducing the time period with conditions favorable to harvesting and transportation of wood.[22] Increased precipitation and storm events will impact the condition of road networks and stream crossing structures[23] and increased frequency of large disturbance events[24 25] may increase risk of damage to financially mature stands. These changes may require altering longstanding harvest schedules (e.g. spring shutdowns, winter harvests), silviculture methods (e.g. growth and yield curves, target species, rotation lengths) and current mechanical harvesting equipment and transportation techniques (e.g. skidders vs. cut-to-length systems, skid trail design techniques, and updated road construction and stream crossing best management practices, known as BMPs).

- **Change the way the public uses and values forest lands** – Climate change will alter the way the public uses and values forest land directly, by shifting the feasibility of recreation activities and the quality of outdoor experiences, as well as the comfort and safety during outdoor activities. In addition, climate change will indirectly shift public recreational uses and values, as the changing climate alters the amount and timing of snow cover, causes unpredictable and warming water and air temperature, and shifts existing distributions of wildlife.[26] Trail-based winter recreation including snowmobiling, cross-country skiing, and snowshoeing are most vulnerable to climate change due to the dependence on natural snow.[27] In Maine, predicted changes in snow pack will provide less snow for fewer days which has severe implications for snowmobiling, an activity that contributes over $170 million a year to the state's economy.[28]

Climate change also has negative consequences for human health and safety. For example, vector-borne diseases including Lyme disease and Eastern equine encephalitis (EEE) are projected to increase in central Maine as the climate warms and precipitation patterns change.[29 30 31] The growth rate, distribution, and potency of poison ivy is also expected to rise under increased carbon dioxide concentrations.[32] These health risks are closely associated with outdoor activities, particularly forest based recreation. The increased risk to human health may reduce the popularity of outdoor recreation and alter the perceived value of forest land to society.

Ecosystem Service Vulnerabilities and Adaptation Actions

Allen-Whitney Forest provides a number of "ecosystem services." Ecosystem services are simply those services such as food and water supply that intact, healthy ecosystems supply to humans. Climate change, in conjunction with other anthropogenic stressors, will impact ecosystem service delivery. Table 1 outlines key ecosystem service vulnerabilities at Allen-Whitney Forest and Table 2 outlines recommended adaptation actions to Allen-Whitney Forest's activities in light of these vulnerabilities.

Table 1. Vulnerabilities of Ecosystems and Ecosystem Services at Allen-Whitney Memorial Forest to Climate Change

ECOSYSTEMS AND ECOSYSTEM SERVICES	VULNERABLE TO CLIMATE CHANGE?	RATIONALE
PROVISIONING SERVICES		
Raw Materials: Timber Production	Yes	Climate change will : 1) shift distributions of tree species and wildlife habitats northward or upslope, 2) increase the frequency and magnitude of disturbance events, 3) introduce new invasive species and/or intensify the impacts of invasive and non-native plant and pest species, 4) require a shift in harvest methods and timing.
ECOSYSTEMS AND SUPPORTING SERVICES		
Ecosystems and Habitat Provision: General	Yes	Combination of warming climate and changing precipitation patterns will stress existing species and introduce new competitors. Increasing deer population will increase browse damage and impact forest regeneration if not properly managed.
Maintenance of Genetic Diversity	Perhaps	Invasive species could diminish biodiversity.
CULTURAL SERVICES		
Recreation: Hiking, snowmobiling, snowshoeing, cross country skiing.	Yes	The absence of snowpack will affect the viability of recreation during the winter months. Increased incidence of vector-borne illnesses, such as EEE, Lyme, and West Nile, may reduce use of the forest for recreation during temperate months.

Table 2. Adaptation of Ecosystems and Ecosystem at Allen-Whitney Memorial Forest to Climate Change

ECOSYSTEMS AND ECOSYSTEM SERVICES	ADAPTATION AND MANAGEMENT MEASURES	RATIONALE
PROVISIONING SERVICES		
Raw Materials: Timber Production	› Maintain species, structural and age class diversity › Conduct sustainable timber harvests › Maintain and increase red oak and white pine on site › Be aware of and plan for threats facing hemlock stands › Promote regeneration of native tree species.	Maximize forest resiliency, anticipate climate change related stressors and maximize financial return.
ECOSYSTEMS AND SUPPORTING SERVICES		
Ecosystems and Habitat Provision: General	› Manage for a diverse mix of habitat types, › Encourage and enhance deer management.	Anticipate introduction of species adapted to warming climate and resulting reorganization of habitats. Minimize habitat destruction associated with deer population growth.
Maintenance of Genetic Diversity	Monitor and manage invasive species.	Limit tendency of invasive species to reduce on-site biodiversity.
CULTURAL SERVICES		
Recreation: Hiking, snowmobiling, snowshoeing, cross country skiing.	Manage trail system and permitted recreational use in response to reduction in snow cover and shorter winter season	Minimize site damage and erosion associated with increase in wet, muddy conditions.

Provisioning Services

Raw Materials: Timber Production

Climate Change Vulnerabilities: Forests dominated by a single species of tree, or composed of uniform age classes may be highly vulnerable to climate change impacts.[33] Temperature and precipitation changes are likely to have multiple effects on New England forests by shifting species distributions, increasing the frequency and intensity of disturbance events and associated tree damage and financial costs, introducing new invasive species and/or intensify impacts of existing invasive and pest species, and forcing modifications to harvest methods and timing.

Recommended Adaptation Actions:

› Maintain species, structural, and age class diversity. Sustainable management strategies that maintain species, structural, or age class diversity are important in the face of climate change because they can create mosaics of habitats for existing wildlife species and new species that may move into the area, diversify stands with species and age classes that are less vulnerable to environmental stresses and disturbance events, reduce risk of damage and financial loss, and create economic opportunities by managing for species that are suited to the changing climatic conditions. Harvest strategies that retain some mature, canopy trees while creating cohorts of younger trees provide a sustainable supply of trees for habitat and timber markets.

BEST MANAGEMENT PRACTICES:

- Create multi-aged stands: Use uneven-aged management practices such as multi-stage shelterwood harvests, and structural and patch retention to maintain or create multiple age classes within stands.
- Plan to diversify species mix of red pine plantations: The 66 acres of red pine plantations are uniform in both species and age class and are highly vulnerable to catastrophic disturbances. Unfavorable markets for red pine limit options for using timber management to diversify these stands. If markets for red pine improve enough to make harvesting even marginally profitable, the species and age classes of these plantations should be diversified.
- Retain areas with no or limited harvesting: Stands dominated by large, old trees are an increasingly rare forest type and can substantially contribute to wildlife habitat and to carbon sequestration.[34 35 36]
- Use short-rotation forestry when appropriate.

› **Conduct sustainable timber harvests**. A shortened winter logging period, extended mud season, and increasingly frequent and severe storm events are likely to reduce the number of days with conditions favorable for low-impact logging, increase logging costs as machinery sits idle during marginal and unfavorable conditions, and increase pressure on managers to operate during marginal or unfavorable conditions, risking damage to soil and water quality.

BEST MANAGEMENT PRACTICES:

- Continue to apply BMPs and sustainable forestry practices,
- Create infrastructure that can withstand a variety of weather conditions: Decreasing dependability of frozen soils, increasing probabilities of large storm events, and general uncertainties about weather and soil conditions may require upgrades to logging infrastructure. Redesigning haul roads, skid trails, landings, and stream crossings to provide access in a wide range of conditions will ensure low-impact access for harvesting equipment and allow rapid mobilization and exploitation of narrow windows of weather and favorable operating conditions.
- Track and respond to changing soil and weather conditions.

› **Maintain and increase red oak and white pine on site.** These species are well-suited for the warmer temperatures and altered precipitation patterns expected under climate change in Maine, and are highly valued for forest products.

BEST MANAGEMENT PRACTICES:

- Use shelterwood harvest systems to increase red oak and white pine: In stands with an oak or white pine component in the understory, conduct multi-stage shelterwood harvests to reduce dominance of tree species that are vulnerable or not well adapted for changing climatic conditions (e.g., hemlock, balsam fir, spruce) and create growing space for white pines and red oaks.

› **Be aware of and plan for threats facing hemlock stands.** Hemlock is a common species in AWF and, although it is not commercially valuable, it provides important habitat for wildlife.

Infestations of Hemlock Wooly Adelgid (HWA) and Elongate Hemlock Scale (EHS) and temperature stress have profoundly negative implications for the long-term survival of hemlock in Allen-Whitney Forest.

BEST MANAGEMENT PRACTICES:

- Track HWA and EHS in Maine and on-site: Track new reports of HWA and EHS infestations to determine the risk to hemlock trees. If infestations are detected in close proximity to AWF, screen hemlock stands for presence of HWA and EHS.
- Reduce risk of introduction and spread of HWA and EHS: If HWA and/or EHS are detected in close proximity or within AWF, conduct harvests when these species are least mobile (from mid-August to February).
- Be prepared to implement hemlock management options if HWA and/or EHS arrive.

Ecosystems and Supporting Services

Ecosystems and Habitat Provision: General

Climate Change Vulnerabilities: Climate change will present the threat of both sudden disruption of existing habitats associated with storm events and more gradual change associated with the warming climate and changing precipitation patterns. In the absence of proper management these pressures could lead to ecosystem simplification associated with deer population increase.

Recommended Adaptation Actions:

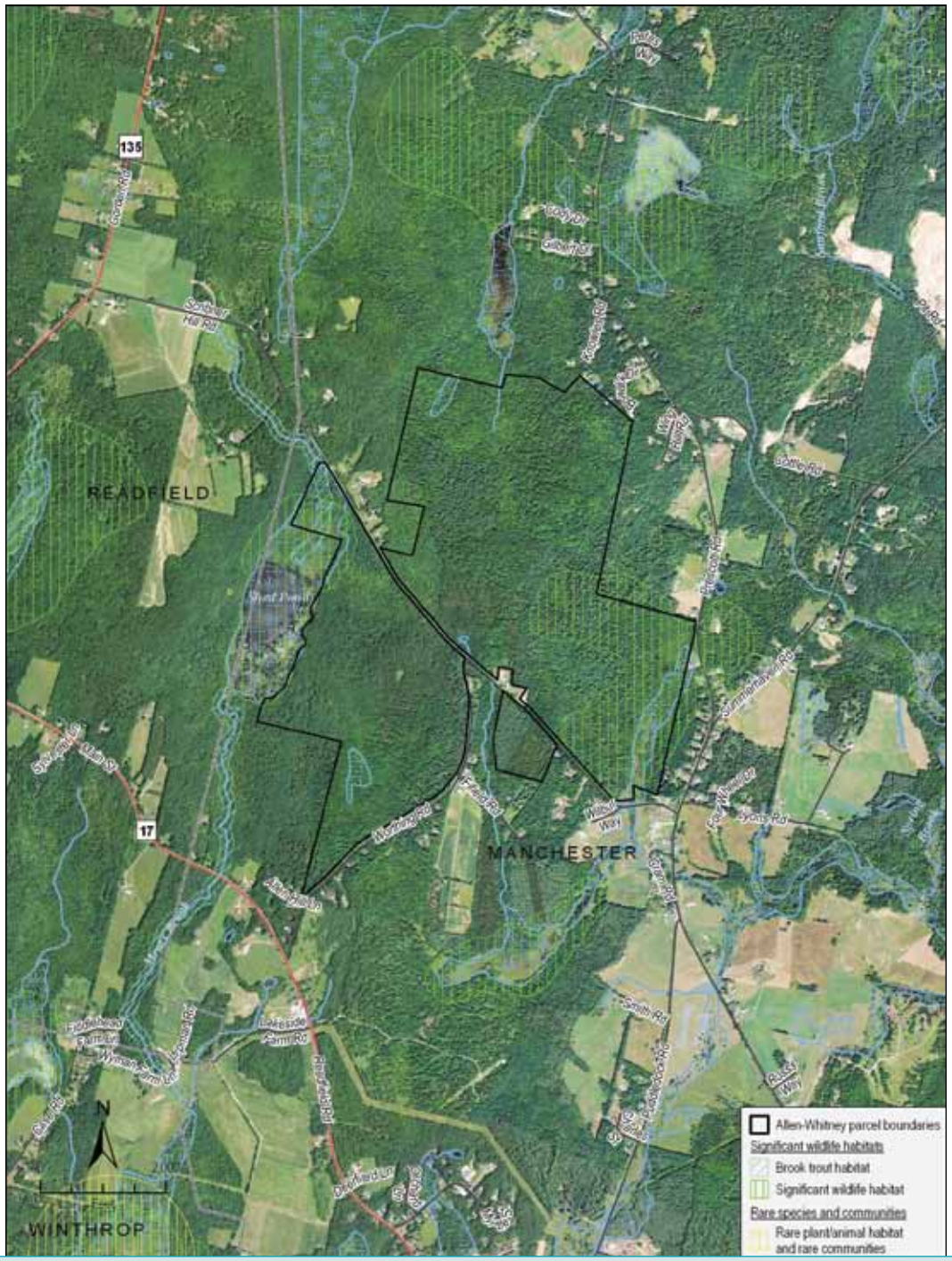
- Manage for a Diverse Mix of Habitat Types: While it is impossible to anticipate the specific nature of the changes that will occur it is possible to manage to maximize resiliency of existing habitats and to minimize both non-climate and climate change related stressors. As mentioned in the section on provisioning services, actions that maintain species, structural, or age class diversity are important in the face of climate change because they can create mosaics of habitats for existing wildlife species and new species that may move into the area. Maintaining some old growth forest on the site, particularly in riparian areas and adjacent to Shed Pond, will contribute to the diversity and richness of habitat types available on the site (Maps 2 and 3).
- Encourage and Enhance Deer Management: Continue to allow recreational access to hunters at AWF and support programs to educate the public about responsible use of private property to ensure continued access to forest land for recreation and hunting. Collaborate with other landowners to garner support for state wildlife agencies to continue monitoring deer herds, be proactive in implementing management strategies to keep herds below densities at which Lyme transmission rates increase and browse damage to understory vegetation occurs, and educate the public about the relationship between deer herd size and forest and human health.
- Incorporate Landscape Level Planning When Possible: Be aware of the need for cross-sector adaptation planning at landscape, state, and regional scales. Climate change impacts multiple economic sectors (e.g. natural resources, transportation, and public health), requiring coordination among government agencies, non-profits, and other stakeholders to effectively prepare for these changes. In addition, climate change adaptation must include regional and state-wide approaches to fully protect forestland.
  - Be aware of landscape-scale adaptation planning efforts.
  - Be aware of interdisciplinary adaptation efforts.

Maintenance of Genetic Diversity

Climate Change Vulnerabilities: Climate change is increasing the competiveness of invasive species through stressing existing ecosystems and providing an increasingly CO^2 rich atmosphere that favors many weedy invasive plants.

Recommended Adaptation Actions:

- Minimize negative impacts of disturbance events: The frequency and intensity of widespread disturbances are predicted to increase due to climate change, resulting in injury or death of canopy trees and loss of economic value.
  - Identify stands most vulnerable to disturbance events. Consider the vulnerability of specific species (e.g., softwoods and other shallow-rooted species) and stand features (e.g., ridgelines, buffers, forest edges) to disturbance events when creating harvest plans and management strategies. For example, softwoods are often shallow rooted and are prone to wind damage and these species may not be well suited for buffer strips or retention patches, especially on exposed ridges or near edges of harvest blocks or clearings.
  - Monitor regeneration and invasive species after stand-replacing events.
- Promote regeneration of native tree species. Invasive plants are expected to thrive under a changing climate, allowing these species to outcompete native trees and quickly colonize forestland.
  - Track existing and emerging threats of invasive species. The USFS's Alien Forest Pest Explorer supports tracking the range and determining forest susceptibility of over 70 pest species. In addition, the Maine Forest Service produces educational materials and offers workshops on identification and management of invasive species.
  - Develop a modest yet effective monitoring program for invasive species. In AWF high-risk species include those already established on site (buckthorn, barberry, multiflora rose, and shrub honeysuckle), and species with a high probability of future establishment and potential to result in large ecological and financial damage (e.g., HWA, EHS, Emerald Ash Borer, Asian Longhorn Beetle).
  - Control invasive species at the early stages of infestation. If monitoring detects that regeneration of native species is being threatened by competition from non-native species take immediate steps to remove and/or control non-native species. Early detection can prevent large infestations and can protect wildlife habitat and timber values.



MAP 2

Map 2. Allen-Whitney Memorial Forest: High Value Habitat

This map depicts high value plant and animal habitats. Streams designated as important brook trout habitat have been shaded with blue cross-hatching, while other areas designated as significant wildlife habitat by MIDFW have various pink cross-hatching. Habitat of rare, threatened, and endangered species appears as green cross-hatching, while rare and exemplary natural communities appear with a green stippled background.

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Map 3. Allen-Whitney Memorial Forest: Riparian Resources

This map depicts surface water and riparian resources. Light blue areas are mapped as streams, rivers, lakes, ponds, or wetlands by either the National Hydrography Dataset or National Wetlands Inventory. Darker blue areas have been identified by The Nature Conservancy's Active River Area model as being important for the maintenance of riparian habitat and streamflow regime.

MAP 3

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Cultural Services

Recreation:

Climate Change Vulnerabilities: Winter recreation is highly vulnerable to climate change. Decreases in the depth and duration of snow cover and increases in extreme precipitation events associated with climate change may degrade trail quality and become a significant source of sediment to water bodies.

Recommended Adaptation Actions:

- Maintain low-impact and high quality trails: Work with local snowmobile clubs and trail users to evaluate the condition of trails and stream crossings and identify areas needing improvement. Increased precipitation can cause wet and muddy conditions that can quickly degrade trails, increase environmental damage, and decrease user enjoyment. Trail closures during wet weather and marginal snow conditions can prevent damage to trail infrastructure, but in routinely wet or degraded areas consider improving or re-routing trails to avoid future problems.
- Clearly communicate all permitted recreational uses: As the number of days with snow cover and the reliability of having adequate snowfall for winter sports decreases it is likely that recreationists will want to diversify their winter activities. Posting clear signage on allowable recreation activities as well as frequent communication with local motorized clubs can make allowable uses of the property publically known and reduce unauthorized ATV access to the property.

Conclusion

The Allen-Whitney Forest is in a unique position with respect to climate change adaptation. As a non-profit teaching forest, Allen-Whitney has the enviable opportunity to learn and adjust as the climate changes without experiencing the direct financial risk that small, private woodlot owners may suffer from the shift in climate. However, the opportunity and obligation for AWF to help develop responses to climate change as models for other woodlot owners is also high. By implementing these recommendations, and by monitoring adaptation concepts as they unfold, Allen-Whitney Forest can continue to be a relevant, reliable source of information to aid forest landowners as the climate changes.

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