Lessons from the Land: A New Approach to Use Site-Level Information to Guide Climate Adaptation

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INTRODUCTION

Foresters and other natural resource professionals are increasingly aware of the anticipated effects of climate change and adaptive management options at both the regional and local scale. Even as we gain more information about the potential impacts of climate change, however, there remain several challenges for translating large-scale and long-term climate change projections into practical action. Climate change projections and vulnerability assessments often deal with large spatial scales and general expectations. Forest managers are challenged to decide how best to apply this broad information at the stand level, where many forest management decisions are made. Among the many potential actions that could help adapt to climate change, some management actions may conflict with others, may not be applicable across forest cover types, or may not be applicable to a specific site.

In other professions, checklists are increasingly being used to manage complex procedures and decision-making (Gawande 2009). Checklists are constructed to help users apply knowledge and situational assessment consistently and correctly. Based on this model, we have created a Northern Hardwood Adaptation Checklist (checklist) tool to help filter the wide array of potential climate adaptation actions specifically for northern hardwood forests, and to help forest managers assess potential adaptation actions based on the conditions and potentials of a specific site. A session at the 2021 Northern Hardwood Conference introduced the initial version of the tool. Here, we explain how we created the Northern Hardwood Adaptation Checklist and offer some reflections on our lessons learned through the process.

CHECKLIST DEVELOPMENT

This checklist relies on a series of diagnostic questions to quickly assess key stand characteristics and potential climate change risks that might alter the course of management for a northern hardwood stand. For example, drought risk may be a critical climate change vulnerability for some northern hardwood stands, and forest managers can consider whether a particular site is vulnerable to this risk based on knowledge of a site's soils, aspect, and topographic features. Evaluating these site-level features can help a manager prioritize certain climate adaptation actions, such as emphasizing a higher proportion of drought-tolerant species when possible.

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We developed a preliminary list of diagnostic questions over an iterative process by reviewing information on projected climate change impacts to northern hardwood forests as well as existing silvicultural guidance. We intentionally considered the wide variety of site conditions that may exist in the northern hardwood cover type across Michigan, Wisconsin, or Minnesota. The list of 35 questions covers a range of stand characteristics that may influence climate vulnerability and adaptive capacity: ecological disruptions; access and operability; moisture and nutrients; diversity factors; and composition and stocking for the overstory, mid-story, and understory (Table 1). The questions are worded as succinct yes/no questions, where a "yes" answer indicates a potential risk factor in the stand. This format will assist forest managers to navigate the stand assessment quickly and consistently.

Additionally, the checklist contains an extensive list of climate change adaptation tactics for northern hardwood forests. We developed this list using the Menu of Adaptation Strategies and Approaches for Forest Management, from "Forest Adaptation Resources: Climate Change Tools and Approaches for Land Managers" (Swanston et al. 2016). We created specific tactics for northern hardwood management, and we organized these actions under the structure of broad "strategies" and more specific "approaches" from the menu. We gathered additional adaptation ideas for the checklist from existing ecological classification systems and northern hardwood management guides, such as the Minnesota Department of Natural Resources (DNR) native plant community classification system and silvicultural stand prescriptions, Kotar habitat classification system, and the Michigan and Wisconsin DNR silviculture guides (Burger and Kotar 2003, Kotar et al. 2002, Michigan DNR 2015, Minnesota DNR 2003, Minnesota DNR 2019, Wisconsin DNR 2017). The current version of the checklist contains 44 adaptation tactics ranging from ideas that span the full continuum of resistance, resilience, and transition options.

As users answer the diagnostic questions in the checklist, they are providing information about risk factors and site conditions as they exist in a given stand. For each question, we determined whether a yes or no answer would support or discourage the possible adaptation tactics. Most questions are relevant only to a few adaptation tactics, but multiple adaptation tactics can be influenced by a single answer or a combination of answers. As all 35 questions are answered, the tool tabulates a score for each adaptation tactic based on how often it is supported or discouraged. We coded these relationships into the tool based on our best understanding of the intent of potential adaptation tactics and the relevance of each adaptation tactic to different site-level conditions and risk factors.

The Northern Hardwood Adaptation Checklist is designed to help filter the list of potential adaptation actions into a more manageable list, but not to prescribe management actions or reduce flexibility. Therefore, the tool ultimately provides users with the entire list of potential adaptation actions, which are color-coded to indicate which actions are most consistent with the information provided. Users are still able to review the entire list of potential adaptation tactics and use their judgement about which actions to recommend for implementation. Adaptation actions are organized into general categories (e.g., tree planting and regeneration) to make it easier for users to review the list and evaluate the suitability of similar ideas.

We created additional steps in the checklist to allow users to provide information about the location and ownership of the stand, to enter specific management goals and objectives, and to review their stand's risk factors prior to selecting adaptation actions. We modeled the structure and intent of the Adaptation Workbook (Swanston et al. 2016), a structured adaptation planning process developed by the Northern Institute of Applied Climate Science.

Table 1.—List of 35 diagnostic questions in the Northern Hardwood Adaptation Checklist, organized by general categories

General category	Diagnostic questions
Capacity for active management	Is the landowner willing to invest additional time and resources into management? (above and beyond a timber sale)
	Are a variety of timber markets available in this area? (for example, small diameter as well as large diameter markets)
	Is maximizing economic return the primary management goal for this stand? (for example, School Trust Land)
Ecological disruptions	Has the site previously been farmed or grazed? (confirmed site history or indications such as old fences)
	Does the site have evidence of high earthworm activity? (humus layer lacking)
	Does the site have evidence of high levels of deer browse?
	Are invasive species common throughout the site?
	Is interfering vegetation disrupting regeneration or other functions in the stand? (ironwood, hazel, Penn sedge, grasses, etc.)
	Does the site have serious current or looming forest health issues? (pests, diseases, etc.)
Access and operability	Do access or operability constraints limit the site's management to frozen ground conditions? (consider surface texture, drainage, impermeable soil layers, and landscape position)
	Would access to the site be impaired by a heavy rain event?
	Is the site south of the tension zone? (outside of Ecological Province 212)
Moisture and nutrients	Does the site have low nutrient availability? (refer to habitat type or NPC class or look for species in the understory that indicate nutrient-poor sites)
	Does the site have coarse-textured or drought-prone soils? (refer to habitat type or NPC class or look for species in the understory that indicate drier sites)
	Does the site's landscape position increase the risk of drought? (south-facing aspect, depth to bedrock, quirks of the prevailing weather pattern, etc.)
	Does the site's landscape position reduce the risk of drought? (toe of a slope, north-facing aspect, springs and seeps, lake effect snow belt)
Composition and stocking - overstory (trees greater than 5 inches d.b.h.)	Is the overstory dominated by a single species such as sugar maple? (more than 70% of the basal area [BA])
	Is the overstory primarily composed of species expected to decline due to climate change or other factors over the next 50 years?
	Are there significant quality concerns in the overstory? (frost cracks, damage, poor form, other defects)
	Is the overstory understocked?
	Is the site overstocked such that growth is being suppressed or there is an elevated drought risk?
Composition and stocking - mid-story (trees 1 to 5 inches d.b.h.)	Is the mid-story less diverse than desired?
	Is the mid-story primarily composed of species expected to decline due to climate change or other factors over the next 50 years?
	Are there significant quality concerns in the mid-story? (frost cracks, damage, poor form, other defects)
	Do mid-story trees have less vigor than large overstory trees? (For example, do small trees have a smaller live crown ratio than large trees?)
	Does the mid-story have below expected or unacceptable stocking?
Composition and stocking - understory (trees less than 1 inch d.b.h.)	Is the regeneration layer less diverse than desired?
	Is the regeneration layer primarily composed of species expected to decline due to climate change or other factors over the next 50 years?
	Is there inadequate regeneration to perpetuate the stand?
Diversity factors	Do vernal pools or other sensitive sites occur on the site?
	Are Canada yew, orchids, or other special species present?
	Is there a high proportion of oak in the stand? (30 BA of oak, well distributed within the stand)
	Does the stand contain oaks or other species anticipated to fare well under future climate conditions?
	Is the site lacking large standing or down dead trees (nurse logs)? (at least 3/ acre greater than 12 inches in diameter, at least 6 feet long)
	Is stand density uniform throughout the site?

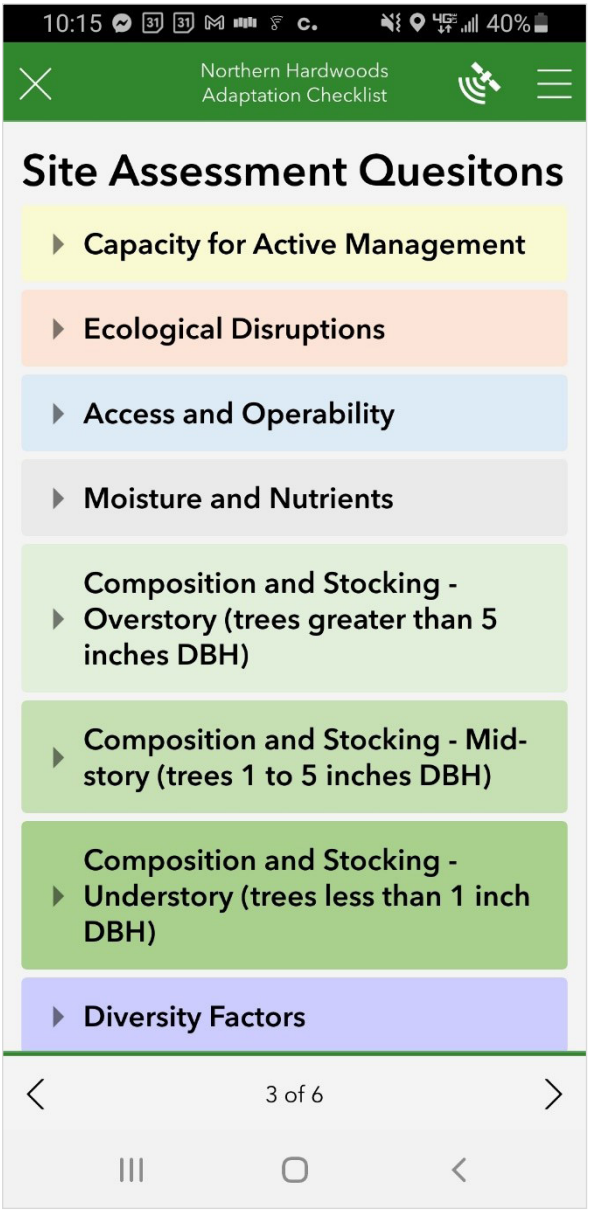

Figure 1.—A screenshot of the Northern Hardwood Adaptation Checklist, displayed on a smartphone within the Survey123 platform.

We created an initial version of the Northern Hardwood Adaptation Checklist in Survey123 to allow many users to access the tool from a phone, tablet, or desktop, even without internet access (Fig. 1). Survey123 is a program developed by ESRI (Redlands, CA) to create, share, and analyze surveys (https://survey123.arcgis.com/). Readers can contact author Stephen Handler for instructions to download the checklist using Survey123.

LESSONS LEARNED

We are pleased that the initial version of the Northern Hardwood Adaptation Checklist provides a simple and consistent way for foresters to consider how site-level conditions may affect the range of climate adaptation actions that could be implemented in a stand. We were able to consolidate a large amount of information into a streamlined process and make useful connections between risk factors and related management tactics for climate change adaptation.

Although northern hardwood is a common forest type across the Lake States region, the site-level conditions across these states vary substantially. It was challenging to write diagnostic questions that would apply to such diverse conditions. We also had to consider the tradeoff between asking dozens of questions to better identify the features of a stand and needing to constrain the tool to a manageable list of questions that could be completed swiftly. From our shared experiences, we learned that even within a state there are regions and sites that have unique characteristics that might not be adequately assessed by our questions.

This process also reinforced the idea that a variety of adaptation actions can be available to address a particular condition, resulting in a tool that is more of a menu of possibilities and not a prescriptive outcome. Therefore, coding the checklist to associate yes/no responses for specific questions with an array of potential adaptation actions can be a matter of interpretation. It will be necessary to thoroughly test this tool across a diversity of stand conditions and management contexts to ensure that the checklist is filtering the list of adaptation tactics consistently.

Similarly, constructing this tool forced us to think creatively about the variety of adaptation tactics that could be employed in a northern hardwood stand. User feedback will be helpful to generate additional ideas as we continue to test the tool. As we refine the diagnostic questions and adaptation tactics, it will be important to clearly document the rationale for associating adaptation tactics with particular questions, recognizing that the justification may be a combination of published literature and manager input.

The Northern Hardwood Adaptation Checklist is only on the starting block for testing and improvement. We used it on a small sample of sites representing some of the vast variability across the Lake States. Testing the Survey123 platform with the audience at the 2021 Northern Hardwood Conference is only the first step in future modifications and full deployment of the tool. Further review by additional researchers and managers will be critical. This version with a northern hardwood focus is the "proof of concept," and this idea could be applied to other forest types in the future.

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