Managing Forest Landscapes for Canada Lynx and American Marten:

Balancing Early Successional and Structurally Complex Forest Habitats in a Changing Climate





Based on Proceedings From: 5/14/2026 workshop *Managing Forest Landscapes for Lynx and Marten*, at the University of Maine Orono

Presented by: The New England Forestry Foundation (NEFF) & The Maine Department of Inland Fisheries and Wildlife (MDIFW)

Executive Summary

Landowners and managers in the Acadian Forest of Maine attempt to balance diverse values, including:

- Timber management in a time of increasingly challenging markets,
- Providing habitat for the full range of native biodiversity,
- Mitigating for climate change.

In pursuit of this balance, some managers promote the use of Canada lynx (*Lynx canadensis*) and the American marten (*Martes americana*) as "umbrella species" for forest management. This model depends on the assumption that if habitat conditions are provided for these discerning species, that could provide necessary conditions for many other native species that depend on similar characteristics of northern Maine forests.

The concept of using lynx and marten as umbrella species in Maine has taken place in a landscape undergoing significant transformation. The spruce budworm outbreak of the 1970s and 1980s, resulted in large-scale salvage harvesting and the expansion of road infrastructure, the Maine Forest Practices Act that emerged in response to public concerns about these harvesting dynamics, and land ownership changes that have all influenced the age class distribution, arrangement, and size of forest patches in ways that affect lynx and marten habitat conditions.

Budworm salvage harvests in the 1970s and 1980s produced a historically unprecedented expansion of young softwood and mixed wood cover in northern Maine that greatly benefited the snowshoe hare (*Lepus americanus*), and therefore also benefited its predator, the Federally Threatened Canada lynx. This has led to lynx populations today that exceed targets set by federal policymakers to maintain robust populations for the species in the northeastern United States. Recent trends indicate that although large patches of young softwood cover are declining as a proportion of the landscape, this habitat type remains above historic conditions. While managing for current levels of young softwood cover may not be feasible or even desirable into the future, a landscape scale management approach could help sustain lynx populations and other species that depend on young softwood cover.

In contrast to lynx, American marten are recognized as preferring structurally complex forests, and while they avoid large open areas, such as clear-cuts, a growing understanding of marten habitat use has shown that they can persist in managed forest landscapes where large patches of structurally complex forest are retained and connected by a matrix of areas managed by partial harvests. This type of landscape-scale habitat management may also confer benefits to many other species that depend on complex forest structure.

Climate change is an additional factor that is anticipated to influence changes in forest structure and composition at a landscape scale. Climate change is predicted to reduce spruce-fir (conifer) abundance over the next 100 years, alter winter snow dynamics, and shift forest management to favor carbon offset projects and climate-resilient forestry, with potential implications for regenerating softwood forests and structurally complex forests depended upon by lynx and marten, respectively.

This summary document synthesizes content and discussions from a 5/14/2026 workshop *Managing Forest Landscapes for Lynx and Marten* which included presentations on decades of research, field monitoring and

practice from academia, wildlife agencies and industrial, public, and non-profit land managers. Improving communications and collaboration between private landowners and land managers and biologists was an important outcome of this event. Included in this document is a current understanding of Canada lynx and American marten habitat use, and the potential challenges and opportunities for maintaining the structural diversity that benefits Canada lynx and American marten and the other species that co-occur in these habitats.

Introduction

Canada lynx and American marten are forest-dependent predators that occur broadly in snowy climates from the Canadian Maritimes to Alaska. Lynx and marten are at the southern extent of their geographic range in Maine and other northern forests where they occur in the contiguous United States. Maine is nearly 90% forested, and populations of lynx and marten in northern and eastern Maine's working forests (i.e. the Acadian forest) are influenced by the forest structural characteristics that have resulted from Maine's long history of forest management. Because lynx and marten are associated with large areas of forest habitat of differing structural and successional development, both species can serve as key representatives for the conservation and sustainable management of the Acadian forest. General habitat characteristics include:

- **Canada Lynx :** The lynx is morphologically adapted to hunt snowshoe hare. Hares thrive in young, regenerating conifer stands that occur both because of natural disturbances such as spruce budworm outbreaks and in Maine's working forests as a result of timber harvesting. Lynx prefer young, dense to moderately stocked regenerating conifer stands (typically 15 to 35 years post-disturbance), where there is moderate to high prey availability and also where there are open areas that allow lynx to see and pursue hares. Canada lynx habitat also supports other young forest specialists such as Olive-sided Flycatchers and Magnolia Warbler.
- **American Marten:** Conversely, the marten is a forest-interior species. It avoids large open areas and early regenerating stands, relying instead on overstory canopy closure, structural height, and an abundance of coarse woody debris (logs, stumps, and root wads) on the forest floor. This complex forest floor environment provides foraging access and cover from larger predators like fishers, red fox, coyotes, and owls. Habitat for American marten is also important for bird species requiring complex forest habitats, such as Bay-breasted Warbler, Canada Warbler, Blackburnian Warbler, and Black-backed Woodpecker. American marten habitat may also provide winter cover for deer.

Some researchers, including workshop presenters Dan Harrison and Erin Simons-Legaard, and the New England Forestry Foundation have been promoting the use of Canada lynx (*Lynx canadensis*) and the American marten (*Martes americana*) as "umbrella species" for forest management for several decades. In conservation planning, an umbrella species is one whose spatial and structural habitat requirements are broadly comprehensive and that managing effectively for their survival may confer protection to a wide array of co-occurring species. Through expert presentations and conversations with forest managers, this workshop explored what we've learned about habitat use and habitat management of lynx and marten over the last several decades since these species were proposed as umbrella species.

The following pages summarize workshop presentation content and discussion points regarding Canada lynx and American marten habitat use, and challenges and opportunities for managing habitat for both species.

Climate Change and Expected Changes to Forest Composition

A summary of historical data and climate models presented by the Maine Forest Service indicates that New England is experiencing shifts in temperature and precipitation regimes. While total annual precipitation is increasing, precipitation occurs more frequently in concentrated events, separated by dry periods. In some years, these dry periods may become more extensive and lead to more frequent "flash droughts."

Bioclimatic envelope modeling projects that the climate zone area suitable for red spruce (*Picea rubens*) and balsam fir (*Abies balsamea*) may decline by 2060. This decline may be modest under a low emissions scenario and limited to southern Maine or much greater under a high emissions scenario and may significantly reduce spruce-fir forest area in northern Maine. However, these models do not describe the underlying ecological process necessary for this change to occur. Under both low- and high-emissions scenarios, red spruce and balsam fir are projected to potentially face widespread physiological stress. Winter thaws, late-spring frosts acting on unhardened buds, and hot summer droughts may impact growth and recruitment of these species and shift competitive advantage toward species like red oak, sugar maple, and red maple, and may lead to a gradual decline in spruce and fir abundance in different regions depending on future emission levels.

Other scientists report how lynx exhibits a strong preference for conifer-dominated or mixed-wood matrices over pure hardwoods. This preference-shifting species composition could represent a challenge to long-term habitat stability. However, a recent study shows lynx in Maine have high genome-wide diversity and gene indicators of adaptive capacity which may help regional populations adapt to the rapidly changing climate (Lama et al. 2026).

American marten are adapted to deep snow in the winter that provides thermoregulation benefits, access to small mammals, and cover from key predators such as fisher. While fishers are already found across the state, others report that shifting forest conditions and decreased snow depth may favor fisher over marten. Marten are not found in southern Maine, where oak-pine forest associations are common and fisher are most abundant.

Canada Lynx: Habitat use and Future Opportunities for Management

Long-term monitoring by the Maine Department of Inland Fisheries and Wildlife (MDIFW) demonstrates that Canada lynx populations reached historically high levels over recent decades. There are an estimated 1,000 adult individuals today—a number that exceeds the federal recovery goals established for the northeastern United States. This population boom was an unintended byproduct of an unprecedented and intensive disturbance regime that is unlikely to be re-created due to silvicultural, political, and operational challenges.

The spruce budworm outbreak of the 1970s and 1980s and the large-scale salvage clearcuts that followed generated massive, relatively uniform cohorts with a high proportion of spruce, fir, and other conifers. Follow-up herbicide applications against intolerant hardwoods pushed many stands even further into conifer dominance. When these stands entered the sapling phase, they offer high-quality cover for snowshoe hares and Canada lynx.

Research suggests that the highest populations of lynx may occur where there are large areas of dense to moderately stocked regenerating conifer stands (typically 15 to 35 years post-disturbance), where there is moderate to high prey availability, and importantly, open areas that allow lynx to see and pursue hares. Habitat models conducted by Erin Simons-Legaard, and which are based on data collected from budworm impacted stands suggest that lynx may benefit from contiguous, regenerating habitat patches of 250 acres or greater. More research is needed to understand lynx habitat use in areas with different management histories and understand what other species may benefit from habitat managed for Canada lynx.

Newer observation data from MDIFW presented by Jen Vashon and Shevenell Webb, including radio collared lynx and snow track surveys, indicates that lynx may have broader habitat use than previously understood, albeit at lower population densities. Preliminary information from radio collared lynx in areas less impacted by budworm and salvage clearcuts show that although their home ranges are larger, these areas can support lynx. Additional research and data analysis should provide more information on the range of habitat conditions including patch size and the forest management practices that provide suitable habitat for lynx.

Management and Conservation Opportunities for Canada lynx

There are a variety of opportunities within a working forest for maintaining populations at the USFWS target of 400 adults in the northeastern U.S. that keep social, economic, and environmental goals across diverse ownership in mind.

- **Shelterwood Silviculture:** Shelterwoods have the potential to produce moderately to densely stocked conifer and mixed conifer sapling stands. A silvicultural system designed to enhance seedling recruitment through initial partial harvests, shelterwoods may result in young stands of spruce-fir or other shade-tolerant softwoods following overstory removals. Some forestry researchers, such as Laura Kenefic from the USFS, suggest that budworm salvage harvests may have more closely resembled shelterwood overstory removals.
- **Intensively managed spruce planted stands**—widespread in New Brunswick (such as J.D. Irving's Black Brook district) and utilized selectively in Maine—have emerged as a potential habitat contributor for Canada lynx. More research is needed to understand how Canada lynx and other species may utilize planted stands.

- **Clearcuts:** Clearcutting practices that mirrored salvage harvests of the 1970s and 1980s could result in large patches of habitat for snowshoe hare and Canada lynx. However, without an advanced regeneration bank of spruce and fir, clear-cuts may not develop into ideal Canada lynx habitat. (Technically a harvest that releases advance regeneration by removing overtopping tree cover is an overstory removal, not a clearcut, but the latter term is widely used beyond its strict silvicultural meaning). To achieve desired habitat conditions, harvests may need to be paired with other management strategies to encourage softwood regeneration.
- **Importance of large landscapes**- Though lynx are most abundant in young sapling- to pole-sized softwood stands, lynx have been demonstrated to have some flexibility in their use of a broad variety of forest types and different structural conditions. Lynx have not only benefitted in Maine from past harvest practices but also from the scale of Maine's forest which includes approximately 6 million acres of spruce-fir and at least an equal area of connecting forests of other types which provide habitat in lower densities. Conservation easements and other measures that keep forest as forest will benefit Canada lynx and other forest-dependent species.

Operational challenges to landscape scale management for lynx:

- **Current stand condition:** The history of management in some areas of Maine forests has yielded a patchwork of successional stages, stocking, composition and regeneration. Managers report that opportunities in these areas for shelterwood or other management that benefit lynx may not be operationally realistic or economical at large scales because of this patchwork of current conditions.
- **Reduced ownership scale:** The potential division of large legacy ownerships into smaller parcels, that could change hands more often, could add more complexity to long-term, landscape-scale planning of lynx habitat.
- **Changes in forest management practices over time:** Enacted in response to public concern to the clearcuts of the budworm era, the Forest Practices Act establishes limits to clearcut size and adjacency requirements. Paired with change in landowner goals, logging equipment availability, and current forest conditions, managers have increasingly incorporated low-residual "partial harvests" into their practices. While regenerating partial cuts can offer cover for habitat for hares, they differ from the uniform, block-scale successional cohorts that defined the post-budworm era. Other forest management strategies outlined above may offset the reduction in habitat areas originating from clear-cuts.
- **Carbon Offset Programs:** Some forest managers note that enrollment of their lands in carbon offset projects can limit their ability to create large, even-aged habitat patches. The volume of timber that can be removed is capped by the conditions of the project. For example, when markets for low-grade wood are weak, managers are incentivized to concentrate this limited volume on high-value timber, which can lead to more partial harvests.

American Marten: Habitat Use and Future Opportunities for Management

The American marten is a medium sized member of the weasel family that is widely distributed throughout northern forests of North America. Historically thought to be associated with contiguous stands of old growth

boreal forests, marten have been documented over the last several decades in a more diverse range of structurally complex coniferous, hardwood, and mixed-wood forest stands. Marten have stable populations and a sustainably managed trapping season in Maine.

Changes in understanding about marten habitat use

Early ecological literature based on the American west categorized the American marten as an obligate of old-growth coniferous forests, or a "wilderness-dependent" species. Decades of intensive tracking and modeling marten in Maine have demonstrated that the species has diverse habitat associations including structurally complex coniferous, mixedwood, and hardwood forests without any apparent preference for softwoods.

Research suggests that the combination of stand-level structural complexity and landscape thresholds determines optimal marten habitat suitability:

- **Structural complexity:** Forest structural complexity provides cover from predators including fisher, coyote, red fox, and owls and habitat for prey species like red squirrels and red-backed voles. In lower elevation areas of Maine, forests of trees 40 feet or taller and with basal area (BA) exceeding 80 square feet per acre are preferred by marten. Features of forests such as coarse woody debris also provide cover for American marten and availability of prey. Deep snowpack additionally provides cover for marten during winter months. Stands that fall below the 80 sq. ft. BA threshold (e.g., partial harvest stands) are not entirely unusable by marten. Instead, they can form a "hospitable matrix." Marten may not use these areas as part of their core home range, but they can pass through them, provided they link back to high-quality structurally complex forest patches.
- **Scale of habitat patches:** Studies indicate that marten occupy home ranges of approximately 1 square mile or 640 acres. Within these home ranges, marten utilize structurally complex forest patches (above) which make up 75% to 80% of the total area. Research from western Maine and New Hampshire indicates that home ranges shift seasonally in areas with more topographic relief, with marten occupying high elevation conifer forests in the winter months (more cover) and hardwood forests following leaf-on.
- **Connectivity** The wider the gap between habitat patches, the less likely it is to be used by marten, with gaps >300 meters seeing minimal marten use. Recent studies from high elevation areas in New Hampshire indicates that even narrow roadways provided access for predators, primarily coyote and red fox, and were less likely to be used by marten possibly due to predator avoidance.

Predation Dynamics and Influence on Habitat Use

As discussed above, habitat qualities preferred by marten—particularly their avoidance of large open spaces and low-basal-area stands—appear to be behaviorally driven by predation avoidance. Predators of marten include fisher, red fox, coyote, owls, and hawks.

This predator-prey relationship is illustrated by comparing isolated ecosystems:

- **Newfoundland Observations:** In landscapes like Newfoundland, where fishers are historically absent, the marten functions as a habitat generalist without “mature forest” structural requirements.
- **High Elevation Forests:** American marten are more likely to utilize open areas or less structurally complex forest where deep winter snowpack and other stressors limit abundance of fisher.

- **The Maine Context:** In Maine, both marten and fisher populations demonstrated stable to positive population dynamics from 2017 to 2024. More research is needed to determine to what extent changing weather patterns relate to species occurrence and if marten may be increasingly stressed from predator avoidance or selecting structurally complex forests to find refuge from fisher populations.

Management and Conservation Opportunities for American marten:

Maine's Furbearer Management Plan includes goals for maintaining healthy, abundant marten populations, a sustainable marten harvest and trapping opportunities, and habitat conservation that will also benefit other species dependent on structurally complex forests. The following management opportunities can be employed to benefit American marten habitat and habitat for other co-occurring species.

- **Reserve Areas:** Reserve patches of mature forest throughout the landscape such as certain state lands (e.g. Baxter State Park, Deboullie) provide source populations for American marten. Maintaining marten habitat cores in the landscape could be considered during delineation of new reserves or acquisition of conservation parcels.
- **Uneven-aged management:** Some managers, especially public and non-profit, may achieve marten habitat suitability by employing forest management practices that maintains 80 sq. ft. of basal area over a large proportion of the landscape.
- **Even-aged silviculture:** Managers that deploy even-aged silviculture (even with planted stands) can employ careful spatial planning and harvest scheduling to achieve these conditions.
- **Landscape scale management:** The likelihood that marten will continue to use a managed forest landscape increases when the matrix between suitable habitat patches is relatively hospitable to movement by the species. In this respect, a partially harvested matrix with some residual overstory cover (even if less than 80 sq.ft./acre) is better than entirely open conditions, such as after a clearcut. A landscape scale management approach could include employing a shifting mosaic of structurally complex forests, among other commercially managed forest areas.
- **Carbon Offset Programs:** In contrast to lynx, these programs provide landowner incentives to allow forests to mature and provide suitable marten habitat.

Operational challenges to landscape scale management for marten:

- **Financial limitations:** Depending on management frameworks of large landowners, business models may depend on short stand rotations. Financial incentives may be needed to incentivize maintaining larger blocks of structurally complex forests.
- **Reduced ownership scale:** Like with lynx, smaller parcels that could change hands more often could add more complexity to long-term, landscape-scale planning of marten habitat.
- **Changes in ownership:** Short term timber investment ownerships may lack the capacity to conduct long-term planning that could benefit marten (or lynx).

Reviewing the Umbrella Species Concept

Past research has indicated that suitable habitat for American marten and Canada lynx also supports a diversity of other species. For example, the 1998 USGS Maine Gap Analysis Report (Krohn et al. 1998), indicate that

habitat modeled to be suitable for lynx and marten was also suitable for 86% of other species studied. More recent research from presenter Erin Simons-Legaard indicates that some bird species were only found in habitat preferred by marten, while other bird species were never found to co-occur with suitable marten habitat. More research needs to be done to determine if species specialize on lynx habitat.

That American marten and Canada lynx depend on large, connected forest landscapes, representing different successional stages is key to why these species have been identified as potential umbrella species. Conservation of large landscapes has been identified in the Maine Wildlife Action Plan by MDIFW as a key strategy for maintaining common species and Species of Greatest Conservation Need. Future research could determine whether habitat parameters most suitable for Canada lynx and American marten also provide high-quality habitat for co-occurring Species of Greatest Conservation Need.

The Umbrella Species framework can help simplify management objectives for landowners, who can rely on a discrete set of practices to benefit a large diversity of species. This framework, for instance, is at the heart of the New England Forestry Foundation's Exemplary Forestry standards for the Acadian Forest region. Another framework widely used in Maine is 'Forestry for Maine Birds' produced by Maine Audubon. While umbrella species frameworks may be useful for managing common forest types for both forest products and biodiversity values, these frameworks are not applicable for managing specialized habitats, unique or rare ecosystems, or late successional or old-growth forests that many of Maine's rare, threatened and endangered species depend on.

Conclusion

Maine has extensive northern temperate (Acadian) forests that support robust populations of American marten and Canada lynx. Together, these species are ambassadors for forest management and conservation in Maine's northern forests. More research is needed to understand whether Canada lynx and American marten habitat quality represents habitat needs of other species of interest, such as Species of Greatest Conservation Need identified by the Maine Department of Inland Fisheries and Wildlife.

A variety of silvicultural tools are available for landscape scale management of lynx and marten habitat. Challenges to landscape scale management include the composition and stocking of forests, regulatory and social environments, markets, financial capacity, and current ownership patterns.

Much still needs to be understood about how climate change and changes in forest management patterns may affect Maine's northern forest habitats. Landscape scale management that retains large areas of forest in differing successional stages will be the best hedge to ensure persistence of habitat for a wide variety of species in the future.

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