CHAPTER 4

Natural Communities: Friends and Neighbors

In light of concerns about the future of northern white-cedar, it is important to fully understand its current distribution and abundance, evaluate its ecological and social importance, and develop a strategy for conservation and sustainable use. In the previous chapter, we discussed the range of northern white-cedar and how that has changed and will continue to change over time. But knowing the extent of northern white-cedar's range and whether it is expanding or contracting isn't enough to understand what is happening to the species. We must also know why these changes are occurring, and for that we must know the characteristics of the places where northern white-cedar lives and the assemblages of plants and animals there. This will help us understand the many connections between northern white-cedar trees and their communities, an important first step in devising a plan to ensure that they continue to thrive.

One of the many values of northern white-cedar is its contribution to biodiversity. This species lives in diverse habitats and contributes to many assemblages of plants and animals—these are its natural communities. If you look at

Northern white-cedar on lowlands on commercial forestland in Maine (*top*), and on uplands on provincial forestland in Quebec (*bottom*). *(Quebec photo by Catherine Larouche)*

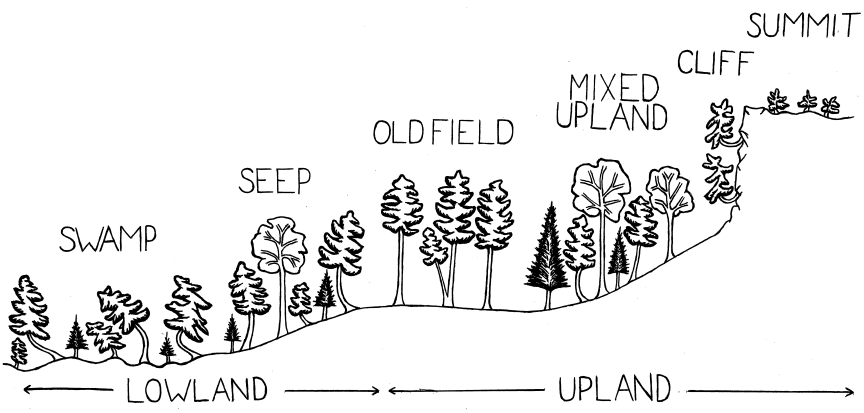
the map of northern white-cedar's range in the previous chapter, you can see that it covers a broad geographic area encompassing different climates, elevations, topographies, and soils. In fact, northern white-cedar grows naturally in swamps, lower slopes and valleys, along lakeshores and streams, and on abandoned pastureland, sandstone bluffs, and limestone cliffs. Each of those habitats supports different natural communities. Just as we recognize people and places in our daily lives, we can recognize not only individual species of plants but the communities in which they live. When we do, we can better understand our natural environment and the importance of habitats and communities to conserving specific organisms.

Landscape Diversity

At the large scale, northern white-cedar lives in many different habitats across the landscape at elevations from near sea level to more than 2,000 feet (610 m) (Grotte 2007). Soils—which determine rooting depth, fertility, and water availability—are a critical component of a tree's habitat and can vary greatly from one location to another. The soils supporting northern white-cedar include well-decomposed plant material (organic matter) near streams, thick mineral soil over sediments (till) deposited by glaciers during the last ice age, thin mineral soil over bedrock outcrops around lakes, and pockets of partially decomposed organic matter (duff) in crevices on cliffs and bluffs (Johnston 1990; Minnesota Department of Natural Resources 2003; Gawler and Cutko 2010; Cohen et al. 2015). Despite their differences, all of these soils have one thing in common: they provide northern white-cedar with reliable access to moisture.

Just like soils, assemblages of plants and animals differ among northern white-cedar's natural communities. Scientists have classified and named these communities to bring order to what would otherwise be a dizzying array of species in various combinations across sites. Yet because classification and naming systems have been developed separately by each state and province, it can be difficult to understand how communities in one place relate to those in another. For that reason, broad categories based on some overarching feature can be useful for splitting or lumping natural community types. For northern white-cedar, scientists often make this distinction based on whether a community is found in a lowland or upland habitat.

Lowlands, as the word suggests, are relatively low-lying areas in floodplains, along streams, and on adjacent lands formed by similar geologic processes.



A schematic showing northern white-cedar communities in lowland and upland landscape positions. *(Illustration by Jeanette Allogio)*

Uplands are on comparatively higher ground, usually above the floodplain and the gentle slopes at the bottoms of hills. Northern white-cedar grows fastest on uplands with moist, well-drained, calcium-rich soils derived from limestone, but tends to be more dominant on lowlands with organic soils. It flourishes in large numbers in forested wetlands (swamps) and seeps near lakes and streams where groundwater flows below or rises to the surface. Scientists think that northern white-cedar is more abundant on these sites because it faces less competition and damaging fires are infrequent (Johnston 1980; Johnston and Booker 1983).

Even though northern white-cedar swamps are a common natural community type, trees in swamps tend to grow slowly and can be prone to decay (Fowells 1965). Scientists have observed that northern white-cedar trees grow more rapidly and have less decay on uplands where soils are better drained, with moving groundwater rich in oxygen and nutrients (Pregitzer 1991; Hofmeyer et al. 2009; Kell 2009). On abandoned pastureland in New England and southern Quebec, for example, stands of what is known as *old-field* northern white-cedar tend to be fast-growing with good form and little decay (Curtis 1946). Such stands are a legacy of our use of the land rather than natural processes alone. Cattle browse less heavily on northern white-cedar than its competitors, and northern white-cedar seedlings are able to withstand trampling (de Blois and Bouchard 1995). For these reasons, northern white-cedar trees grow well on pastureland, albeit often

An old-field northern white-cedar stand in Vermont where local farmers cut small trees to use as fence posts.

with multiple stems. Local farmers cut these trees to use as fence posts; it is common to see barbed wire on locally sourced northern white-cedar posts around fields in northern Vermont and elsewhere.

Natural Communities

Natural communities—groups of interacting plants and animals and their physical environment—result from natural processes rather than human activities. They might occur repeatedly across the landscape where environmental conditions are similar. Identifying and naming natural communities helps us make sense of natural variation (Gawler and Cutko 2010) and is a necessary first step in developing plans for conservation or restoration. Because trees are larger and live longer than most other plants, they have an outsized effect on the characteristics of a natural community. Similarly, among the tree species in a community—which may be few or many—those that are most abundant

Examples of some natural community types with northern white-cedar:

(a) *Forested Seep*, Flambeau River State Forest, Wisconsin. *(Photo by Susanne von Schroeder)*
(b) *Rich Conifer Swamp*, Dukes Experimental Forest, Michigan.
(c) Volcanic Cliff, Porcupine Mountains Wilderness State Park, Michigan. *(Photo by Friedrich Wendorff)*
(d) *Evergreen Seepage Forest*, Penobscot Experimental Forest, Maine.
(e) *Northern Wet-Mesic Forest*, Argonne Experimental Forest, Wisconsin.
(f) *Rocky Summit Heath*, Cadillac Mountain, Maine.

(called the *dominant tree species*) tend to have the greatest influence. If management is desired and feasible, it would logically be driven in large part by the characteristics of those species. For this reason, our focus here is on communities in which northern white-cedar is dominant, though it is common throughout its range in communities where other species predominate, and contributes importantly to biodiversity there too. After narrowing our focus to the communities where northern white-cedar is dominant, we find that there are relatively few, even in the four states where it is most abundant: Minnesota, Michigan, Wisconsin, and Maine. Natural community types similar to these are also found in Canada; examples from Quebec are described in Sidebar 6.

Lowland Communities

Forested wetland community types where northern white-cedar is a dominant species include White Cedar Swamp in Minnesota, Rich Conifer Swamp in Michigan, Northern Wet-Mesic Forest in Wisconsin, and Northern White Cedar Swamp in Maine, among others (Minnesota Department of Natural Resources 2003; Gawler and Cutko 2010; Cohen et al. 2015; Epstein 2017). Soils are typically organic and include deep, saturated peat (partially decomposed plant material), muck (well-decomposed plant matter), and shallow peat over mineral soil. Though the water table remains at or near the surface for much of the year, northern white-cedar swamps have moving groundwater rich in nutrients and oxygen that allows diverse plant communities to flourish. The forest floor is a lush carpet of bryophytes such as sphagnum and brown mosses. Keeping company with the northern white-cedar are a number of conifers and hardwoods, including varying amounts of black, white, and (in Maine) red spruce; tamarack; balsam fir; eastern white pine; black ash; red maple; and birch and aspen species. Species of alder, honeysuckle, holly, raspberry, and blueberry are among the shrubs often found in these swamps. The diverse nonwoody plants include a number of rare or otherwise sensitive plants such as fairy slipper (calypso orchid), ram's head lady's slipper, showy lady's slipper, and roundleaf orchid (Gawler and Cutko 2010; Epstein 2017; see Appendix D). In fact, in the Great Lakes region several rare plant species occur more frequently in northern white-cedar swamps than in any other habitat (Epstein et al. 2002). This association of northern white-cedar with rare plants is an excellent example of why it's important to conserve natural communities, rather than focus only on charismatic animals or plants.

Rare orchids found in northern white-cedar swamps include the fairy slipper (*above left*), ram's head lady's slipper (*above right*), and roundleaf orchid (*left*). *(Photos by Chelsea Kieffer)*

Northern white-cedar swamps have unusually high structural diversity, which helps to diversify habitat. Many birds, mammals, insects, and fungi rely on structures in forests that look messy to people, like broken branches, dead treetops, leaning or fallen trees, and damaged or hollow stems. Because of their shallow roots, northern white-cedar trees in swamps sometimes fall over during wind or ice storms, creating pits and mounds on the forest floor and tangles of leaning stems and branches that shelter many species of wildlife. Wind and ice cause branches to break, and falling trees or logging machinery can damage stems and roots, allowing fungi to colonize living trees. Insects and woodpeckers excavate the exposed wood, creating cavities for nesting. Wildlife need many of these small habitat features (microhabitats) to feed, shelter, or breed at some point in their lives (Larrieu et al. 2018).

Northern white-cedar can be a dominant species in lowland seepage forests on gentle lower slopes or near lakes and streams where groundwater rises to the surface. These natural community types, such as the Lowland White Cedar Forest in Minnesota and Evergreen Seepage Forest in Maine, are often slightly upslope from those in swamps (Minnesota Department of Natural Resources 2003; Gawler and Cutko 2010). Underlying soils are typically shallow peat or muck over mineral soil, or mucky mineral soil (mineral soil with a high proportion of well-decomposed organic matter). As you might guess from those descriptions, these soils tend to be saturated with groundwater, which sometimes emerges in spring-fed brooks. On the forest floor, feather mosses and liverworts are more abundant than sphagnum (peat) moss. Intermixed with northern white-cedar trees are varying numbers of black, white, and (in Maine) red spruce, as well as balsam fir, black ash, red maple, and paper, yellow, or mountain paper birch depending on region and site. Shrubs such as American fly honeysuckle, mountain maple, and speckled alder are present but tend to be less abundant than in northern white-cedar swamps. Both upland and wetland species of herbaceous plants grow here, sometimes including the rare orchids showy lady's slipper and giant rattlesnake-plantain, the latter of which is threatened in some areas by collecting and logging (Gawler and Cutko 2010; Maine Department of Agriculture, Conservation and Forestry 2015).

Upland Communities

Natural community types on uplands where northern white-cedar is a dominant tree species include White Cedar–Yellow Birch Forest in Minnesota, Boreal Forest in Michigan and Wisconsin, and White Cedar Woodland in Maine,

◀ Structural complexity in a northern white-cedar stand.

Giant rattlesnake-plantain. *(Photo by Chelsea Kieffer)*

among others (Minnesota Department of Natural Resources 2003; Gawler and Cutko 2010; Cohen et al. 2015; Epstein 2017). You will often find these wooded upland communities on moderate to steep slopes with thin mineral soil over bedrock, though soils and moisture regimes vary. Bryophyte cover ranges from sparse to plentiful depending on community type, but typically includes dicranum and other mosses. Balsam fir or eastern white pine are abundant (Gawler and Cutko 2010; Cohen et al. 2015; Epstein 2017). Other associated tree species in the Lake States include yellow, paper, or mountain paper birch, as well as white spruce in the Boreal Forest community type. The mix of shrubs and non-woody plants depends on how much water is present, but can include various species of honeysuckles, hollies, and blueberries; woodfern; shining clubmoss; and starflower. Rare or otherwise sensitive plants, such as fairy slipper and ram's head lady's slipper, may also grow in these communities (Cohen et al. 2015; Epstein 2017).

Northern white-cedar can also predominate on cliffs and bluffs. In the forested Wet Cliff community type in Wisconsin, northern white-cedar, eastern hemlock, eastern white pine, and balsam fir grow on damp vertical bedrock or eroded bedrock ridges undercut by streams (Epstein 2017). These communities often occur in dense shade on slopes facing north and east, where direct sunlight is limited and conditions are cool and moist. Other woody species growing here include Canada yew, red elderberry, and mountain maple. In the understory, ferns and herbaceous species like bluebell bellflower, orange and yellow jewelweed, wild columbine, and wild sarsaparilla flourish. These difficult-to-access habitats are also home to the rare carnivorous plant common butterwort—which has leaves that excrete a sticky fluid that traps insects to be digested and absorbed by the plant—as well as the threatened northern blue monkshood and the endangered Lapland rosebay (Epstein 2017).

Unlike the Wet Cliff community type in Wisconsin, some cliff and bluff communities have sparse plant cover and stunted trees due to poorly developed soils, erosion, and exposure to the elements. In Michigan, the Clay Bluff natural community type occurs on steep, nearly vertical clay slopes along the shores of Lakes Superior and Michigan (Cohen et al. 2015). Only scattered, stunted northern white-cedar grow there, along with willow, paper birch, as well as jewelweed, alder, dogwood, and cherry species. In Maine, the Rocky Summit Heath natural community type grows on exposed bedrock on upper slopes and ridges near the coast and inland (Gawler and Cutko 2010). Soils consist of a thin layer of organic duff in bedrock pockets. Dwarf shrubs such

as lowbush blueberry and northern mountain cranberry grow beneath red and black spruce, balsam fir, and northern white-cedar trees that become patchy and stunted as elevation increases.

Even in seemingly inhospitable environments like cliffs and bluffs, northern white-cedar trees can survive for many hundreds of years. Scientists have found very old trees in the Boundary Waters Canoe Area Wilderness and Great River Bluffs State Park in Minnesota, and on the north shore of Lake Superior and the Niagara Escarpment (Tester 1995; Minnesota Department of Natural Resources 1996, 2005). Stretching from upstate New York, through southern Ontario, and into Michigan, Wisconsin, and Illinois, the Escarpment is home to northern white-cedar trees more than 1,500 years old (Larson and Kelly 1991).

To find out more about all of the natural communities in which northern white-cedar and its neighbors live, consult the many state guides that offer detailed descriptions and useful photographs, species lists, and conservation and management suggestions.

Changes in Natural Communities

The process of change in natural communities after a disturbance—a destructive storm or fire, for example—is known as *succession*. Though scientists have recognized that plant communities change for millennia, the concept of an orderly process of predictable change was not fully developed until the last century. In particular, the work of American ecologist Frederic Clements advanced our understanding of succession and promoted the idea that development after disturbance proceeds in one direction and results in a single, stable community called the *climax community* (Clements 1916; Odum 1969; Leopold et al. 1996). During this process one species or group of species was thought to dominate the community until being replaced by another. Prior to the mid-twentieth century, ecology textbooks generally supported this understanding of succession. In lowland forests, for example, ecologists believed that pioneering communities of sedges and grasses gave way to shrubs such as alder and willow, then to a more permanent, mature tree community (Aaseng et al. 1993). This mature community would experience fewer changes in species composition and structure than had occurred in earlier stages.

Unfortunately, succession is rarely that simple. Many different and competing theories developed, and the topic of succession now occupies multiple chapters in many ecology textbooks. To put it simply, scientists questioned the

Common butterwort. *(Photo by Andreas Fleischmann)*

Mature northern white-cedar, Dukes Experimental Forest, Michigan.

idea that natural communities follow a predictable sequence of change ending in a single, stable climax condition. Instead, they now recognize that—among other complexities—frequent disturbances change the successional pathways in many community types, meaning that progression toward a stable climax might not occur. Fire, windstorms, insect infestations, fungal infections, and nonnative invasive plants are so common that a stable climax community might be the exception rather than the rule (Tester 1995). Today, scientists generally accept that natural communities are in a constant state of change, and most ecosystems do not exhibit a stable endpoint or successional climax condition.

What does this constant state of change look like in northern white-cedar's communities? In forests where it grows, natural disturbances typically create small openings in the canopy. These canopy gaps result from trees dying of old age, windthrow, breakage, or localized insect or disease outbreaks. When a canopy tree dies, the light, water, and nutrients it was using become available to other vegetation. If the gap is small (created by the death of one or a few trees), then branches and roots of existing trees might take up these newly available resources, or seedlings of species tolerant of shade might start to grow in the

partially illuminated understory. If the gap is large (created by the death of multiple trees), then species that are intolerant of shade and those that benefit from disturbance, such as paper birch or pin cherry, might grow. In either case, gap dynamics add compositional and structural complexity to an established forest community and are common in northern white-cedar stands (Ruel et al. 2014; Fraver et al. 2020). Northern white-cedar, with its shade tolerance and exceptional longevity, has the ability to not only persevere but thrive in such stands over the very long term.

A number of factors lead to deviations from the expected development of natural communities as described above. Browsing by white-tailed deer, for example, can greatly change community structure and composition, particularly with regard to the amount of northern white-cedar and other plant species they selectively browse. This may account for the many northern-white cedar stands in the Lake States and New England that have understories of balsam fir instead of northern white-cedar (e.g., Johnston 1972; Kenefic et al. 2020). Because northern white-cedar can live hundreds of years longer than balsam fir,

Northern white-cedar stand with an understory of balsam fir near Dismal Swamp in Maine.

we would expect stands composed of these two species to become increasingly dominated by northern white-cedar over time. Yet the young trees growing beneath the canopies of many northern white-cedar stands—the trees poised to capture newly available resources in gaps and ascend to the canopy—are often balsam fir rather than northern white-cedar. Why is this compositional shift happening in two regions a thousand miles apart? Scientists think the driving factor may be excessive browsing by deer, which prefer northern white-cedar foliage to that of balsam fir. Similarly, Canada yew was once a common species throughout much of northern white-cedar's range but has also suffered from deer browsing to the point that it is now scarce or absent from many stands where it once grew (Lemieux 2010).

Effects of Human Disturbances

Deer are not the only ones to blame for declining numbers of northern white-cedar in some parts of its range. People have degraded some of the natural communities in which the tree usually grows, including the globally rare Alvar communities found on the shorelines of the Great Lakes in the United States and Canada. This natural community type occurs on thin soil over bedrock, is prone to wet and dry cycles, and may have open, savanna-like forest cover. Rare plants and animals such as the threatened dwarf lake iris and cherrystone drop land snail live here. Yet quarrying, road construction, and residential development are serious dangers to these unique communities (Epstein 2017). Scientists have cautioned that we must prioritize these areas for protection and restoration.

Some common northern white-cedar communities have also been degraded by people but might respond well to careful management. Roads intercept groundwater near northern white-cedar swamps, causing flooding on one side and drying out (dewatering) on the other (Chimner et al. 2017). Urban development disrupts the movement of water through the soil, as well as water uptake by plants. Large openings created by some types of harvesting create conditions inhospitable for northern white-cedar, leading to shifts to other tree or shrub species. Other threats include the spread of nonnative invasive plants such as glossy buckthorn and marsh thistle, and as we've already discussed, excessive browsing by deer, particularly in the Lake States (Rooney and Waller 2003). Climate change is likely to exacerbate all of these threats as the conditions northern white-cedar encounters become increasingly different from those to which it is

adapted. The ability of the tree to successfully regenerate is of particular concern, as increased variability in precipitation and climate increases the probability that fragile seedlings will succumb to flooding or drought.

In short, many things people do disrupt plant communities, ecosystem stability, and the values ecosystems provide (ecosystem services). These services include not only maintaining biodiversity and producing wood, but recharging groundwater, filtering pollutants, and storing carbon to counteract the effects of greenhouse gas emission and climate change. Better planning, siting, and technological changes can mitigate damage associated with road building and construction (see Sidebar 7). Where northern white-cedar trees are abundant and sites suitable, integrating species' requirements for regeneration and growth into forest management will lead to more favorable outcomes. In all of these instances, careful consideration of the structure and function of natural communities can help guide sustainable use, restoration, or preservation of northern white-cedar and its diverse communities.

NORTHERN WHITE-CEDAR

The Tree of Life

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