

A survey of northern white-cedar (*Thuja occidentalis*) limestone woodlands at Point au Roche State Park, New York

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ABSTRACT

Limestone woodlands are an ecological community type identified by the New York Natural Heritage Program. These communities are characterized by shallow soil over limestone bedrock. Two northern white-cedar (*Thuja occidentalis*) limestone woodland stands were surveyed in Point au Roche State Park (Clinton County), one at Middle Point and the other at Ram's Head. Both stands were dominated by white-cedar and both stands were essentially even-aged. The Ram's Head stand was determined to be the older of the two stands. The structure of these stands indicates that they were probably regenerated by a clearcut. Northern white-cedar survivorship was determined for the Middle Point stand based on snag density per diameter at base height (dbh) class. The northern white-cedars showed a "type II" survivorship curve, with relatively constant mortality rates between 26 and 79 years of age. Although northern white-cedar is a commercially valuable species, the white-cedar limestone woodlands at Point au Roche State Park should be protected for their ecological value.

Key Words: *white-cedar; Thuja occidentalis; Point au Roche State Park; limestone woodlands*

INTRODUCTION

To further our knowledge of the natural world, and to discover where to concentrate conservation and management efforts, it is necessary to make an inventory of ecological communities. Reschke (1990) defined an ecological community as "a variable assemblage of interacting plant and animal populations that share a common environment." Exact delineations of ecological communities are human constructs, since natural communities usually blend at ecotones rather than having distinct edges. Nevertheless, it is useful to categorize ecological communities into discrete, relatively homogeneous units to make them

easier to study.

The New York Natural Heritage Program (NYNHP) has documented, and updates as needed, the ecological communities of New York State (Reschke 1990; Edinger et al. 2002). The goal of the NYNHP is to provide a complete list of the biological diversity throughout the state and to assess which ecological communities are in need of conservation. While the NYNHP has collected a tremendous amount of information, more data are still needed on many of New York's ecological communities in order to assess the need for any future conservation efforts (Reschke 1990; Edinger et al. 2002).

One of the community types that require more survey efforts is limestone woodland (NYNHP 2009). These woodlands are characterized by limestone bedrock with shallow soils (Reschke 1990; NYNHP 2009). The canopy cover can be open or closed and can be dominated by one or more species (Reschke 1990; Edinger et al. 2002; NYNHP 2009). Canopy species range from stands dominated by northern white-cedar (*Thuja occidentalis* L.) and other evergreens such as white pines (*Pinus strobus* L.) or white spruce (*Picea glauca* [Moench] Voss) to those dominated by hardwoods such as hophornbeam (*Ostrya virginiana* [Mill.] K. Koch) (Edinger et al. 2002). The limestone woodlands at Point au Roche State Park are dominated by northern white-cedar.

Northern white-cedar is a common belonging to the cypress family (Cupressaceae) that is found in the northeastern United States and southeastern Canada (Johnston 1990). White-cedar stands occur in both in dry, calcareous upland sites as well as wet, bog and swamp habitats. Growth rate can differ depending on soil conditions, varying from 4.5–12 m in height over 50 years (Johnston 1977). The height of mature white-cedars averages between 12 to 15 m with a dbh of 30–60 cm (Johnston 1990). Northern white-cedar trees can live for more than 400 years (Johnston 1990). White-cedar is shade tolerant, with the ability to survive for hundreds of years without a growth release (Heitzman et al. 1997; Hofmeyer et al. 2010). Saplings, however, are a preferred food source for browsing by white-tailed deer (*Odocoileus*

virginianus) and snowshoe hare (*Lepus americanus*), which can prevent stand establishment in recently disturbed areas (Johnston 1977).

The goal of this study was to quantify the richness and age of the two northern white-cedar limestone woodlands in Point au Roche State Park, Clinton County, New York. The objectives of this study were to describe the white-cedar stands on Middle Point and Ram's Head by the following variables: tree species composition; northern white cedar density; basal area; and survivorship.

METHODS

Site Description

Point au Roche State Park is approximately 344 hectares of land located in Clinton County, New York. The Park is currently owned and maintained by the New York State Office of Parks, Recreation and Historic Preservation (OPRHP); however, it has had a history of various land uses and owners (Evans et al. 2003). The Park was nearly closed in 2010 due to New York's fiscal crisis and the future of the Park remains uncertain.

The study areas for this project were two stands dominated by white-cedar, located along the eastern sides of Middle Point and Ram's Head (Figure 1). These sites are included in the 40 ha of limestone woodlands at Point au Roche State Park (Evans et al. 2003). While the bedrock is considered limestone by the NYNHP, technically it consists of argillite, as much of the calcite has been leached out and replaced with clay (Fisher 1968; Gillett personal communication).

Sampling Protocol

Five, 0.02 ha circular plots (radius=7.98 m) were installed near the eastern shore of Middle Point. Plots were measured according to methods developed by Nyland and Remele (1975), using a target pole and BAF-10 prism. Distance between plots was at least 50 m, however, to avoid recently disturbed areas

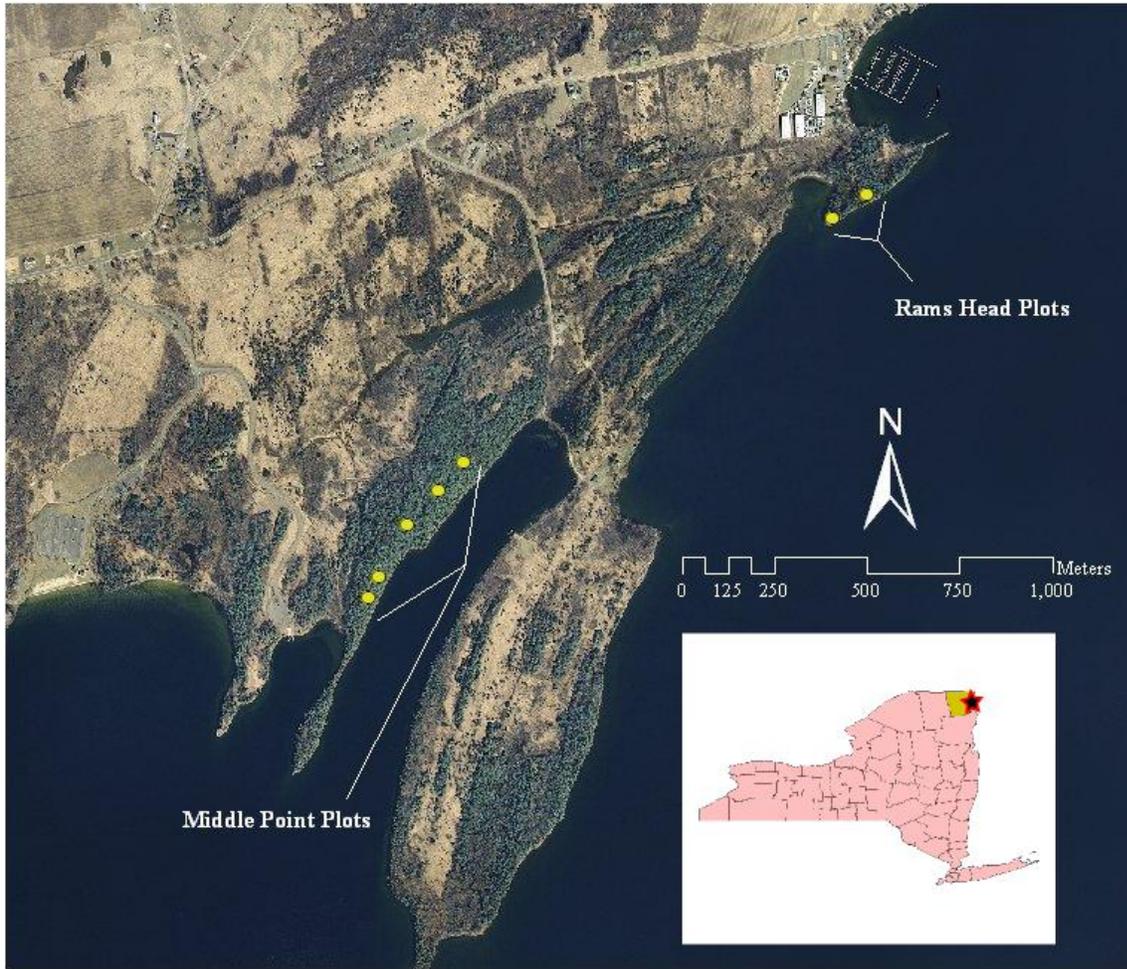


Figure 1. Location of the limestone woodland plots surveyed in Point au Roche State Park, Clinton County, NY. Orthomimagery obtained from the NYSDOP (2009).

and trails, inter-plot distances were adjusted as needed.

Only two plots could be installed at Ram's Head. Due to the proximity of the trail, 0.02 ha rectangular plots (10m x 20m) were used. Coordinates of all plots were recorded using a GPS unit (Garmin eTrex Legend HCx) (Table 1, Figure 1).

Table 1. GPS coordinates of sampled plots in Point au Roche State Park, Clinton County, NY.

Middle Point	Rams Head
N44.77472 W73.38439	N44.78379 W73.36843
N44.77522 W73.38403	N44.78435 W73.36722
N44.77648 W73.38306	
N44.77730 W73.38198	
N44.77799 W73.38111	

In each plot, the dbh of all trees greater or equal to 5.1 cm was recorded. Standing dead trees (snags) were measured if bark was still present. Trees were identified and recorded using a six-letter code consisting of the first three letters of the genus and the first three letters of the specific epithet.

Data Analysis

Stem density per ha was calculated for each species. For Middle Point, stem density per ha was calculated by dividing the number of stems recorded by 0.1 ha (0.02 ha plots x 5 plots). For Ram's Head, stem density per ha was calculated by dividing the number of stems recorded by 0.04 ha (0.02 ha plots x 2 plots). Basal area (m²) per ha was also calculated for each species. Basal area (m²) per tree was calculated by the formula: Basal Area (m²) = dbh (cm)² * 0.00007854.

Survivorship was calculated for northern white-cedars on Middle Point based on snag density. Age was estimated using the median dbh for each size class, multiplied by 7 years per cm radius. The number of snags was then extrapolated to find mortality per 1000 trees entering the smallest dbh class. Survivorship was found by subtracting the proportional number of snags from each age class for a cohort of 1000 trees. Survivorship was not calculated for white-cedar at Ram's Head because there were not enough representative age classes of sampled snags.

RESULTS

A total of seven species were found in the Middle Point plots: northern white-cedar, white pine, big-tooth aspen (*Populus grandidentata* Michx.), eastern hemlock (*Tsuga canadensis* [L.] Carrière), hophornbeam, basswood (*Tilia americana* L.), and common buckthorn (*Rhamnus cathartica* L.). White-cedar had the highest density (3020 live trees per ha), while all other species were far less abundant (200 live trees per ha) (Table 2). The size class with the highest density of live white-cedar trees was 10.1–15

cm dbh (Table 2). The size class with the most snags was 5.1–10.0 cm dbh (Table 2). Contrastingly, Ram's Head was a pure northern white-cedar stand, with fewer live trees (2775 trees per ha) than Middle Point (Table 3). The highest density of live trees was in the 15.1–20.0cm size class (Table 3).

The structure of the white-cedar stand on Middle Point is essentially even-aged, but with the small number of cedars in the 35.1–40.0 size class, this stand could also be regarded as two-aged (Figure 2). The Ram's head white-cedar stand is essentially even-aged and older than the Middle Point stand (Figure 2).

Northern white-cedar was dominant in both Middle Point and Ram's Head limestone woodlands. Ram's Head had a higher dominance of live northern white-cedar than Middle Point (86.1 and 62.1 m²/ha, respectively), while Middle Point had a higher dominance of northern white-cedar snags than Ram's Head (8.3 and 2.8, respectively) (Figure 3).

Survivorship for northern white-cedar in the Middle Point stand was similar to a “Type II” curve (as per Deevey, 1947) (Figure 4). Northern white-cedar mortality rates were relatively constant between the ages of 26 and 79, with a small reduction in rate of mortality near 50 years of age (Figure 4). No snags were older than 80 years (estimated).

Table 2. Stem density (trees per ha) for species and dbh classes, northern white-cedar stand on Middle Point, Point au Roche State Park, Clinton County, NY.

Size Class (cm)	THUOCC	THUOCC ^a	Others ^b
5.1-10.0	490	1160	40
10.1-15.0	1140	130	0
15.1-20.0	830	30	60
20.1-25.0	440	20	20
25.1-30.0	100	0	30
30.1-35.0	0	0	30
35.1-40.0	20	0	10
40.1-45.0	0	0	0
45.1-50.0	0	0	10
Total	3020	1340	200

^a snag trees

^b Others includes white pine, big-tooth aspen, eastern hemlock, hophornbeam, basswood, and common buckthorn

Table 3. Stem density (trees per ha) for species and dbh classes, northernwhite-cedar stand on Rams Head, Point au Roche State Park, Clinton County, NY

Size Class (cm)	THUOCC	THUOCC ^a
5.1-10.0	225	275
10.1-15.0	525	125
15.1-20.0	975	0
20.1-25.0	600	0
25.1-30.0	300	0
30.1-35.0	125	0
35.1-40.0	25	0
40.1-45.0	0	0
45.1-50.0	0	0
Total	2775	400

^a snag trees

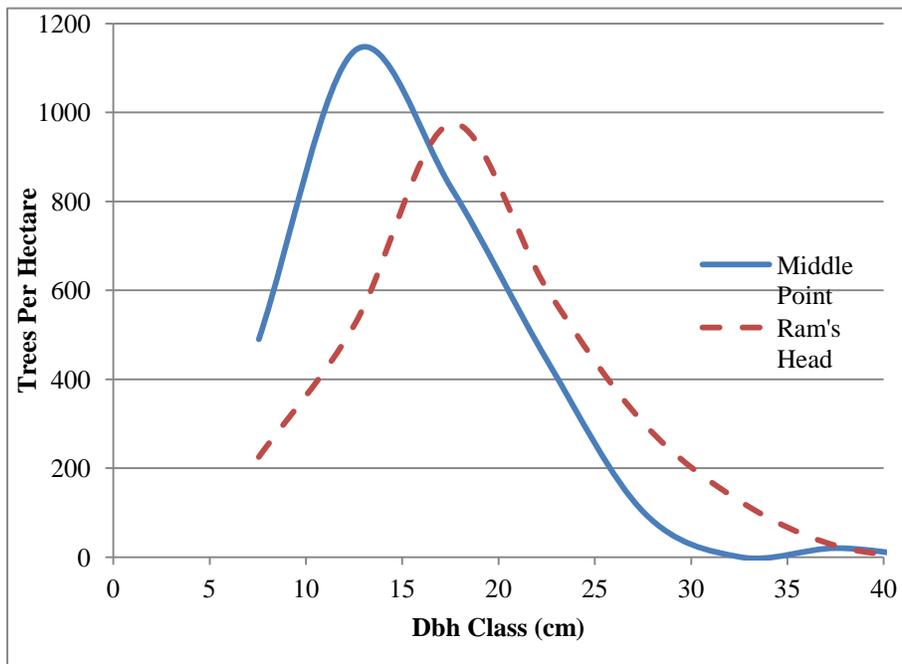


Figure 2. Age structure of live white-cedar trees in the Middle Point and Ram's Head limestone woodlands, Point au Roche State Park, Clinton County, NY.

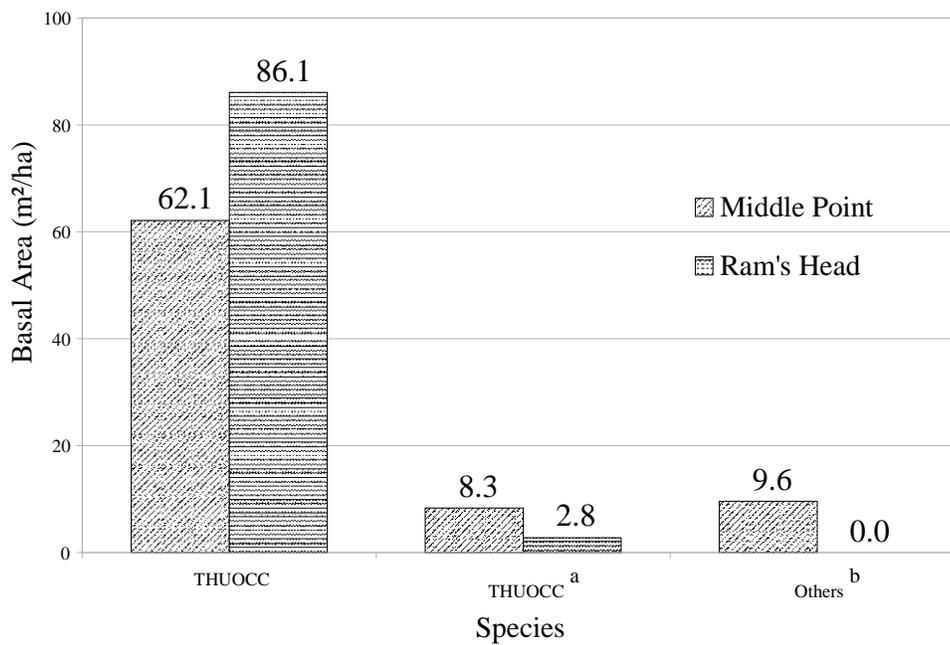


Figure 3. Dominance of trees in the Middle Point and Ram's Head limestone woodlands, Point au Roche State Park, Clinton County NY. ^a denotes snag trees, ^b Others are: white pine, big-tooth aspen, eastern hemlock, hophornbeam, basswood, and common buckthorn.



Figure 4. Survivorship curve of Middle Point white-cedar stand based on snag density. Note that age was an estimate of median age for each size class, using 7 years/cm stem radius.

DISCUSSION

The rarity status of limestone woodlands is a rank of S2S3 (6 to 100 occurrences, possibly vulnerable in New York) (Reschke 1990; Bonanno 1994; Edinger et al. 2002). Globally, these woodlands are ranked G3G4, indicating that they might be secure but rare in parts of their range (Edinger et al. 2002). The NYNHP (2009) suggested the need for data recognizing new limestone woodland types. The two limestone woodlands studied at Point au Roche are dominated by white-cedar, which is not a new type. It is still important to quantify and document these community types for baseline data in future studies.

Comparing age structures of the Middle Point and Ram's Head northern white-cedar stands suggests that both stands are essentially even-aged. The Ram's Head stand is older than the Middle Point stand, with its bell-shaped curve shifted to the right of the curve for the Middle Point stand (Figure 2). The even-aged structure of these stands hints to the land use history of Middle Point and Ram's Head.

Typically, even-aged stands result from a clearcut or some other large disturbance. While it may not be possible to determine the exact origin of these two stands, examining the history of Point au Roche gives us some insights.

Land use in Point au Roche was extremely varied over the past two centuries. Native Americans occupied the land prior to the late 18th century, when the first European settlers arrived (Oberon and Wonderly 1987). Benjamin Mooers, one of the first European settlers, reportedly cleared some land for a log house in 1783, and lived at Point au Roche year-round from 1786–1794 where “exploitation of forest resources” was likely (White 1979). Evans et al. (2003) mentioned that land ownership changed over a dozen times since 1820, and that one of the park's many uses was as a summer camp. Given the northern white-cedar size classes in this study, these stands were probably regenerated sometime in the early 20th century. The ability of northern white-cedar to survive under suppressed conditions for over 300 years (Hofmeyer et al. 2010) makes it difficult to estimate tree ages precisely without examining tree cores or cross-sections of tree stems.

The mortality rates of northern white-cedars displayed in the “type II” survivorship curve of Middle Point is probably attributed to competition (Figure 4). A comparison of the white-cedar density and basal area at Middle Point with Johnston’s (1977) white-cedar stocking guide shows that tree competition remains high in the Middle Point stand, especially in the smaller size classes. The absence of snags in the larger size classes suggests that mortality is low among older northern white-cedars, those that are dominant or co-dominant in the canopy.

While seedlings were not sampled in this study, very few were seen during field work. This suggests high mortality among seedlings, perhaps due to herbivory from white-tailed deer or snowshoe hare, as white-cedar is a preferred food source for these herbivores (Johnston 1977). Deer and hare density in Point au Roche State Park is currently unknown, and an investigation into the relationship

between herbivore population density and northern white-cedar mortality in the park would be a useful future study.

The white-cedar limestone woodlands at Point au Roche State Park are as interesting as the history of the park itself. While the limestone woodland ecological community type is not considered threatened by the NYNHP, the fate of Point au Roche State Park may affect these ecological communities, should the state of New York ever decide to sell the property. Members of the “Friends of Point au Roche State Park,” along with other local environmental groups, should consolidate their political influence toward the long-term preservation of the special ecological communities that comprise Point au Roche State Park.

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