An Evaluation of Northern Red Oak (*Quercus rubra)* at Seney National Wildlife Refuge (2005)

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Introduction

Northern red oak (*Quercus rubra*) is a widespread and common deciduous tree species found throughout eastern North America (Figure 1). It grows best on well drained upland soils with a north or east aspect at elevations between 0-1,800 m (0-5,900 ft) and can reach dimensions of 20-30 m (65-98 ft) in height and 61-91 cm (24-36 in) in diameter (USDA 2005). Northern red oak can live up to 500 years.

Northern red oak is identifiable by several distinct characteristics. The tree derives its common name from the red hue the foliage turns in the fall and the red coloration of the petioles and heartwood. The leaves are alternate, simple, 10-25 cm (5-8 in) in length, yellow-green above and have 7-11 bristle tipped lobes. The bark can be various shades of dark brown to black and is smooth on young trees, forming "ski-track" like fissures with flat ridges as the tree matures. Acorns are 2-3 cm (1 in) in length, a third of which is covered by a flat cap, lined with fine silky hairs (USDA 2005).

Northern red oak can produce acorns as early as 25 years of age, with larger and more abundant crops occurring after age 50. Masting intervals occur every two-five years and the number of acorns produced varies between individual trees and subsequent years based on weather conditions (USDA 2005). The acorns of northern red oak take two years to mature and ripen in late August-October. Viable acorns germinate and develop into seedlings, but continued growth is often limited by several factors; light intensity, moisture, soil nutrient content, browsing, and competing vegetation. This species is notoriously difficult tree to establish and maintain within a forest stand.

The seedlings of northern red oak are intermediate in shade tolerance and unless sufficient light from gaps in the canopy is provided they will often be replaced by shade tolerant

species such as sugar maple (*Acer saccarum*), American beech (*Fagus grandifolia*), and American basswood (*Tilia americana*) (USDA 2005). This tree species is also capable of regenerating by producing numerous stump sprouts that utilize the intricate root system of the existing tree for development. This method of asexual reproduction can be commonly observed in trees that have undergone periods of stress such as low intensity fires, browsing, and mechanical damage.

The acorns, leaves, and young seedlings of northern red oak are utilized as a food source by a wide variety of wildlife species. Acorns are easily digestible and are high in lipids (fats), starches, soluble protein, sugars, carbohydrates, and vitamins B and C (Short 1976). The hard outer seed coat allows the acorns of northern red oak to be stored through the winter, providing an invaluable food source through this time period. Over 90 wildlife species commonly incorporate acorns into their diet, some of which include white-tailed deer (*Odocoileus virginianus*), wild turkey (*Meleagris gallopavo*), red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), bobcat (*Lynx rufus*), striped skunk (*Mephitis mephitis*), black bear (*Ursus americanus*), squirrels (*Sciurus* spp.), chipmunks (*Tamias* and *Eutamias* spp.), mice (*Peromyscus* spp.), and blue jay (*Cyanocitta cristata*) (VanDersal 1940).

Northern Red Oak at Seney National Wildlife Refuge

The topography and soils found at Seney National Wildlife Refuge (SNWR) were formed by glacial activity occurring over the past 10-15,000 years. Soils vary from poorly drained Dawson and Greenwood peats composed of fine woody material underlain by wet sands to excessively drained sand and gravel deposits (Burgar & Cotar 2003). Elevation varies from

approximately 244 m (800 ft) in the northwest portion to 195 m (640 ft) in the southeast corner, with undulating ridges, sandbars, and depressions occurring throughout.

Existing tree species and plant communities at SNWR have been influenced by a variety of factors. In the early 1900's large tracts of land were logged and converted to agriculture. After farming failed, the land was transferred back to the state and later obtained by the U.S. Fish and Wildlife Service. Since establishment of SNWR in 1935, the land has been managed with wildlife abundance and diversity being among the priorities. Timber management continues to be a crucial part of land management at SNWR. However, a shift from a utilitarian perspective to forest restoration has occurred.

Since many anthropogenic alterations (e.g. pools, ditches, dike systems) have occurred at SNWR, it is not surprising to find plant species that were not present prior to European settlement. Northern red oak may be among such species. Between 1947 and 1949, approximately 10,200 northern red oaks were planted in all three Water Management Units for the purpose of establishing a hard mast food source for wildlife species (Johnson 1947, 1948, 1949). Due to the nature of the establishment of this species and its relatively small population, northern red oak is not included as a "stand alone" cover type in the draft cover type map for SNWR.

Project Objectives

This project aims to answer the following hypothesis: are northern red oak trees on the Refuge primarily the product of plantings? Specifically this work will describe the geographical distribution and relative stem density of northern red oak, determine the age distribution and the proportion of single and multiple stemmed trees, estimate the current recruitment status (number

of seedlings, saplings, and stump sprouts) of northern red oak throughout the non-Wilderness portion of the Refuge, and characterize soil conditions within mapped stands. It is assumed that the major areas containing stands of northern red oak (not individual trees) are known by SNWR staff from prior field reconnaissance. Thus, this project does not focus on mapping all individual trees, but instead focuses on characterizing the larger stands of northern red oak that are presently known.

Methods

To characterize the geographic distribution of northern red oak within SNWR, road surveys were conducted within each of the three Water Management Units at the Refuge. Since forests at SNWR primarily exist on narrow, linear strips of high ground formed by glacial activity, such a survey is assumed to be appropriate since these same areas are where roads may be found. Major roads surveyed included Driggs River Road, Pine Creek Road, Chicago Farm, and Riverside Dike. Areas with trees were marked on a Refuge map and later digitized and the density of northern red oaks in each group was categorized as relatively high, medium, or low. Groups were identified and assigned by consulting the resulting map that displayed the distribution of northern red oaks through each Unit.

In order to be representative of each Unit, 12 trees greater than 12.7 cm (five in) DBH (diameter at breast height) were sampled within each Unit for a total of 36 trees. Data collected for each tree complex included: GPS coordinates, number of stems within each complex, height, DBH, and the number of northern red oak seedlings, saplings, and stump sprouts within a five m (16.4 ft) radius of the complex. An increment bore was used on 11 of the sampled trees

distributed evenly between each Unit to determine an age range. Trees with the greatest DBH from each complex were selected for coring.

Due to the sparse and patchy distribution of northern red oak within SNWR, a standard sampling technique was difficult to implement. In order to select the trees to be sampled, a central point (or points) was identified along a road system of each group within all three units. A random azimuth (that would include an oak) was taken from the coinciding road at the central point. A random distance from the road was selected in half chain (10 m or 33 ft) increments up to five chains (100 m or 330 ft). Upon reaching the coordinating tree complex, it was marked and assigned a Unit, group, and complex number. From this point, a random azimuth and a chain length was again selected. This method was continued within each group until the corresponding number of trees was sampled making sure that the sampled trees were > 10 m (32.8 ft) apart.

Results & Discussion

A total of 10 stands of northern red oak were mapped on non-Wilderness portions of SNWR. These stands were distributed across approximately 566.6 ha (1,400 acres): Unit 1 had two stands, Unit 2 had five stands, and Unit 3 had three stands. Northern red oak was primarily found in narrow strips adjacent to the SNWR road system, often occurring in patches of medium to high density or as scattered individual complexes of low density (Figure 2). Of the 10 stands of northern red oak that were mapped, two were of high relative stem density, three were of medium density, one was of low-medium density, and four were of low density. Existing stocking levels may be a reflection of several factors such as planting intensity, disturbance history, and site quality (e.g., soils, micro-habitat conditions, frost pockets).

A total of 88 northern red oak stems were sampled from 36 complexes. Stems sampled varied in height from approximately 4.3-24.4 m (14-80 ft) and DBH from 12.4-49.5 cm (4.9-19.5 in). Thirty-five percent of the 88 individual stems sampled and 47% of the largest 36 stems were 22.8-30.2 cm (9.0-11.9 in) in diameter, making this diameter class the most prominent across the identified groups within the Refuge (Figure 3, Figure 4). A total of 11 northern red oaks were found to be between 50-63 years of age, with an average and median age of 54. Of the cored trees, 64% were 50-54, 27% were 55-59, and 9% were 60-64 years old (Figure 5).

Of the 36 tree complexes selected, eight (22%) were single-stemmed and 28 (78%) contained a range of two to six stems. Complexes composed of two (36%) or three stems (25%) were the most common (Figure 6). The high proportion of multi-stemmed complexes may be due in part to heavy browsing or other factors (such as fire) that may have occurred.

The number of seedlings of northern red oak was variable among stands and ranged from three to 85 seedlings. In low density stands the mean = 36 seedlings and the median = 30 seedlings. In medium and high density stands these values were, respectively, mean = 38 seedlings, median = 35 seedlings; mean = 28 seedlings, median = 25 seedlings (Figure 7).

Only two tree complexes, both from Group 3-1, contained any saplings within a five m (16.4 ft) radius. Notable differences between this site and others sampled were visually apparent, such as the number of trees per unit area and the absence of a dense canopy and competing vegetation (e.g., ferns, blueberry). It was also evident that a fire had occurred fairly recently (<50 years) and this disturbance may have killed the main stems of several complexes within the area. Such complexes had a flourish of stem sprouts radiating from the fire charred central stem and also had higher numbers of saplings nearby.

Stands containing northern red oak were found to be composed of a variety of wetland and upland soil types (Figure 8). Approximately 140 ha (346 acres or 24% of the initial 1,400 acres) were listed as "unclassified wetland" while the remaining 429 ha (1,060 acres or 75%) were described as "excessively well drained sites" and varied from poor to good growth potential for northern red oak (Burger & Kotar 2003). Identified habitat types included PVE (*Pinus strobes/Vaccinium angustifolium-Epigaea repens),* PArVAa (*Pinus strobes-Acer rubrum/Vaccinium angustifolium-Aralia nudicaulis),* and AFPo (*Acer saccharum-Fagus grandifolia/Polygonatum pubescens).* Only PVE mentions the possibility of northern red oaks occurrence and notes, "when present is poorly formed and lacks vigor" (Burger & Kotar 2003).

Soils do not seem to reliably predict the presence of northern red oak at SNWR. For example, soil type 66 (Markey Mucky Peat) exists on approximately 53.4 ha (132 acres or 9% of the area mapped with northern red oak) but occurs on 17,705.6 ha (43,750 acres) of SNWR. Therefore, if the sampling scheme employed allowed for an adequate mapping of the larger stands of northern red oak at SNWR (even including the Wilderness Area), only 0.3% of the area with this soil type has stands of northern red oak (Table 1). Furthermore, soil type 540D (Deford-AuGres-Rubicon Complex) composes 2,991.5 ha (7,392 acres) of SNWR, but only 236.7 ha (585 acres or 7.9%) supports northern red oak and 525B (Neconish-Kinross-Wainola Complex) occurs on 1,436.7 ha (3,550 acres) of SNWR and only 6.5 ha (16 acres or 0.5%) is occupied by this species.

Conclusion

Stands of northern red oak mapped contained trees that were quite similar in age and size. The distribution and occurrence of oak complexes along major road systems, combined with planting records and the above-mentioned statistics, suggest that these stands are the product of previous plantings by staff of SNWR.

Figure 1. North American range of northern red oak.

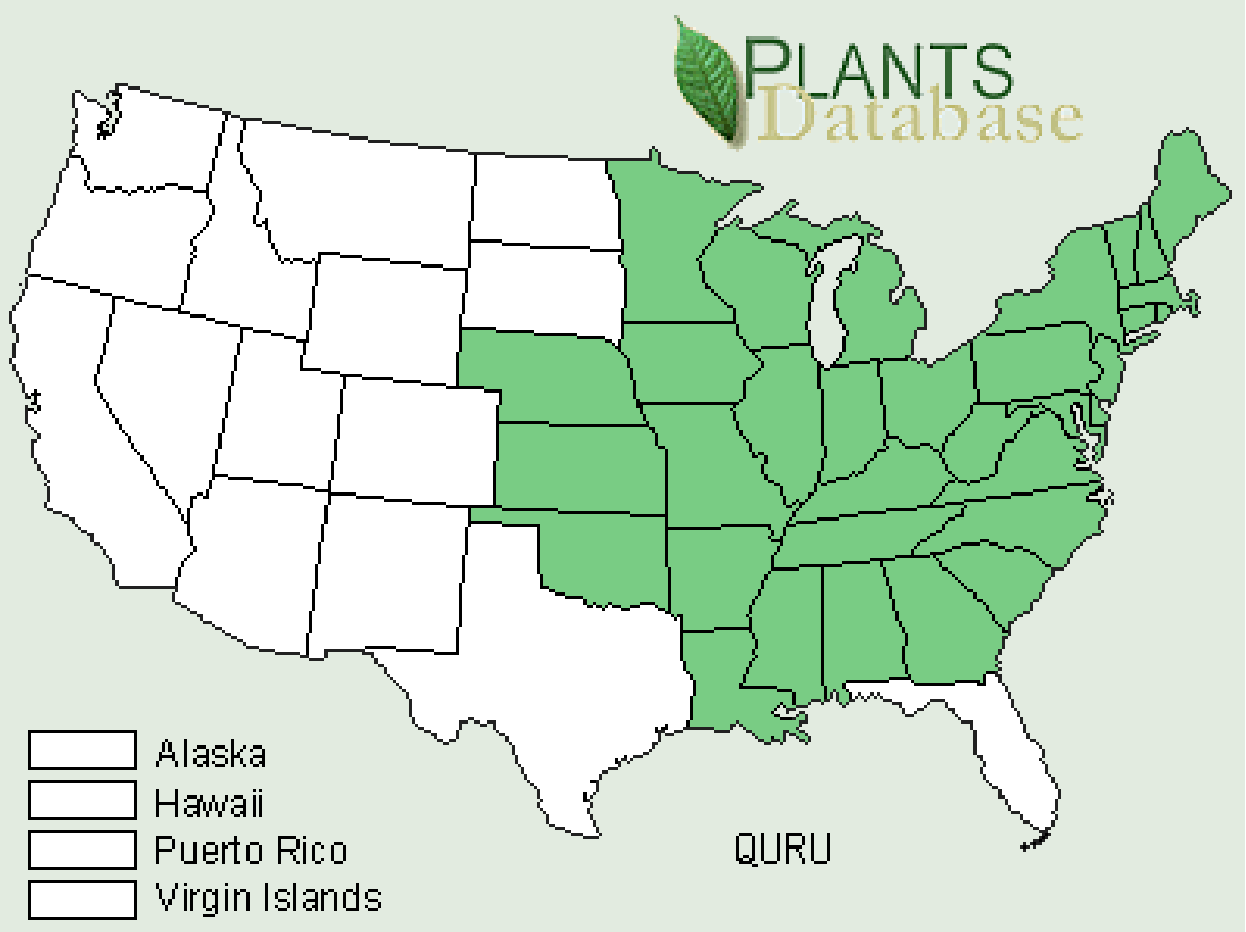

Figure 2. Geographical distribution and relative stocking density of northern red oak, Seney National Wildlife Refuge (2005).

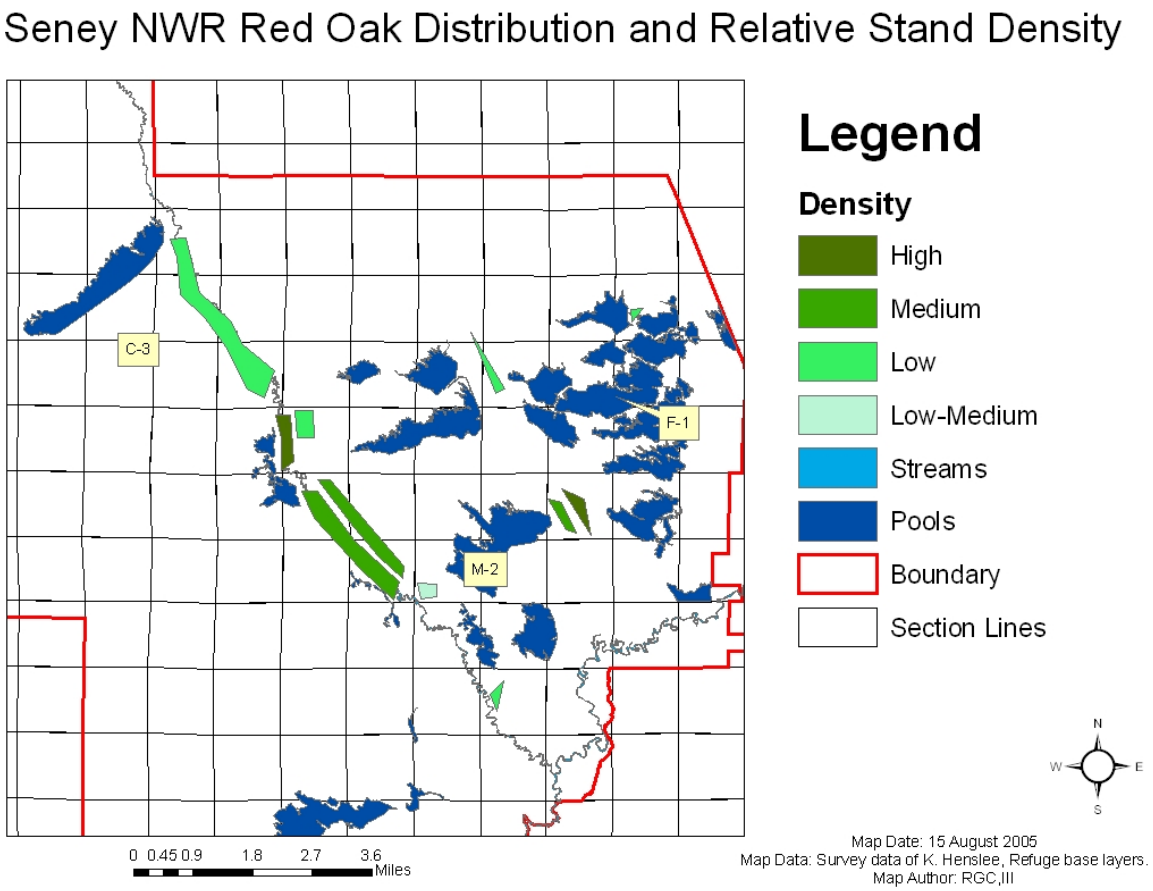

Figure 3. Size distribution of all northern red oak trees in selected complexes, Seney National Wildlife Refuge (*n=88*, 2005).

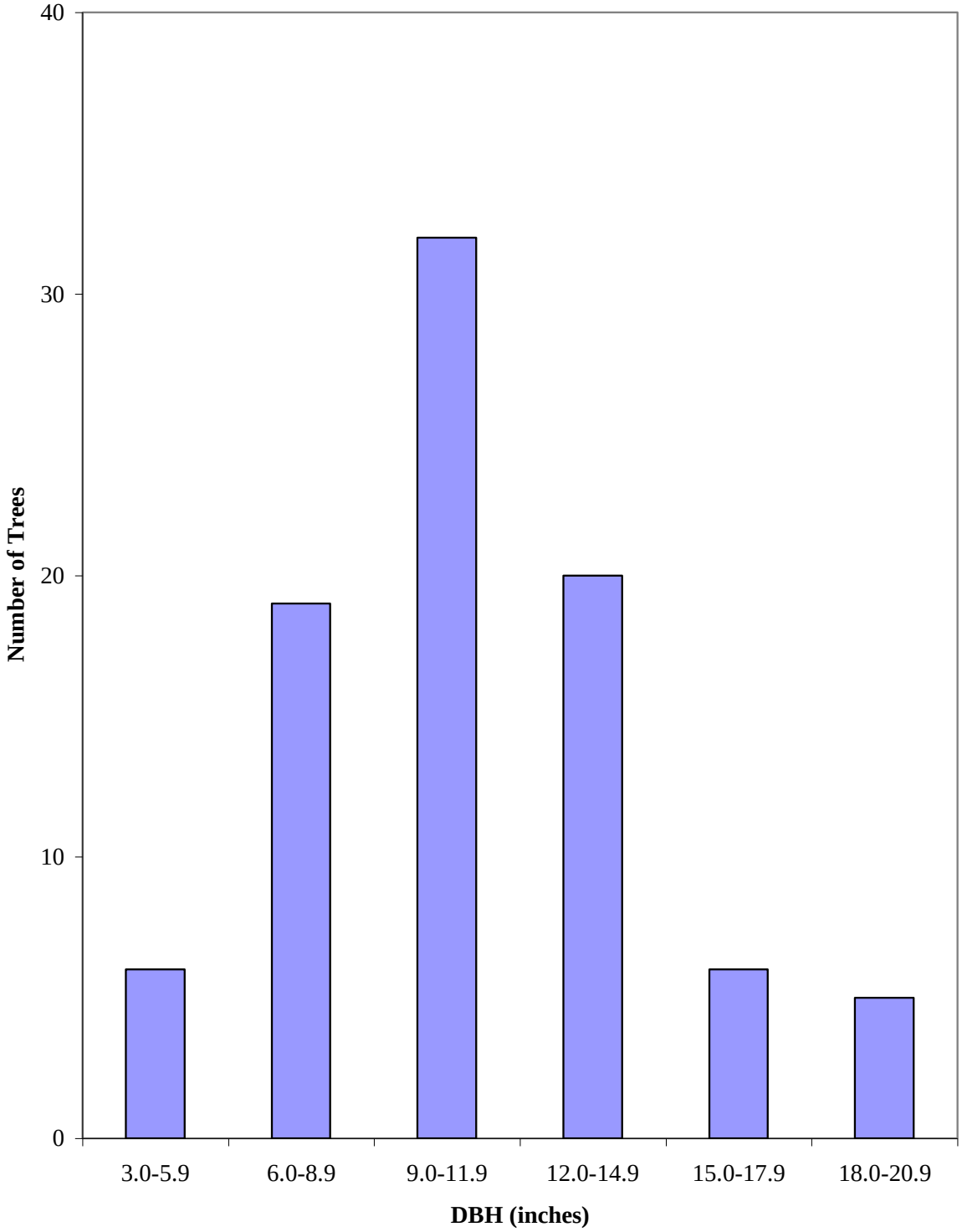

Figure 4. Size distribution of largest northern red oak trees in each selected complex, Seney National Wildlife Refuge (*n=36,* 2005).

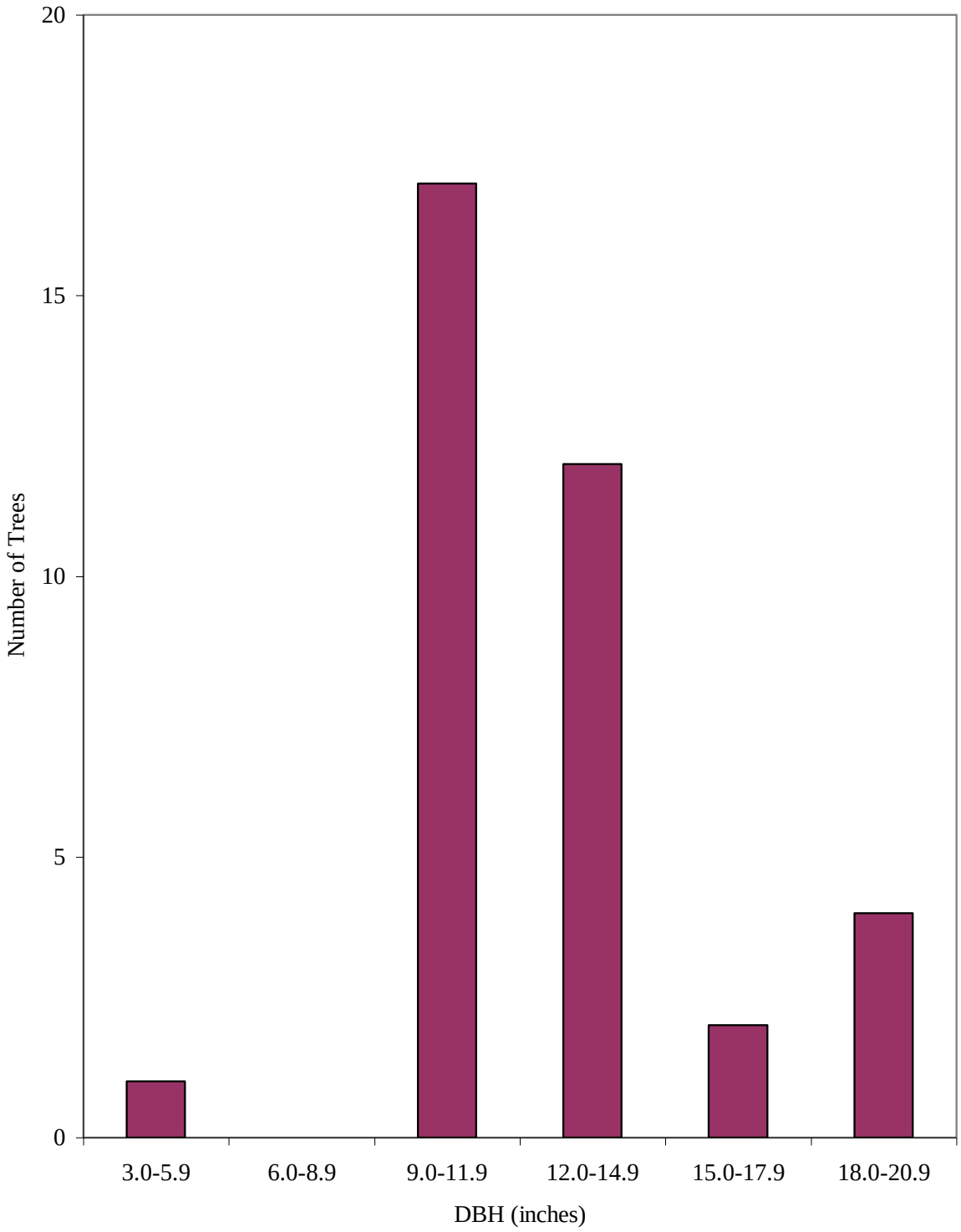

Figure 5. Age distribution of cored northern red oak trees, Seney National Wildlife Refuge (*n=11,* 2005).

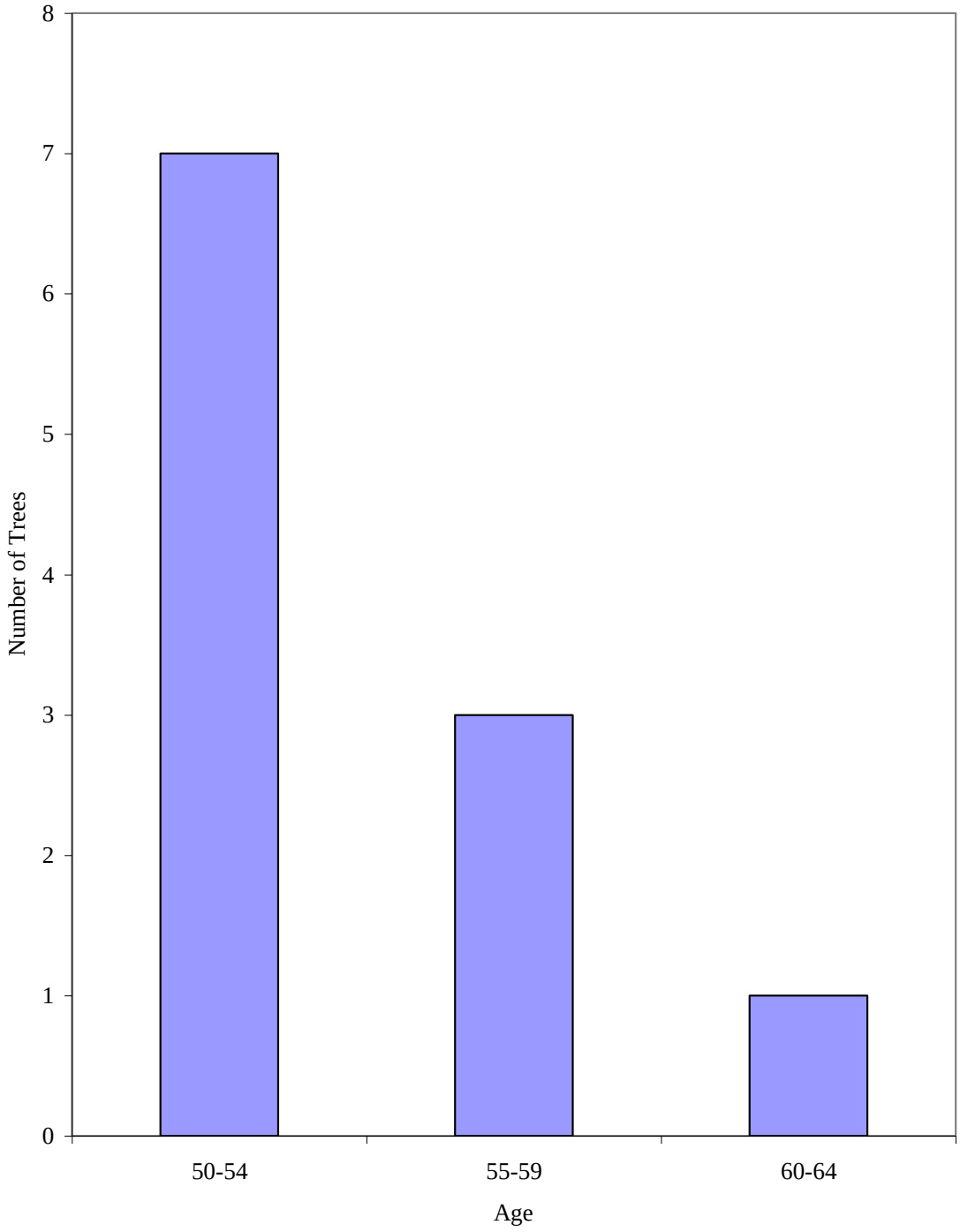

Figure 6. Number of stems per sampled northern red oak complex, Seney National Wildlife Refuge (*n=36*, 2005).

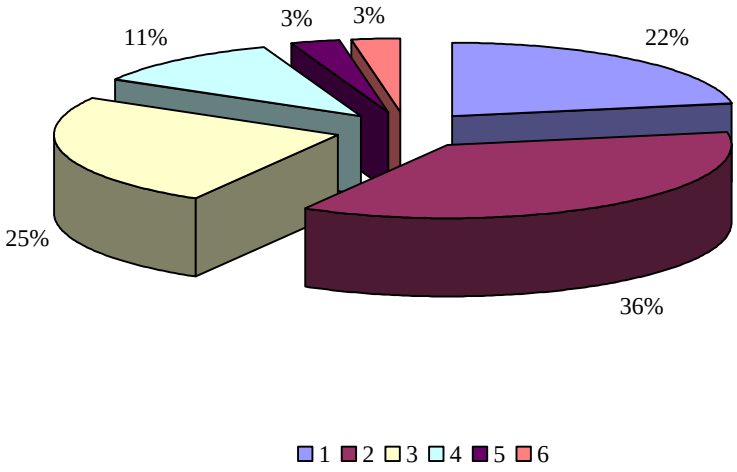

Figure 7. Average number of seedlings of northern red oak by stand density, Seney National Wildlife Refuge (2005).

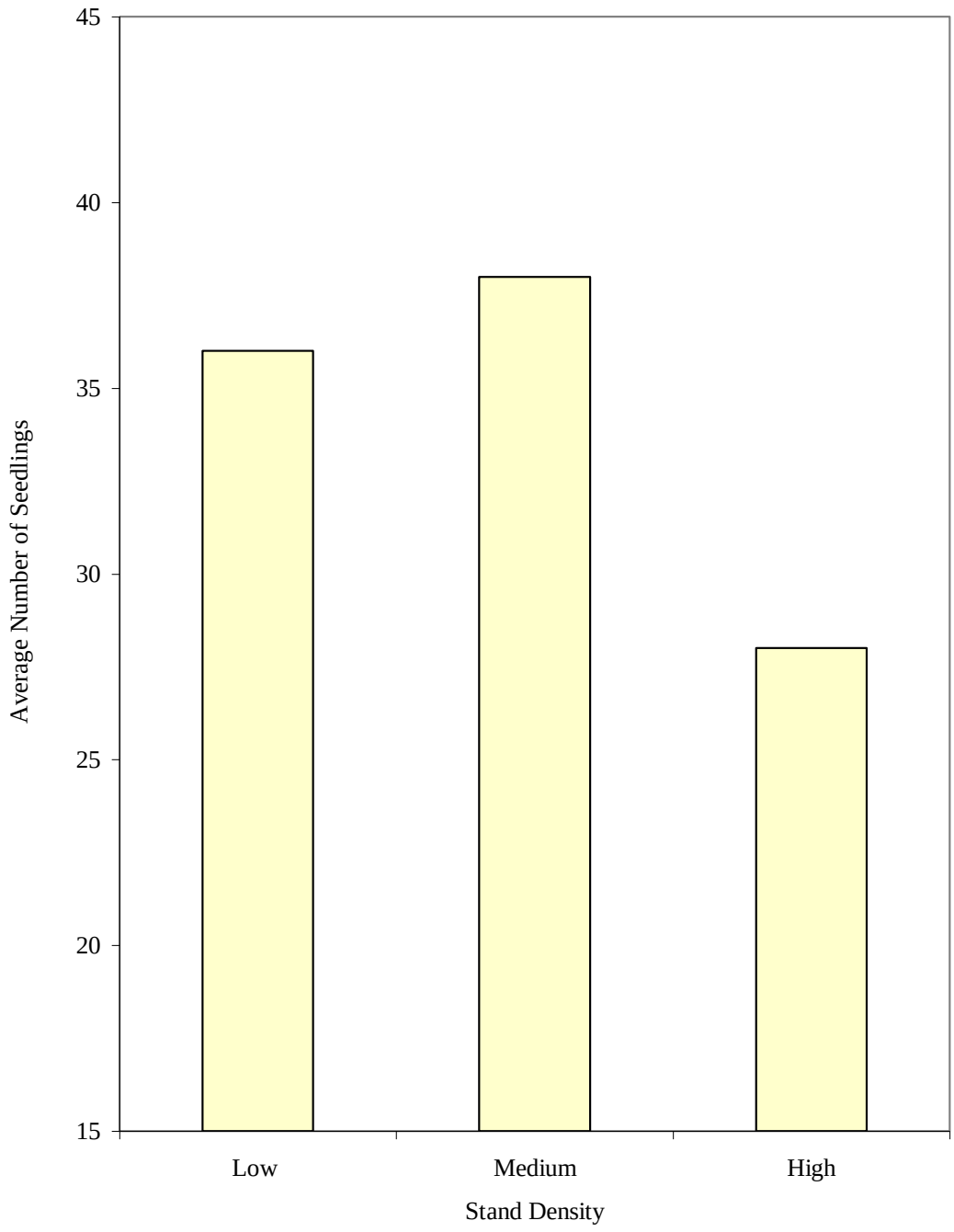

Figure 8. Northern red oak distribution and soil associations, Seney National Wildlife Refuge (2005).

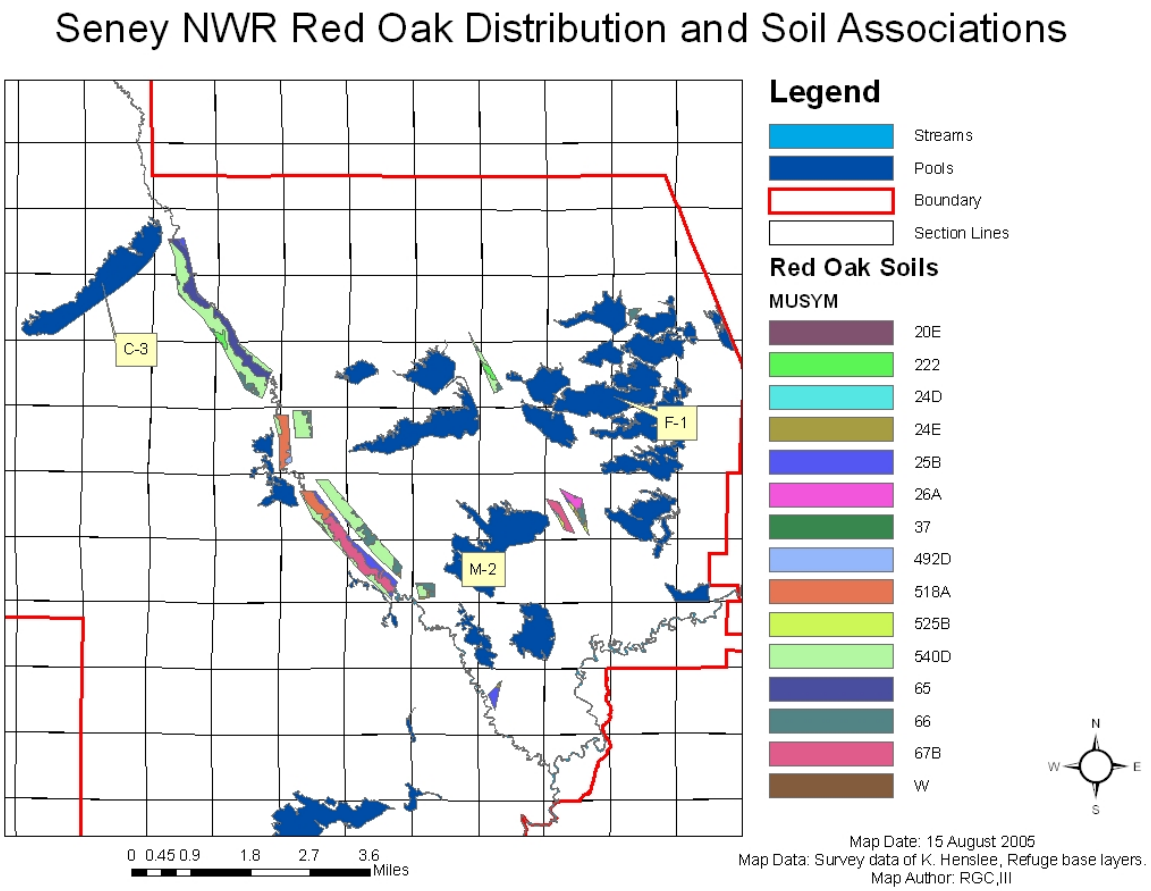

Table 1. Soils of mapped stands of northern red oak, Seney National Wildlife Refuge (2005).

Soil Type	Acres within Mapped Stands	% of Mapped Stands	Total Acreage of Soil at SNWR	% of SNWR	Northern Red Oak Groups	Primary Habitat Types	Forest Comm. Assoc.
65	183	13	1,316	14.0	3-1	unclassified wetland soils	NONE
66	132	9	43,750	0.3	1-1, 1-2, 2-1, 2-2, 2-3, 3-1	unclassified wetland soils	NONE
222	31	2	1,638	1.9	3-1	unclassified wetland soils	NONE
24E	17	1	600	2.8		PVE	very poor-very dry, excessively well drained. Low nutrients and organic matter. Poor growth potential for northern red oak.
25B	104	7	1,266	8.0	2-5, 3-3	PVE	very poor-very dry, excessively well drained. Low nutrients and organic matter. Poor growth potential for northern red oak.
26A	27	2	888	3.0	1-2	PArVAa	dry, mesic, excessively well drained. Fair-good growth potential for northern red oak.
492D	10	0.7	827	1.2	3-2	PArVAa	dry, mesic, excessively well drained. Fair-good growth potential for northern red oak.
518A	124	9	1,057	11.7	3-2, 3-3	unclassified wetland soils	NONE
525B	16	1	3,550	0.5	1-2, 2-4	PVE	very poor-very dry, excessively well drained. Low nutrients and organic matter. Poor growth potential for northern red oak.
540D	585	41	7,392	7.9	2-1, 2-2, 2-3, 3-1, 3-2, 3-3	unclassified wetland soils	NONE
67B	174	12	1,303	13.4	2-4, 3-3	AFPo	mesic, medium nutrients, moderately well-excessively well drained. Very good growth potential for northern red oak.

Table 2. Group-level northern red oak stand characteristics, Seney National Wildlife Refuge (2005).

Group	Density	Avg. DBH (in) of Largest Stem in Complex	Avg. Height (ft) of Largest Stem in Complex	Avgerage # Seedlings	Soil Types
1-1	L	16.9	59.5	9	66
1-2	H	12.1	56.9	26	525B, 26A, 66
2-1	L	11	57	34	540D, 66
2-2	M	11.8	56	33	540D, 66
2-3	L-M	12.8	50	70	540D, 66
2-4	M	12.5	51	8	525B, 67B
2-5	L	18.5	72	80	25B
3-1	L	14.2	46.5	27	540D, 65, 66, 222
3-2	H	12.4	52	31	492D, 540D, 518A
3-3	M	10.2	45.3	42	67B, 25B, 518A, 540D

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