Forest Habitat Value Assessment Protocol

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Due to the important ecological and habitat values of forests and woodlands and the ecosystem services they provide, the following protocol will help to identify forested tracts that have either low, medium, or high habitat values. Using this protocol will help to develop conservation strategies to protect, improve and maintain these values. The methods described below measure habitat values of a forested site and should remove subjectivity, not be open to interpretation, are repeatable, consistent, and can be verified in the field.

Methodology

The methods described here are exclusive to the state of Delaware and should be strictly followed to maintain consistency in data collection. If you wish to use or modify these methods for use outside of Delaware, then permission is required by the author.

The first step in conducting a forest habitat value assessment, is to identify the site boundaries for the area of study. The area of study should be a well-defined and delineated area in which sampling plots are placed.

Potential habitat values are measured by sampling plots that are 0.1 acre (0.4 hectares) in size, which is an accepted standard for sampling forests and woodland vegetation. To maximize the percent confidence in results and to decrease the potential for uncertainty and inaccurate assumptions associated with extrapolation, the following number of plots are required based on the size of the forest being studied. There is a minimum number of plots required based on the number of acres [e.g., 1-10 acres (0.4-4.1 hectares), with a minimum of 2 plots], but it is recommended that if the surveyor feels that more plots are needed to accurately represent the area being studied, then one or more plots should be added.

Number of plots required per acre(s)

1 - 10 acres (0.4 – 4.1 hectares) = 2 plots
10 - 20 acres (4.1 – 8.1 hectares) = 3 plots
20 - 30 acres (8.1 – 12.1 hectares) = 4 plots
30 - 40 acres (12.1 – 16.1 hectares) = 5 plots
40 - 50 acres (16.1 – 20.2 hectares) = 6 plots
50 - 60 acres (20.2 – 24.3 hectares) = 7 plots
60 - 70 acres (24.3 – 28.3 hectares) = 8 plots
70 - 80 acres (28.3 – 32.4 hectares) = 9 plots
80 - 90 acres (32.4 – 36.4 hectares) = 11 plots
90 - 100 acres (36.4 – 40.5 hectares) = 12 plots
100 - ……

Subjective placement of sample plots shall be used because it is a more efficient way of sampling rather than placing sample plots randomly, particularly in fragmented or disturbed landscapes. Capturing examples that best represent the full range of habitats and plant communities within a site requires the intentional selection of sample plots, which means deliberately placing them away from field edges, clear-cuts, roadsides, and other human disturbed areas. In selecting sampling plots, it is important to place the plot in areas that floristically and structurally best represents the overall forest area that is being sampled. Aerial imagery and computer mapping data (e.g., soil and wetland maps) can be utilized to initially analyze the forested area for study. Field maps can be created utilizing these data by marking potential areas for plot placement that contain potentially mature forest, forest interior, mapped wetlands, and different mapped soil types. One or more plots should be placed within these various environmental settings.

When a plot has been selected for sampling, the center point of the plot is established and located with a GPS unit. From the center point, 37.2 feet (11.3 meters) is measured from the four (4) compass points, which then creates a circle that is 0.1 acre in size. Use brightly colored flagging to mark each end point, as well as the center point. Once the plot is established data collection begins.

The forest within each plot should be characterized. A forested plant community is characterized by the dominant species in the upper tree canopy, followed by the dominant species in the shrub layer, followed by the dominant species in the herbaceous layer. For example: Canopy = American beech/red oak/tulip poplar; Shrub Layer = arrowwood viburnum/spice bush; Herbaceous Layer = Christmas fern/Bosc's witch grass/loose-flowered sedge. In addition to the dominate plant species, include an estimate of the forests successional stage. For example, early-

to-mid successional, mid-to-late successional, late successional. Trunk diameters, as well as canopy height, and the degree of cover within the shrub and herbaceous layers will help in making this estimation. Also describe the soil moisture of the plot, e.g., mesic (moist), well-drained (dry), poorly drained (wet).

Scoring Sample Plots

Forests with high ecological and habitat values are areas that contain some or many of the following characteristics or attributes. Included with each attribute, is the required method for sampling and ranking.

Large Diameter Trees: Large diameter trees are an indication of a late successional, maturing, or mature forest. A mature forest ecosystem provides key environmental values and services and can support a high degree of biodiversity.

Methods and Scoring: All trees within the plot that are 18 inches or greater in diameter (measured at 4.5 feet from the base of the tree), are measured and recorded. An 18–19-inch diameter tree receives 1 habitat value point. For every 2-inch increase in diameter, an additional value point is added for each individual. For example: 18-19" = 1 point, 20-21" = 2 points, 22-23" = 3 points, 24-25" = 4 points, etc. Round up or down based on the trunk diameter, e.g., 19.1-19.4" = a 19" diameter tree and 1 value point, 19.5-19.9" = a 20" tree and 2 value points. In addition, if any tree 18 inches or greater in diameter is a "value tree" (see description below), then that tree receives and additional point. For example, if an 18-19" diameter tree is a native oak species, then that tree receives 1 extra value point. When an individual tree with multiple trunks is encountered, and the trunks are 18 inches or greater in diameter, than the larger of the trunks is measured and recorded as one trunk.

Presence of Valued Tree Species: Most species of trees provide a variety of benefits to wildlife; however certain species are highly valued by wildlife. To ensure that the forest is a relatively stable ecosystem in the long term and that dead or dying valued trees are being replaced by other value tree species, it is critical that valued tree species be found in multiple layers of the forest, from the canopy as mature trees to the herbaceous layer as seedlings.

Methods and Scoring: All valued tree species (see below) within the plot (any size: seedling, sapling, tree) are recorded in the following forest layers: Canopy (uppermost layer), Sub-canopy (12' to below uppermost level), Tall Shrub (6'-12'), Low Shrub (2'-6'), Herbaceous (0"-2'). For each value tree species found in a forest layer, one habitat value point is assigned. For example, if the value tree species white oak (*Quercus alba*), Northern red oak (*Quercus rubra*), and mockernut hickory (*Carya tomentosa*) all occur in the canopy, then 3 habitat value points are assigned for that layer. However, if these value trees are 18 inches or greater in diameter, then they are not counted because they were previously counted from the canopy in the Large Diameter Tree attribute (an 18-inch diameter tree is more likely to occur in the canopy, then in lower forest layers). Only value trees less than 18 inches in diameter in the **canopy** are counted. Each layer is treated and scored separately, so the same species that were recorded in the canopy, can also be recorded, and scored in subsequent layers.

Value Native Tree Species

Botanical Name	Common Name
Amelanchier arborea	downy shadbush
Amelanchier canadensis	Eastern shadbush
Amelanchier laevis	smooth shadbush
Betula lenta	sweet birch
Carya cordiformis	bitternut hickory
Carya glabra	pignut hickory
Carya ovalis	small-fruited hickory
Carya ovata	shagbark hickory
Carya pallida	sand hickory
Carya tomentosa	mockernut hickory
Diospyros virginiana	persimmon
Fagus grandifolia	American beech
Magnolia virginiana	Northern sweetbay magnolia
Nyssa sylvatica	blackgum
Pinus echinata	short leaf pine
Pinus rigida	pitch pine
Pinus serotina	pond pine
Pinus taeda	loblolly pine
Pinus virginiana	Virginia pine
Prunus serotina	wild black cherry
Quercus alba	white oak
Quercus bicolor	swamp white oak
Quercus coccinea	scarlet oak
Quercus falcata	Southern red oak
Quercus lyrata	overcup oak
Quercus marilandica	blackjack oak
Quercus michauxii	swamp chestnut oak
Quercus montana	chestnut oak
Quercus nigra	water oak
Quercus pagoda	cherrybark oak
Quercus palustris	pin oak
Quercus phellos	willow oak
Quercus prinoides	dwarf chinquapin oak
Quercus rubra	Northern red oak
Quercus stellata	post oak
Quercus velutina	black oak

Plant Species Richness: High plant species richness (the total number of species and varieties represented in a plot), indicates minimal disturbance and stability within the forest ecosystem. And a rich diversity of plants offers great value to wildlife. Plant species richness can be measured using the Floristic Quality Index (FQI). The FQI is a quantitative measure to determine the ecological quality of a natural area or site by recording all the native and non-native plant species observed within a sample plot. The FQI has been shown to be a reliable means of assessing quality with minimal data collection and allows for the comparison of floristic quality among many sites. Coefficient of Conservatism ranks (C-values) are used to determine the FQI of a specific site or plant community and C-values have been applied to the entire known flora of Delaware. Access C-values here: https://www.wrc.udel.edu/de-flora.

Each species is assigned a C-value based on their observed behavior within the state of Delaware. C-values range from 0 to 10 and represent an estimated probability that a plant is likely to occur in a habitat that is relatively unaltered from what is believed to be a pre-settlement condition. For example, greenbrier (*Smilax rotundifolia*), shows little to no fidelity to any specific plant community and can be found almost anywhere, so a C-value of 1 is applied. A C-value of 10 is applied to species such as the grass-pink orchid (*Calopogon tuberosus*), which is almost always restricted to a high quality, specialized habitat. All non-native species are given a C-value of 0.

Methods and Scoring: All native and non-native vascular plants within the plot are recorded. The C-values for each species are applied, and the FQI is calculated (to apply a C-value, all plants observed must be identified to species). The floristic quality index is determined by calculating the average C-value of all vascular plants recorded from a plot. All C-values are added, then divided by the number of species recorded, which then gives you the FQI. The calculated index is the number of habitat value points assigned to the plot.

Forest Productivity: Forest soils that are productive for deciduous tree growth allow trees to reach their full biological potential, and for a functioning forest ecosystem to develop.

Methods and Scoring: The USDA soil survey for New Castle Co. (1970), Kent Co. (1971), and Sussex Co. (1974) lists the soil types found below as having a rating of "good," which indicates that the soil is "well suited for the production and growth of deciduous trees" and is also "well suited for woodland wildlife." If any one of these soil types have been mapped for the plot being sampled, then 3 habitat value points are assigned to that plot. At least one or more plots should intentionally be placed within any, or all these soil types if mapped for the site. Frequently, a soil type is composed of different percentages of other soil types. The soil type with the highest percentage is how the soil type is mapped. For example, an area mapped as Glenelg loam (GeB) – a soil type with a "good" rating for forest productivity and wildlife – is composed of 85% Glenelg, 10% Gaila, and 5% Glenville. Soil types can be identified by using the USDA Web Soil Survey: https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm; or Soil Web: https://casoilresource.lawr.ucdavis.edu/gmap/

Soil types rated as “good” for forest production and wildlife.

Aldino	Kalmia
Butlertown	Keyport
Chester	Manor
Codorus	Matapeake
Collington	Mattapex
Comus	Montalto
Delanco	Neshaminy
Elioak	Sassafras
Fallsington	Talleyville
Glenelg	Woodstown
Glenville	

Course Woody Debris, or fallen trunks and limbs, and dead standing trees or snags: Course woody debris creates microhabitats for wildlife, provides a substrate for mosses and lichens, and contributes to the nutrient cycle within the forest ecosystem. Dead standing trees attract food for wildlife in the form of insects that burrow into bark and rotted wood, and snags often have hollows or cavities that provide shelter and nesting habitat.

Methods and Scoring: All dead standing trees or snags, and all down trunks and limbs within a plot that are 12 inches or greater in diameter are worth 1 habitat value point each.

Delaware Ecological Network: The Delaware Ecological Network (DEN) is a statewide conservation network developed from computer and field-collected data that provides a consistent framework to help identify and prioritize areas for natural resource protection. The DEN is composed of the following elements: **Core areas**, which contain relatively intact natural ecosystems, and provide high-quality habitat for native plants and animals; **Hubs**, which are slightly fragmented aggregations of core areas, but have contiguous natural cover; and **Corridors**, which link core areas together, allowing wildlife movement and seed and pollen transfer between them.

Methods and Scoring: If the site that is being assessed is within a DEN Core, then 5 habitat value points are added to the overall final score. If in a DEN Hub, 4 value points are added to the overall final score. If in a DEN Corridor, 3 value points are added to the overall final score. The DEN can be accessed through First Map: Delaware Ecological Network 2.0 | Delaware Ecological Network 2.0 | State of Delaware (arcgis.com)

Forest Interior: The forest interior or the “core,” is habitat deep within woodlands, away from the influence of forest edges and open habitats. Forest interior is of high ecological value and research has shown that forest interior habitat begins at 300 feet from the forest edge. Many species of wildlife are dependent on forest interior habitat for their survival.

Methods and Scoring: Determining forest interior requires computer or cellphone software capabilities. Forest interior begins 300 feet from the forest edge. Identify all forest edges related to the site that is being assessed – which may be off-site on an adjacent property – and measure 300 ft. inward. If using computer or cellphone software to determine forest interior is not an option, then measuring in the field can be done using measuring tapes or measuring wheels. If a plot being sampled is within forest interior, then that plot receives 5 habitat value points. One or more plots should intentionally be placed within forest interior areas.

Mature Forest Potential: The biodiversity and environmental values of a forest ecosystem increases with age, meaning that a mature or late successional forest will be able to support a greater variety and number of plants and animals as time progresses, as well as provide a higher level of key environmental services and benefits.

Methods and Scoring: Determining mature forest potential of a forested site requires computer or cellphone access. Historical aerial photographs of Delaware [1937, 1954, 1961, 1968, 1992, 1997, 2002, 2007, 2012, 2017, 2021, and 2022 (imagery from 1926 is also available for Delaware but does not provide full state coverage)] are available for use (https://demac.udel.edu/tiles/), and may help to identify potential areas of mature forest. For example, if imagery from each of the years previously mentioned show that a site has been in continuous forest cover since 1937, then there is a high probability that the site is mature (assuming that the forest was 10-20 years old in 1937). If a plot being sampled is within forest that has been in continuous cover since 1937, then that plot receives 5 habitat value points. One or more plots should intentionally be placed within forested areas that have the potential for being mature based on review of available aerial imagery.

Wetlands: Wetlands are areas where the soils are saturated with water or covered by shallow water at some time during the growing season of each year. Wetlands have many important functions and values within an ecosystem and often support a high degree of biodiversity. The presence of non-tidal, freshwater wetlands within a forested area adds ecological value to that forest.

Methods and Scoring: If non-tidal, freshwater wetlands have been mapped within the boundaries of the site being surveyed, then 5 habitat value points are added to the overall final score. Unchannelized (not ditched) streams or creeks that flow through a site are included as non-tidal, freshwater wetlands. Human-made, excavated wetlands such as ponds and gravel pits are not to be considered. Wetlands can be identified through First Map: 2017 Wetlands (not regulatory) | 2017 Wetlands (not regulatory) | DE FirstMap (arcgis.com).

Analysis

Once sampling of plots within a forest are completed, data are then summarized and analyzed. Habitat value is determined through a numerical, value point system and is based on the maximum number of value points possible for each of the attributes to be measured. A range of values has been calculated: 1-18 habitat value points (Low habitat value), 19-37 value points (Medium habitat value), and 38 or greater value points (High habitat value). If more than 1 plot was sampled within the site, then the total habitat value points from each plot are averaged, giving an overall habitat value for that forest. A site with a rank of Low or even Medium, identifies an area that may be improved through management. A forest with a rank of High, identifies an area that should be protected and monitored to maintain that high level of habitat value.

- Low habitat value = 1-18 points
- Medium habitat value = 19-37 points
- High habitat value = 38 or greater points

To account for environmental variability and confidence in sampling efforts, if a forest is within one habitat value point of the next level (either Medium or High), then that forest is elevated to the next level. For example, if an assessment results in the maximum amount of habitat value points for a Low habitat level (18), then that forest is raised to a Medium habitat value level. Similarly, if an assessment results in the maximum amount of habitat value points for a Medium quality habitat level (37), then that forest is raised to a High habitat value level.

Documentation and Justification

Forest Habitat Quality Attributes	Maximum Potential Habitat Value Points
Large Diameter Trees	13
Presence of Valued Tree Species	5
Plant Species Richness	10
Forest Productivity	3
Coarse Woody Debris	2
Delaware Ecological Network	5
Forest Interior	5
Mature Forest Potential	5
Wetlands	5

Total number of habitat value points (sum of all attributes) = 53
53 divided by 3 habitat value categories (low, medium, high) = 18
1-18 habitat value points = Low Habitat Quality
19-37 habitat value points = Medium Habitat Quality
38 or greater = High Habitat Quality

The maximum potential number of habitat value points for the following attributes are arbitrary but are consistent in scoring (not more than 5 maximum habitat value points): Forest Productivity, Coarse Woody Debris (potential exists for at least one snag, and at least one down trunk or limb = 2), Delaware Ecological Network, Forest Interior, Mature Forest Potential, and Wetlands.

The maximum potential number of habitat value points for the Presence of Valued Tree Species is based on the 5 forest layers that exist within a forest type (Canopy, Sub-canopy, Tall Shrub, Low Shrub, and Herbaceous), and the fact that the potential exists to find at least one value tree in each layer.

Plant Species Richness, or Floristic Quality Assessment Index (FQAI) is based on Rooney, T.P. and D.A. Rogers. 2002. The Modified Floristic Quality Index. Natural Areas Journal 22(4): 340-344, where the highest FQAI that can be achieved is 10.

The maximum potential number of habitat value points for Large Diameter Trees is based on 238 data points, or trees that were measured that are 18 inches or greater in diameter and occur in a natural, or "wild" setting (McAvoy, DE Division of Fish & Wildlife, unpublished data, 2022; DE Forest Service, unpublished data, 2012). The average trunk diameter of the 238 data points was 40 inches. The largest trunk diameter measured was 79 inches. The chances of

finding a tree that is 79 inches in diameter within a study plot is unlikely, but it is more likely that a 40-inch diameter tree will occur within a study plot, which equals 12 habitat value points. Adding one point for the potential that a 40-inch diameter tree is a value tree, the potential for 13 habitat value points are available. Although, plot sampling may result in calculating more than, or less than 13 value points. Thirteen (13) habitat value points are the potential maximum number of points calculated for the purpose of developing a range of value points that could be used to assess forest habitat quality.

Wetlands are mapped primarily through the interpretation of aerial imagery, and wetland types are based on characteristic aerial signatures, however this method of mapping may not always be accurate. If questionable, a determination in the field during the time of sampling can be made as to whether wetlands do exist within the site. If current wetland maps are disputed, then quantitative justification is required.

A 12-inch diameter, dead standing tree provides more area for a large enough cavity to be created for cover, nesting, and overwintering for wildlife. A 12-inch diameter trunk on the forest floor provides more surface area for animals such as salamanders to utilize and provides more area for non-vascular plants (bryophytes and lichens) to establish and spread, and to serve as nurse logs for vascular plant seeds to germinate and grow.