THE YALE GOLF COURSE TREE MANAGEMENT PLAN

Submitted by:

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TREEFOIL

CONSULTING ARBORISTS

Stonington, Connecticut 06378

June 12, 2024

ACKNOWLEDGEMENTS

PLANNING TEAM

YALE UNIVERSITY
NEW HAVEN, CONNECTICUT

Mr. Jeromy Powers | Associate Director, Planning
Mr. Peter Palacios | Yale Golf, General Manager

TREEFOIL, LLC
CONSULTING ARBORISTS
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ABBREVIATIONS

ANSI	American National Standards Institute
ANSI A300	United States, industry-developed, national consensus standards of practice for tree care.
ANSI Z133.1	United States Safety standards for arborists
BMP	best management practice
DBH	diameter at breast height
D-tape	diameter tape
GIS	geographic information system
ISA	International Society of Arboriculture
ISA LEVEL 1	International Society of Arboriculture Level 1 (limited visual assessment, see glossary)
ISA LEVEL 2	International Society of Arboriculture Level 2 (basic assessment, see glossary)
RCA	Registered Consulting Arborist
TMP	Tree Management Plan
TRAQ	Tree Risk Assessment Qualified by ISA

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EXECUTIVE SUMMARY

Treefoil was contacted late November 2023 by Yale University planner Mr. Jeromy Powers requesting a tree inventory for the Yale University Golf Course. Mr. Powers was looking for a tree management plan like the current Yale Tree Management Plan created in 2020 (Treefoil, *Yale Tree Management Plan*, 2020). The Yale Golf Course was going to start a comprehensive renovation of the golf course original design implemented in 1925. Some of the existing golf course tree population was already in the process of being removed due to poor health, deferred maintenance and general poor placement and associated growth.

Treefoil was scheduled by the golf course construction team to start their inventory work in conjunction with full construction also starting in early February 2024. A total of 6,896 trees were inventoried between Late January 2024 and May 2024. The overlapping nature of deferred tree maintenance and impending construction tree preservation, removals, thinning or hazard tree status within the project required the consultant to designate 7 areas for tree inventory collection. Trees were tagged (except for trees within construction removal zones) and all inventoried to identify species, condition, size (DBH), estimated height, width, sun exposure and more.

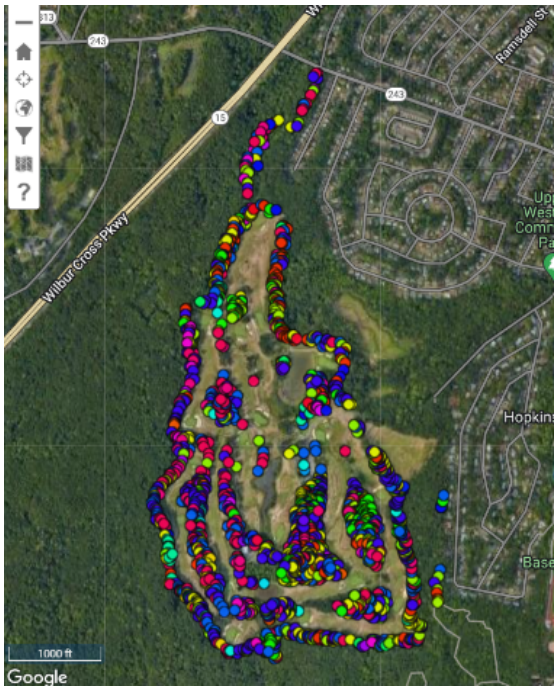


Figure 1 All Geolocated Trees (Color by Species)

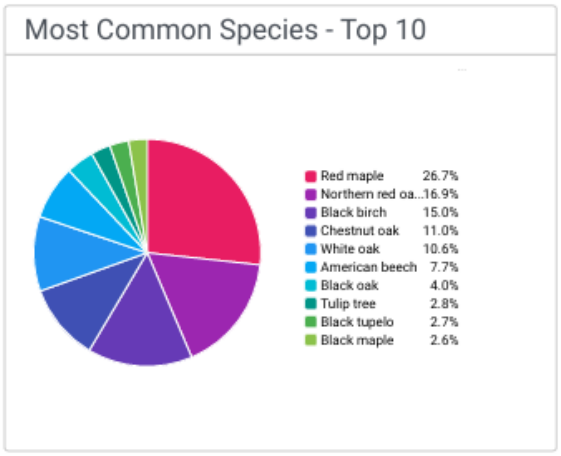
Trees by Project - Top 10

CLIENT SITE	COUNT	PERCENTAGE
Yale Golf Course ALL INTERIOR	3,925	56.9%
Yale Golf Course 50' BORDER PRESERVATION	2,384	34.6%
Yale Golf Border REMOVALS	272	3.9%
Yale Haul Road REMOVALS	98	1.4%
Yale Golf Priority Removals	97	1.4%
Yale Haul Road PRESERVATION	71	1.0%
Yale Golf Stevenson Road Removals	49	0.7%

Figure 2 Inventoried Tree Totals by Area

Inventory Highlights

The top ten most common species are noted below with red maple (*Acer rubrum*) at 1,577 count, Northern red oak (*Quercus rubra*) 997 and black birch (*Betula lenta*) 883.



Most Common Species - Top 10

COMMON NAME	COUNT	PERCENTAGE
Red maple	1,577	26.7%
Northern red oak	997	16.9%
Black birch	883	15.0%
Chestnut oak	649	11.0%
White oak	627	10.6%
American beech	457	7.7%
Black oak	235	4.0%
Tulip tree	164	2.8%
Black tupelo	161	2.7%
Black maple	155	2.6%

Figure 3 The Top Ten All Atrea Species Count, left and percentages, right

A total of 68 species were identified with the average DBH 12.72 inches and largest tree DBH 56.9".

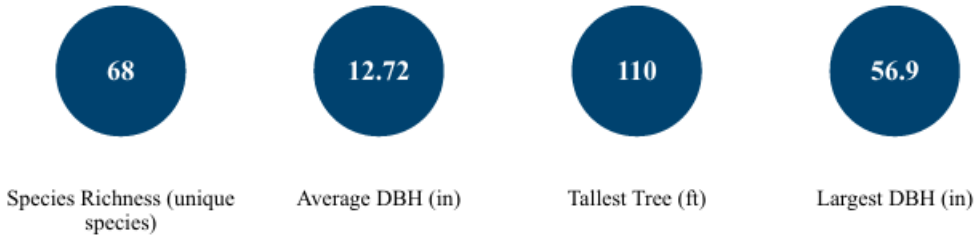


Figure 4 Assorted Snapshot of species and size

The top ten species by condition gives insight to vulnerabilities that might impact condition ratings such as pests, climate vulnerabilities (drought, winds, precipitation), site conditions (slopes, wetlands) and more.

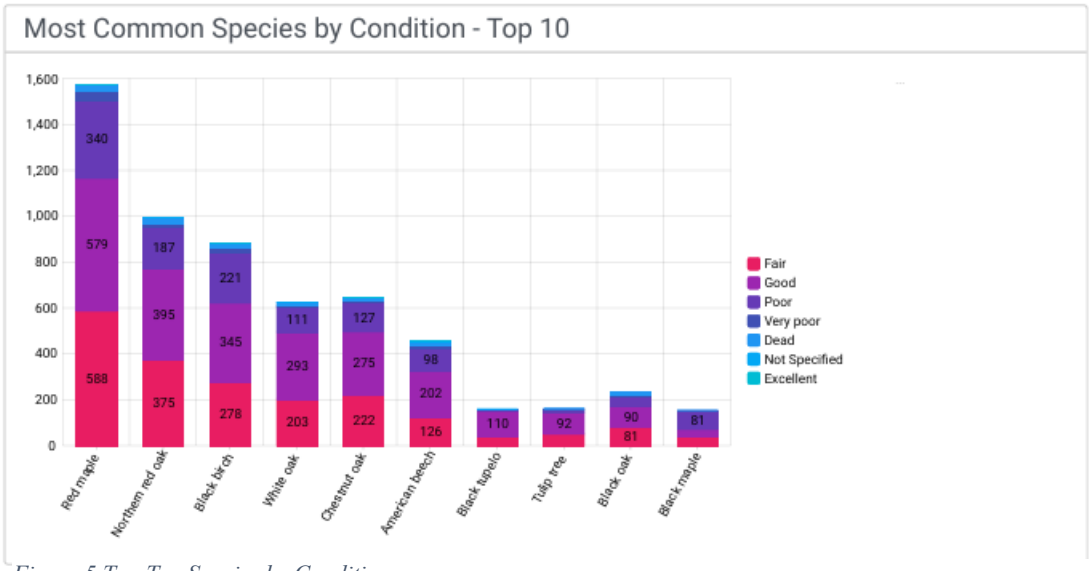


Figure 5 Top Ten Species by Condition

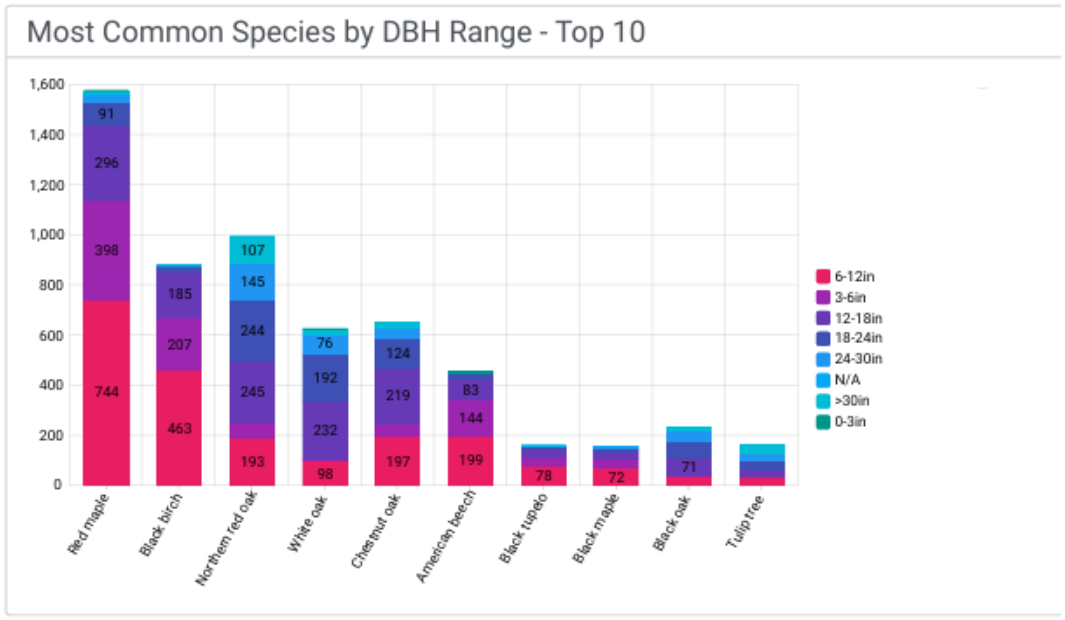


Figure 6 Top 10 Species by Size Range

Total tree value and savings $39,787.35 Tree species, size, canopy exposure and height are considered for an i-Tree analysis. Site specific eco benefits for all inventoried trees are totaled in the environmental benefits table below and noted as “annual” or “lifetime” benefits.

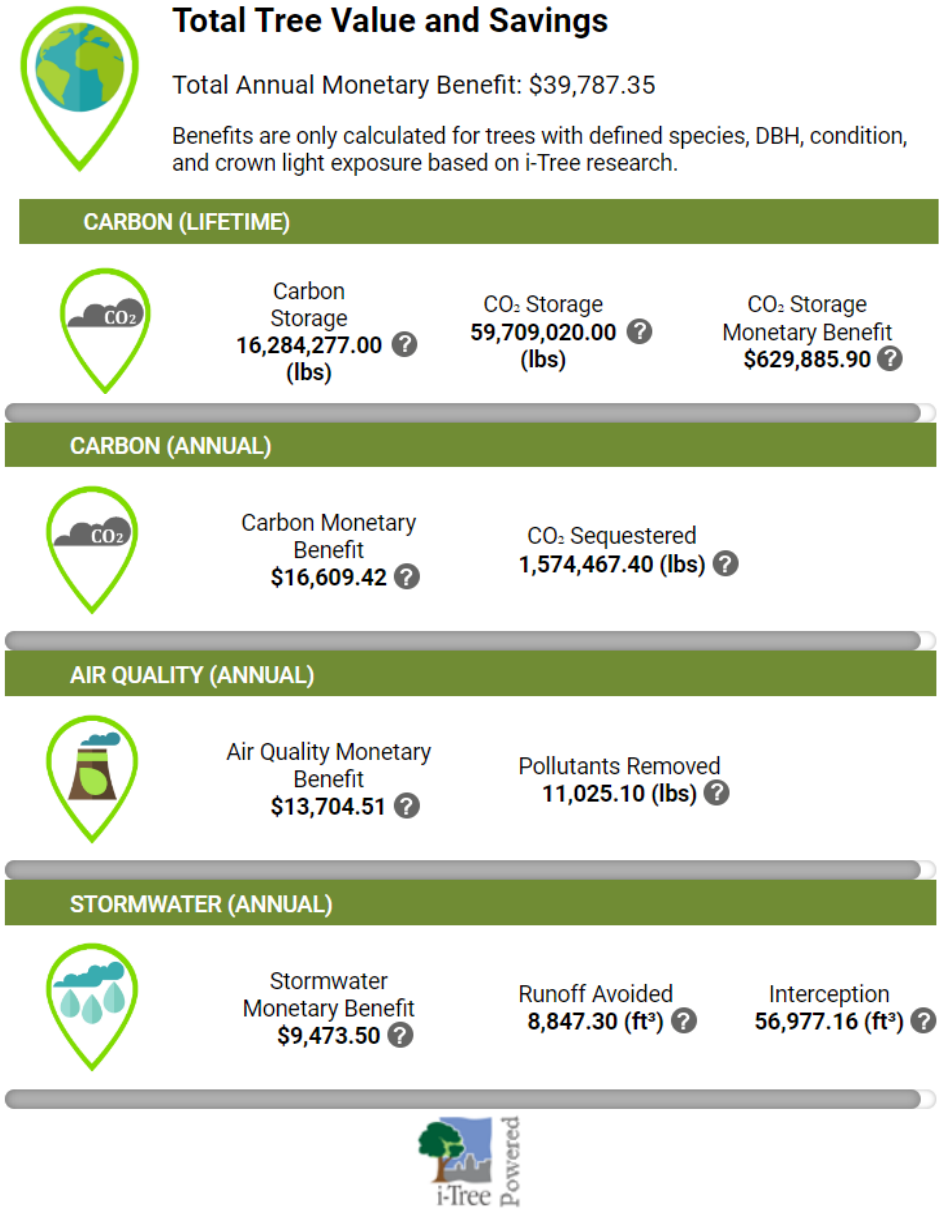


Figure 7 Eco Benefit Values

Pruning by designated area and removal totals provides insight for management planning.

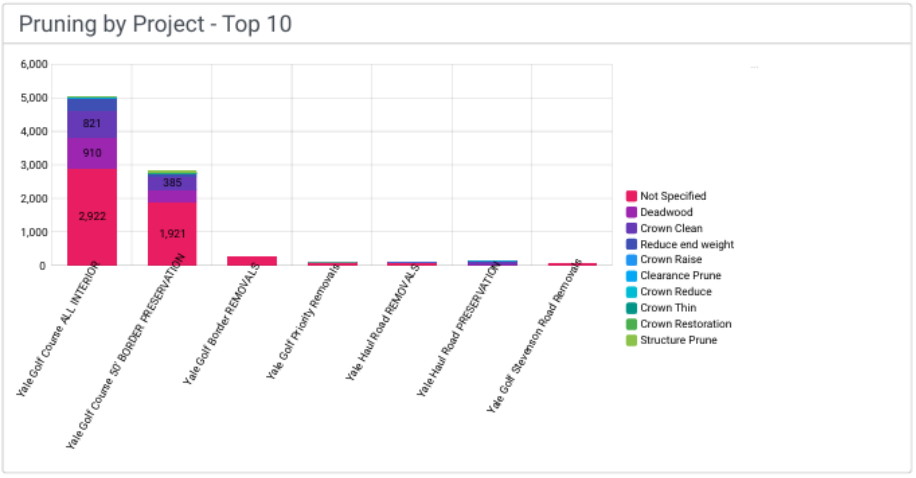
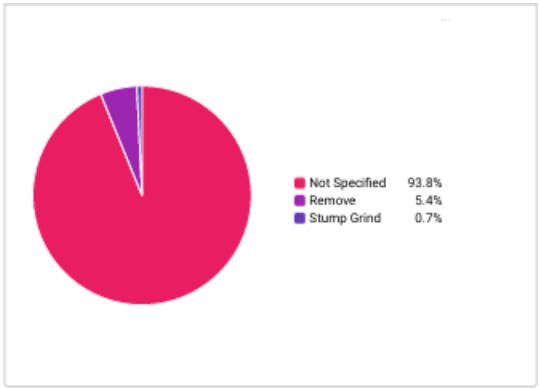


Figure 8 Top Ten Pruning Project by Area Designation



TREE WORK-OTHER	COUNT	PERCENTAGE
Not Specified	6,518	93.8%
Remove	377	5.4%
Stump Grind	52	0.7%

Figure 9 Tree Removals (Does Not Include "Priority Removals")

Trees by Project - Top 10

CLIENT SITE	COUNT	PERCENTAGE
Yale Golf Priority Removals	97	100.0%

Figure 10 Priority Removals

INTRODUCTION

Background and History

Treefoil, LLC, a consulting arborist company, was contacted in early November 2023 by Mr. Jeromy Powers, an Associate Director of Yale University Planning Department. Mr. Powers was seeking a tree inventory and management plan for the Yale University Golf Course. Treefoil created a 2020 Tree Management Plan for Yale University that did not include the golf course. Mr. Powers requested an inventory and tree management plan for the Yale Golf Course with a similar format to the 2020 Yale University Tree Management Plan (Treefoil 2020). The inventory area is clear and well defined, being located separately to the northwest of the core university campus as well as nearby main athletics campus.

Figure 11 Yale University Campus Areas - Yale Golf Course in Bold Circle in Upper Left

Figure 12 Yale Golf Course Satellite Picture

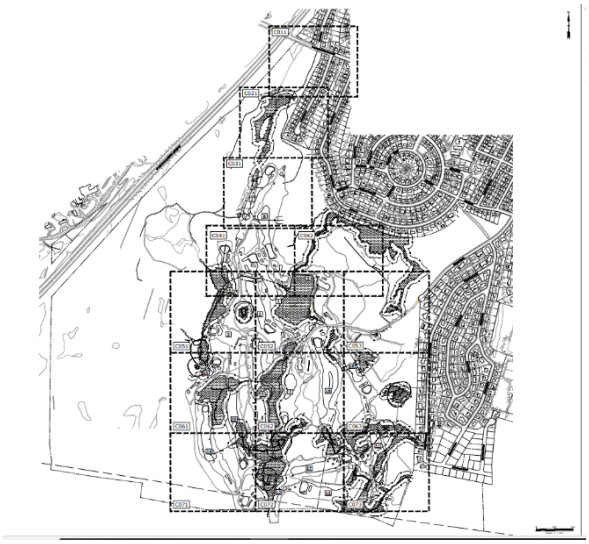


Figure 13 Yale Construction Zones (Tighe & Bond 2023)

Figure 14 Property Marker Where West Haven, Orange, and New Haven Borders Meet

The Yale University Golf Course had been planning a restoration of its 1925 vintage golf course design over the past few years after working with university planners, engineers, a golf course architect, community groups and local, state and federal officials. Yale Golf Course received approvals for the golf course renovation project in late 2023 and began the project with fast-track construction February 2024.

The consultant met with Mr. Jeromy Powers, Dr. Canavan of Tighe and Bond, the Yale Golf Course General Manager, Mr. Peter Palacios, and, at the time, Yale Golf Course Superintendent, Mr. Jeffrey Austin, as well as Dr. Marlyse Duguid of Yale School of Environment and Forestry, and Ms. Amber Garrard, Director of Yale University Office of Sustainability at an onsite meeting on January 11, 2024. The meeting focused on the access route through Yale Nature Preserve regarding tree removal within the surveyor's staked out centerline. An additional follow up meeting on February 6, 2024, with Mr.

Palacios, Mr. Austin, Mr. Edward Grant of K&J Tree Service, and Ms. Laura Green, a Yale University Research and Extension Forester and Principal Consultant at Green Fieldwork reviewed progress and suggested additional forest management insight.

Figure 15 Tree Numbered Tags and Screws

Mr. Jeromy Powers and the consultant agreed that the inventory be supported by numbered tags affixed to trees and recorded with GPS location, size, condition, and species on the consultant's Arc**GIS** digital platform with final content delivered as a CSV file. The data would also be exported as separate dxf and shapefiles to be delivered for the ArcGIS platform for use by Yale University staff.

The consultant, aided by four other arborist technicians, was directed to first tag, assess and inventory trees within the agreed areas bordering and adjacent to the golf course. The first inventory work began with a northern portion within the Yale Nature Preserve for a construction access road called "The Haul Road" (see Appendix I, "Haul Road Report") on January 26, 2024, and completed the collection within an interior southern course area on May 3, 2024. Mr. Peter Palacios, Yale Golf Club Manager, provided golf carts to the consultants, eased access to the course and was available to answer any technical questions.

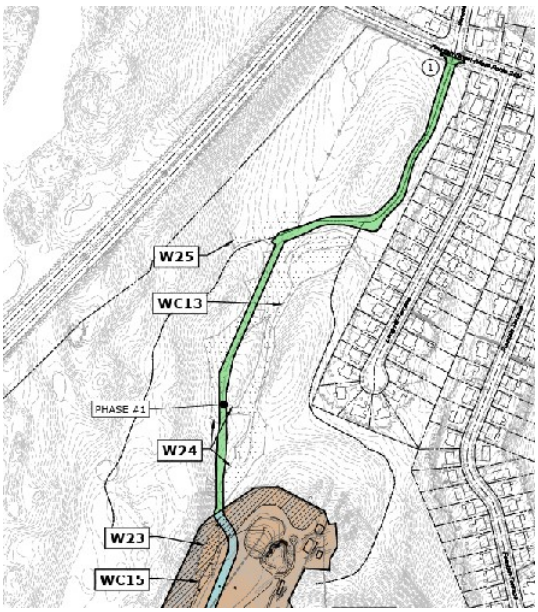


Figure 16 Haul Road Route in Green (Tighe & Bond 2023)

Assignment

The consultant's assignment was to conduct a tree inventory of the golf course trees and, separately, an inventory of trees within the wide Yale Preserve access road or "haul road" (see Overall Site Plan, C100, dated 09/20/2023, Tighe & Bond) and adjacent tree protection.

The proposed project consists of four phases: the tree inventory, a report summarizing findings and associated recommendations for the Haul Road and, separately the Yale Golf Course:

1. **Golf Course Tree Inventory** – The tree tagging, assessment, data collection and GIS mapping (approximated within 1 meter accuracy) of all trees greater than four-inches in diameter within the Golf Course and interior woodlands and approximately 50' of the surrounding forest border immediate to the golf course managed area as defined by the attached map. The data collected is provided in an exported CSV and Shapefile format compatible with XCEL and the Yale University ArcGIS platform.

2. **Yale Nature Preserve Access Road Tree Survey** - The tree tagging, assessment, data collection and GIS mapping (approximated within 1 meter accuracy) of all trees greater than four-inches in diameter within the proposed access road will be collected. The data is provided in an exported CSV and Shapefile format compatible with XCEL and the Yale University ArcGIS platform.

3. **Yale Golf Course Management Plan and Tree Protection Plan** - Based on the data collected, current Best Management Practices and other research, the consultant will provide a tree protection plan for trees impacted by construction, a detailed maintenance and management strategy report for the Yale Golf Course.

4. **Yale Nature Preserve Access Road Inventory and Tree Protection Plan** – Trees within the north access road footprint (approx. 16' width) will be tagged and inventoried. The data and locations will be provided to the Yale Golf Course. The flanking 10' wide east and west sides of the access road were tagged and inventoried. All trees selected for preservation within 5' of a wood mat access road have a tree protection plan unless otherwise recommended for removal as based on health and assessment.

OBSERVATIONS

The 200-acre Yale Golf Course has unique qualities such as expansive open fairway views interspersed by large linear islands of mixed hardwood woodlands, wetlands and ponds and bordered by Yale Nature Preserve Forest.

Figure 17 View to the South at Hole #8 tee

The consultants were on site from January into early May allowing visual access into forested and woodland zones without seasonal leaf cover. Tree architecture such as leans, broken branches and general structural shape are more clear though certain foliar conditions are not evident such as discoloration, insect damage or dead branching due to necrosis (dead branches display best when tree is foliated).

Figure 18 Typical Ledge & Rock Rubble In Interior Woodlands

Large (20" DBH plus) individual trees or smaller groups of 4 or 5 deciduous trees can be found within fairway edges and managed "rough" fairway borders. The numerous deciduous trees found within adjacent interior woodland areas and exterior golf course borders are growing in blasted rock rubble – remnants from the dynamite blasting operations performed during the original 1920's construction operations. Numerous service or course cart pathways transect these areas. Some trees grew around remnant iron irrigation pipes seen throughout the property.

Figure 19 Tree Base Growing Around Original 1920's Irrigation Piping

It is interesting to note that dynamite was commonly used in agricultural clearing operations in the late 1800's into the 1920's. Stone and stumps were efficiently removed when using dynamite (Swart 2019). 12-16" chunks of fractured rock are visible throughout the interior woodland and parts of the Yale Nature Preserve (northern region). The original pre-Yale Golf Course land was fully forested with established trees and wetlands as mentioned in the following Yale Daily News article:

"The building of [the Yale Golf Course] was about as difficult an engineering problem as that of the Lido or the Mid-Ocean," Macdonald wrote in his book "Scotland's Gift." "The land was high, heavily wooded, hilly and no part of it had been cultivated for over forty years. There were no roads or houses upon it. It was a veritable wilderness when given to Yale."

"More than 50 tons of dynamite were used to help clear the land, 3.2 miles of 3-by-2-foot ditches had to be constructed to drain the course and 35,000 feet of pipe were laid to help irrigate the greens and fairways. All in all, the construction ultimately cost Yale $440,000, which was then a record for the construction of a golf course, Sheehan told the News" (Yale Daily News March 23, 2021).The consultant coordinated data collection and ongoing renovation activities with golf course

Figure 20 Ongoing Construction May2024

management. Ongoing construction activities included tree removal and cart path realignment to irrigation trenching and golf green installation and material hauling efforts.

The fairways, skies, interior woodlands and wetlands and bordering forest were occupied by a variety of wildlife as observed by the consultant: muskrat, wild turkeys, squirrels, chipmunk, deer, bald eagles, nesting hawks, Canada geese, redwing blackbirds, bluebirds, woodcock, woodpeckers, wood ducks, opossum, great blue heron, frogs, tadpoles, and garter snakes. There were wildlife habitat

Figure 21 Golf Woodland Wildlife Habitat

Figure 22 Golf "Tom" Turkey on Display May 2024

Figure 23 Standing Deadwood Habitat (w/leaning GPS Pole)

opportunities with numerous decaying or dead trees with nesting cavities throughout the interior woodlands and the bordering Yale Nature Preserve.

There are also swaths of interior woodland area ("INTERIOR TREES") varying from 10 acres and under. Some of the bordering trees of the interior woodlands and preservation border forest trees had been removed prior to/during the consultant starting/finishing the project. An unknown number of woodland and forest border trees had also been removed in prior years for various reasons such as having been in poor condition with the risk of failure, or they had started failing or had completely failed. It is also expected that the natural encroachment of the migrating woodland or forest edge into open fairway areas obstructed the field of play and flow and were consequently removed.

Figure 24 South Woodland Border and Cart Path 12th Hole Fairway (Thinned Area)

Figure 25 Woodland Border on East side of Course along 10th Hole Fairway (Cleared Area and New Edge)

METHODOLOGY

A critical part of a tree inventory is first identifying species, location, size, condition, management needs and more of individual trees while quantifying aspects of the entire area tree population such as size, health, species diversity and environmental benefits. All trees were assessed with an ISA Level I limited visual assessment to identify any risk issues of imminent concern, tagged (unless identified as "Clear" by Tighe & Bond) and inventoried.

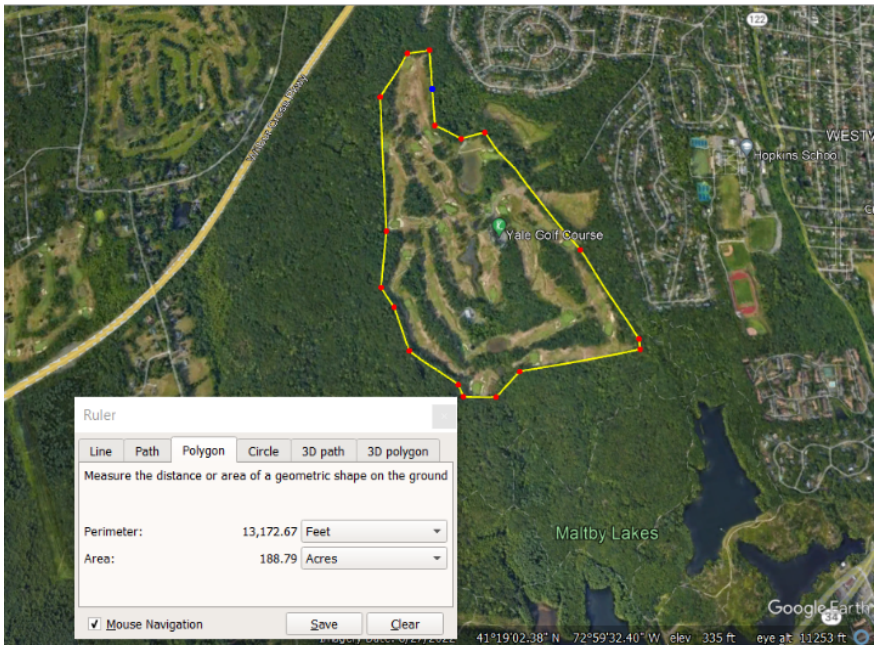


Figure 26 Approximate Inventoried Acreage (Interior and 50' Preservation Border)26

The area that was inventoried is approximately 200 acres out of the 720-acre parcel originally donated in 1923. All trees over 4" diameter were inventoried within all designated areas. Additional areas on the eastern side of the property, the Driving Range and an area to the north of Conrad Drive across from the driving range were under construction with ongoing site work and tree removals and not part of the inventory project. Two small areas on the south wetland watercourse were not inventoried due to high water conditions.

The current renovation addresses tree encroachment and includes tree removals that have been identified as unstable and/or not aligning with the original golf course design. The "clear"/" thin" areas were identified by the engineering team Tighe & Bond (plan set Y5000-088-C-100SITE) as either clear cut or thin on their tree removal plans. Tighe & Bond provided these area designations as shapefiles so the consultant could geo-locate the areas on their inventory software (see below) for in field use when investigating cut or thin areas.

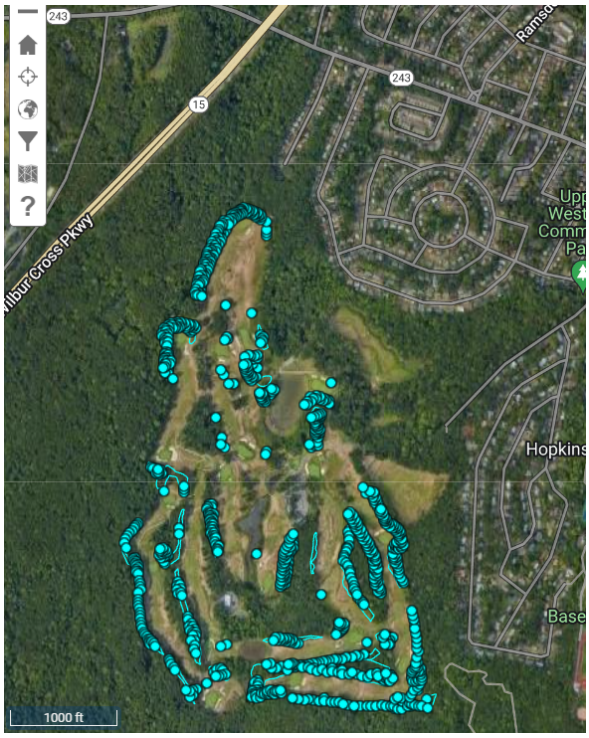


Figure 27 Reference Layer for "Clear" and "Thin" (Tighe & Bond 2024)

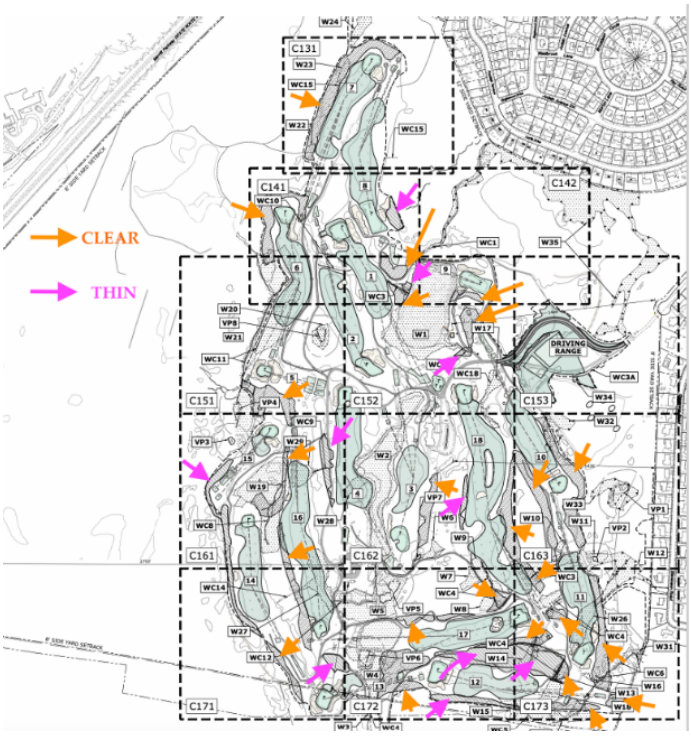


Figure 28 "Clear" and "Thin" Areas on Plan (Tighe & Bond)

Trees marked as "clear" in the 50' Border Preservation were noted as "50' Border Preservation Removals" but not tagged. Trees marked as "thin" were inventoried as "50' Border Preservation" and tagged. Trees within the golf course field of play and interior woodlands are considered "Interior Trees" and are all tagged. A separate category, "Priority Trees" are trees recommended as "high priority" removals due to the high likelihood of failure.

Trees marked as "cut" in the 50' Border Preservation were noted as "50' Border Preservation Removals". Trees marked as "thin" were inventoried as "50' Border Preservation". Trees within the golf course field of play and interior woodlands are considered "Interior Trees". A separate category, "Priority Trees" are trees recommended for removal as "high priority" removals (97) and are primarily found in "All Interior", "50' Border Preservation".

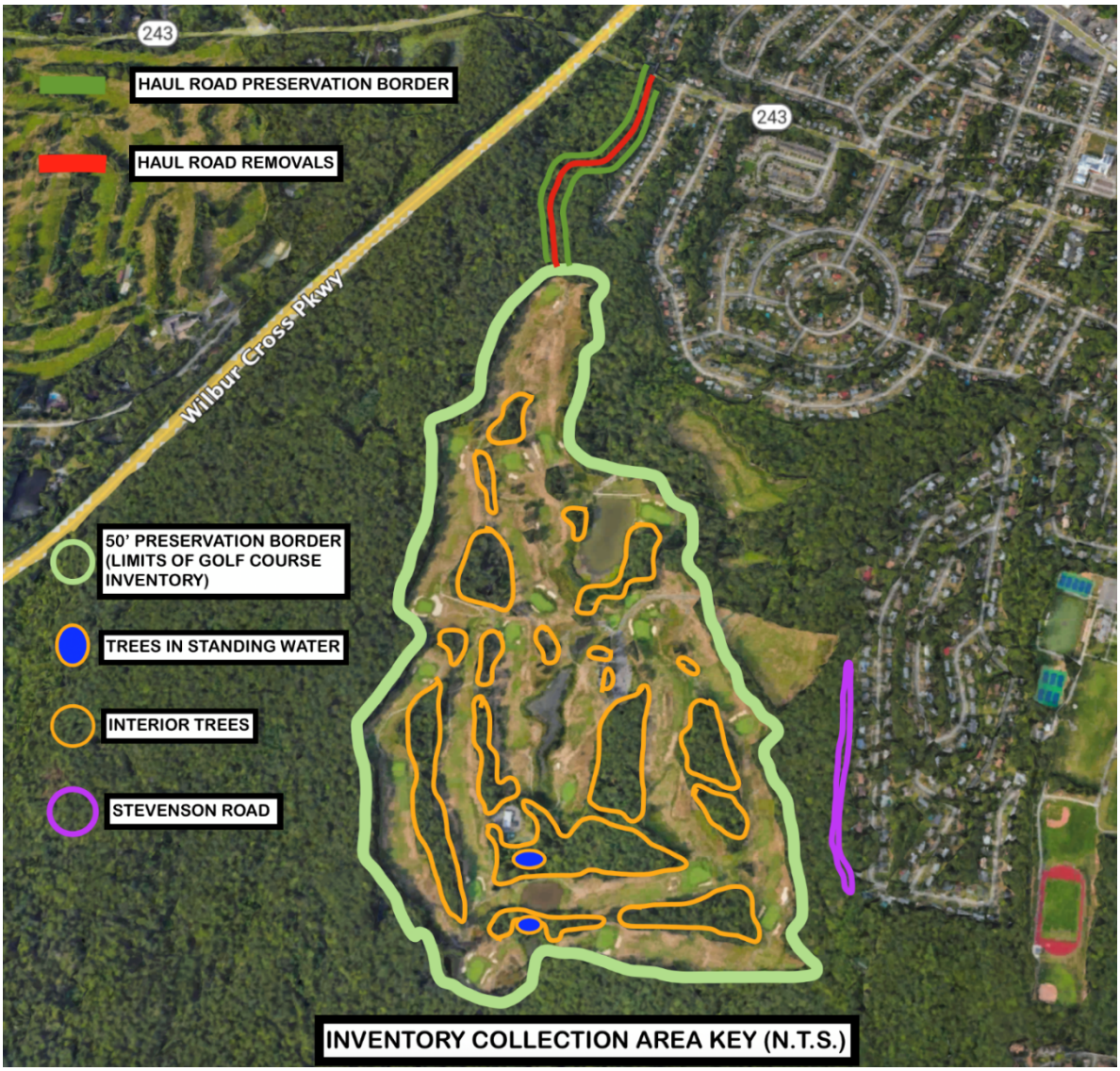


Figure 29 Inventory Areas of Note

Treefoil consultants used diameter tapes (D-tapes), clinometers, sounding hammers and proprietary software and GPS collectors on iPhones and iPads to assess, collect and record data. Collection was performed using pole mounted Juniper Geode GNS3S single frequency GNSS receivers. Global positioning locations were recorded on the unit and relayed via Bluetooth to the collector's iPhone or iPad and uploaded to the proprietary software site via cellular connections. Sub-meter accuracy is anticipated though not guaranteed with such collection.

Figure 30 Treefoil's Geode Collectors

Figure 31 Isabelle, Arborist Technician, Collecting Data Points in Preservation Border February 2024

The data were downloaded, post-processed, edited, and supported this report separately as an attachment in the form of csv, dxf and shapefiles for upload.

Data Collection Fields

The following are the data fields the project team agreed to have collected during the golf course inventory phase. Fields that did not apply to the tree were not checked and remained blank. Deciduous trees were not foliated due to seasonal leaf drop so canopy assessment was limited.

1. Inventory Date – Date the assessment occurred for the subject tree.
2. Assessor Name – Full name of the person assessing the tree.
3. Id Number – A unique ID number assigned to each tree.
4. Tag Number (trees for preservation only) – trees have a unique number and are labeled with a numerical brass tag.
5. Diameter – measured at 4.5' above ground (DBH).
6. Species – Common and Latin name of tree.
7. Condition – Condition assigned based on *The Guide for Plant Appraisal 10th Second Edition* of the International Society of Arboriculture plant appraisal guide: Excellent, Good, Fair, Poor, Very Poor and Dead.
8. Maintenance Needs – Picklist of short and long-term maintenance needs.
9. Status Level – A picklist that identifies trees as "alive", "dead" or "memorial", or "specimen".
10. Attributes – Picklist of distinct observable features of the subject tree.
11. Defects. A defect is a visible flaw or an aberration that causes an item to be less than perfect.
12. Cavity/Decay. Cavity/decay is the deterioration of wood by a decay fungi.
13. Recommended maintenance actions. The selections included: Prune, Removal, and Grind Stump.
14. Prune. If Prune was selected, a specific type of pruning was noted in this field of all A300 recommended pruning: Cleaning, Clearance, Reduction and Structural.
15. Monitor. Tree had some structural aberration that requires a shorter inspection interval.
16. Observations – Biotic Pest signs such as bacteria, boring, fungus, leaf feeding insect, vertebrae.

17. Observations – Abiotic such as lightning, mechanical damage, nutrient deficiency phytotoxicity, saturated soil and underwatered.
18. Latitude. 1984 State Plane Coordinates—Connecticut
19. Longitude. 1984 State Plane Coordinates—Connecticut
20. Comments. Field for additional details to be recorded.

The Treefoil consultants referenced numerous sources for information such as: the Connecticut Agricultural Extension Service, Dirr's *Manual of Woody Plants*, International Society of Arboriculture (ISA) publications and the University of Connecticut Plant Database (see sources). The consultants also drew on their experience to assess any subjective data collection pertaining to interpreting tree architecture, health, conditions, and future prognosis.

The inventory area was broken down into seven regions based on location (Haul Road, Stevenson Road), construction focus ("cut", "thin" or "removals") or priority ("high" priority removal recommended):

Yale Golf ALL INTERIOR (3925 Trees)
Yale Golf 50' BORDER PRESERVATION (2384 Trees)
Yale Haul Road REMOVALS (98 Trees)
Yale Golf PRIORITY Removals (97 Trees)
Yale Haul Road PRESERVATION (71 Trees)
Yale Golf Border REMOVALS (per construction documents and reference layer) (272 Trees)
Yale Golf Stevenson Road REMOVALS (49 Trees)

INVENTORY RESULTS

Tree Count

The total number of trees inventoried of all the 7-area designations is 6,892.
The total number of trees within Yale Golf INTERIOR and Yale Golf Preservation is 6309.

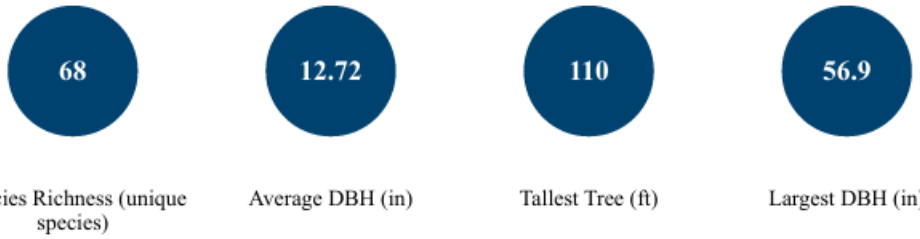


Figure 32 Random Data Facts for All Trees

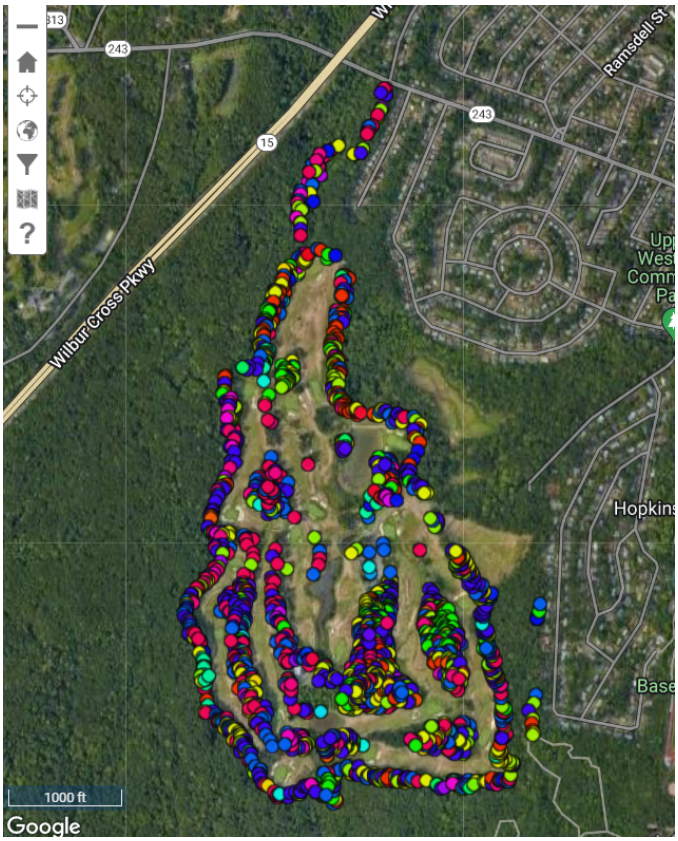


Figure 33 All Data Points Collected with Species by Color

Trees by Project - Top 10		
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Figure 34 Area Quantities of Inventoried Trees

Species Distribution

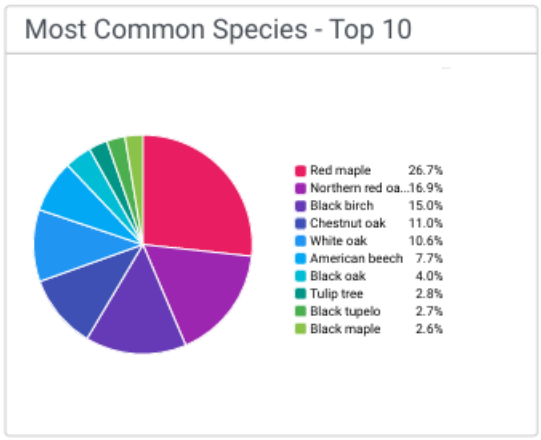
Tree diversity within an urban forestry setting is often interpreted using a 10-20-30 guideline that suggests a tree population shouldn't include more than 10% of any one species, 20% of any one genus or 30% of a family (Santamour 1990). Red maple, Northern Red Oak and black birch accounted for 58.6% of all inventoried trees. This count would be helpful for selecting and establishing future planting schedules as the current renovation is scheduled to add a significant number of sizes of native forest species (see Tighe & Bond 2023).

The existing interior woodlands were most likely volunteer trees influenced by surrounding remnant forests. The consultants are not foresters, nor certified to make forestry assessments and recommendations but view data results as helpful indicators of the tree population tendencies, health and stability as it relates to an ISA Level I assessment.

Tree Diversity

The Tree Diversity charts show the top five most common tree species, genera, and families within the inventory or subset of your inventory based on data or map filters. The red horizontal lines demonstrate the 10-20-30 rule, which suggests an urban tree population should include no more than 10% of any one species, 20% of any one genus, or 30% of any family. Tree managers, researchers, and practitioners use these parameters first recommended by Santamour in 1990 as an industry standard to measure a tree population's resiliency to harmful tree pests and diseases and other factors. Consider establishing these thresholds on a community-wide scale and/or at smaller-scales such as by neighborhood, street corridor, block, or project.

Figure 35 Tree Diversity 10-20-30 Rule (iTree 2024)



Most Common Species - Top 10

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Figure 36 Top Ten Most Common Species/Quantities/Percentages

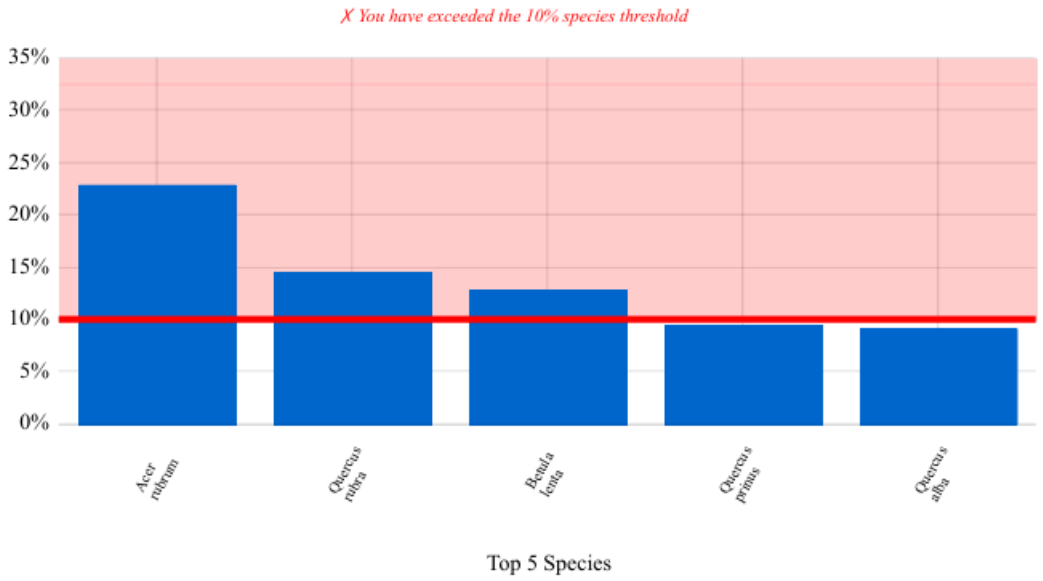


Figure 37 10% Species Diversity Goal (Surpassed in Red)

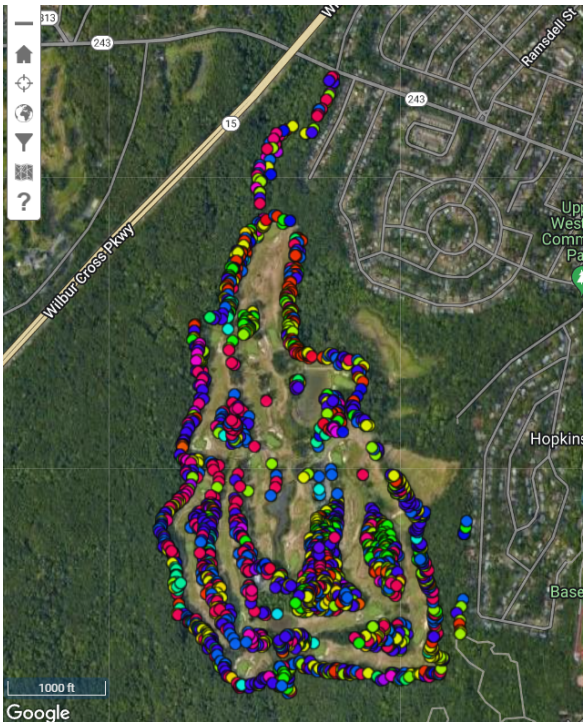
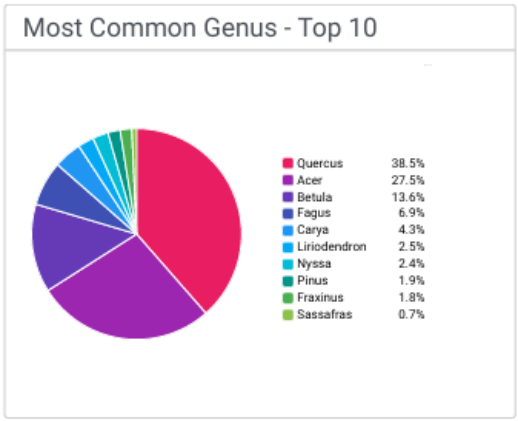


Figure 38 All Areas Trees Species by Color

Genus Distribution



Most Common Genus - Top 10

GENUS	COUNT	PERCENTAGE
Quercus	2,564	38.5%
Acer	1,827	27.5%
Betula	903	13.6%
Fagus	457	6.9%
Carya	285	4.3%
Liriodendron	164	2.5%
Nyssa	161	2.4%
Pinus	125	1.9%
Fraxinus	119	1.8%
Sassafras	48	0.7%

Figure 39 Most Common Genus Count and Percentages

Figure 40 Genus Goals (Surpassed in Red)

Species by Condition

Condition of a particular species can supply insight into patterns that are indicative of otherwise unseen negative impacts on a particular species. Similar patterns of balanced conditions between species allows another pattern to be clear. The Yale Golf Course inventory results show similar condition patterns between species.

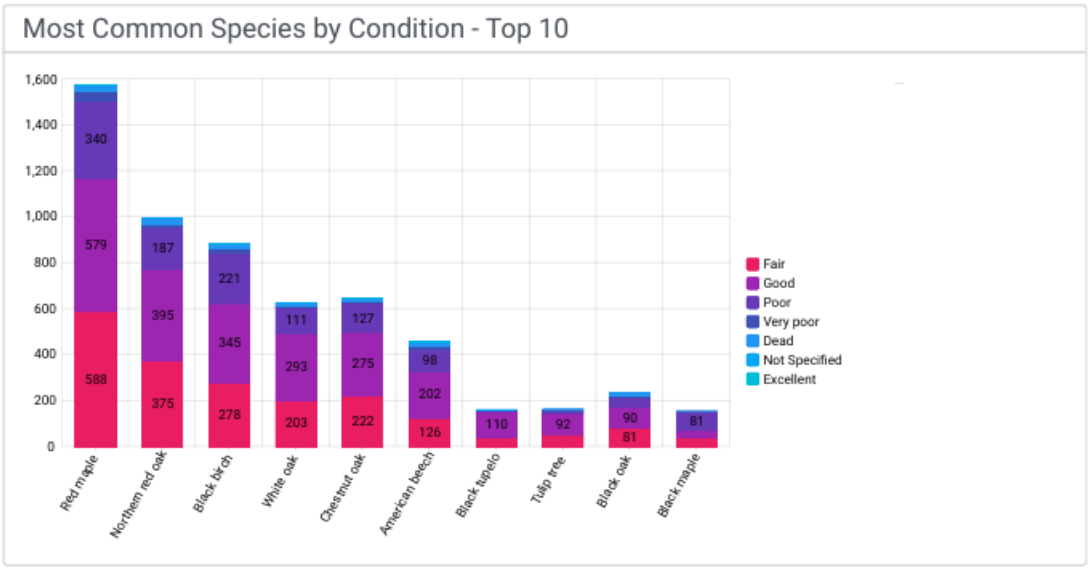


Figure 41 Top Ten Most Common Species by Condition

Rating category	Condition components			Percent rating
	Health	Structure	Form	
Excellent	High vigor and nearly perfect health with little or no twig dieback, discoloration, or defoliation.	Nearly ideal and free of defects.	Nearly ideal for the species. Generally symmetric. Consistent with the intended use.	100%
Good	Vigor is normal for the species. No significant damage due to diseases or pests. Any twig dieback, defoliation, or discoloration is minor.	Well-developed structure. Defects are minor and can be corrected.	Minor asymmetries/deviations from species norm. Mostly consistent with the intended use. Function and aesthetics are not compromised.	61% to 80%
Fair	Reduced vigor. Damage due to insects or diseases may be significant and associated with defoliation but is not likely to be fatal. Twig dieback, defoliation, discoloration, and/or dead branches may comprise up to 50% of the crown.	A single defect of a significant nature or multiple moderate defects. Defects are not practical to correct or would require multiple treatments over several years.	Major asymmetries/deviations from species norm and/or intended use. Function and/or aesthetics are compromised.	41% to 60%
Poor	Unhealthy and declining in appearance. Poor vigor. Low foliage density and poor foliage color are present. Potentially fatal pest infestation. Extensive twig and/or branch dieback.	A single serious defect or multiple significant defects. Recent change in tree orientation. Observed structural problems cannot be corrected. Failure may occur at any time.	Largely asymmetric/abnormal. Detracts from intended use and/or aesthetics to a significant degree.	21% to 40%
Very poor	Poor vigor. Appears to be dying and in the last stages of life. Little live foliage.	Single or multiple severe defects. Failure is probable or imminent.	Visually unappealing. Provides little or no function in the landscape.	6% to 20%
Dead				0% to 5%

Figure 42 Condition Ratings

Figure 43 Tree Condition Rated by Color Codes

Top 10 Species Distribution by DBH

Trees vary in their ability to adapt and become resilient in the face of extreme environmental conditions. A broader range of appropriate species can help provide a broader resilience to pests and disease, and extreme climatic events. Diversity in species selection can increase tree population resistance and minimize reliance on dominant species planting. Red Maple dominates this class at a 1,504 count.

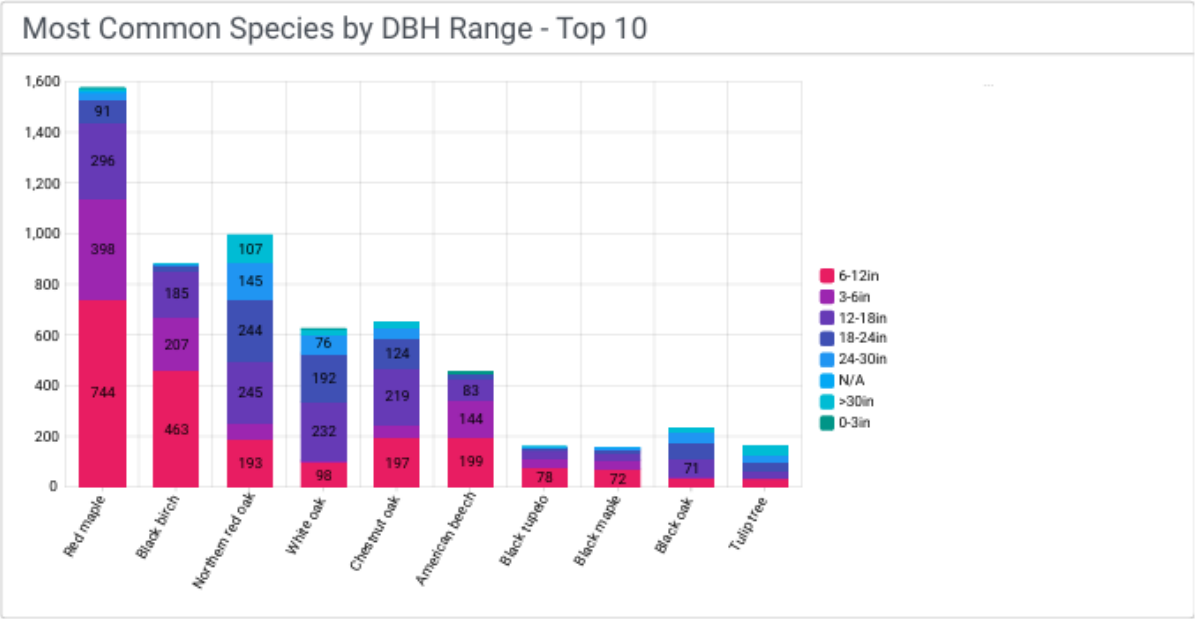
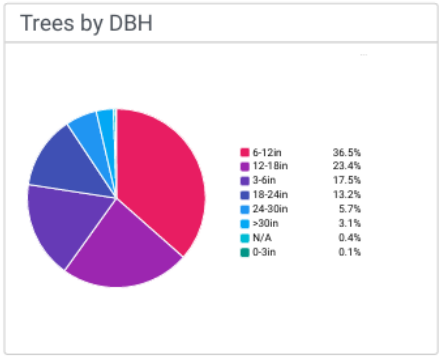


Figure 44 Top Ten Species by DBH

Trunk Diameter Distribution

Trunk diameter distribution offers tree data that are presented in terms of diameter size class. This detail is important for figuring out current management needs as well as predicting how needs will change, given the total numbers and aging of individual species. The size distribution within a tree population influences present and future costs as well as the flow of benefits. A staggered or unevenly aged population allows managers to distribute annual maintenance costs uniformly over many years and assure continuity in overall tree canopy coverage. Total diameter inches for each class are supplied



Trees by DBH

DBH RANGE	COUNT	PERCENTAGE
6-12in	2,516	36.5%
12-18in	1,616	23.4%
3-6in	1,209	17.5%
18-24in	909	13.2%
24-30in	394	5.7%
>30in	215	3.1%
N/A	28	0.4%
0-3in	9	0.1%

Figure 45 Tree DBH Distribution

as it may inform on some potential maintenance costs derived by total class-size inches. The number of lower (0-6" DBH) in the size distribution graph shows more smaller trees are recommended.

Figure 46 Ideal Tree Size Distribution

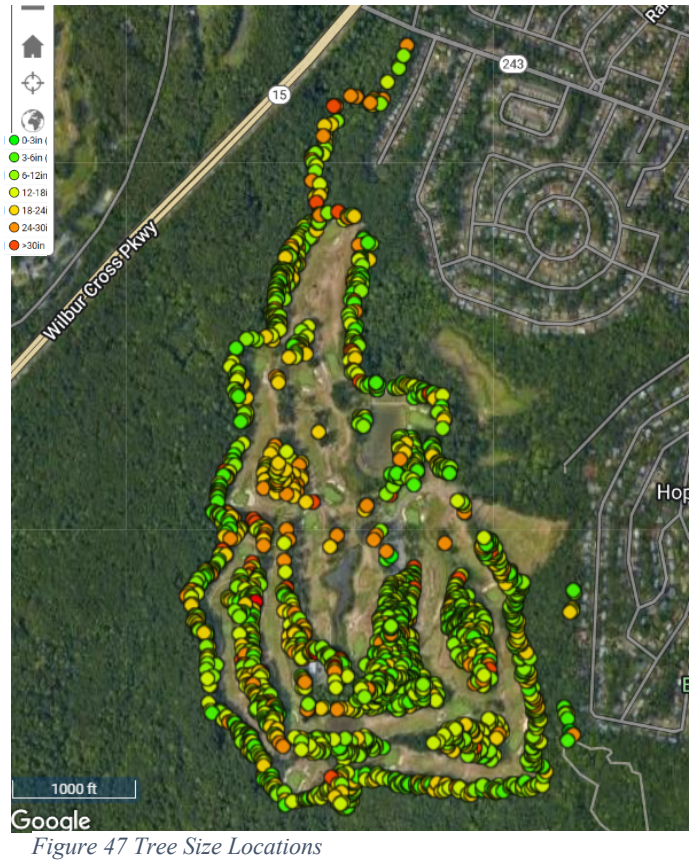
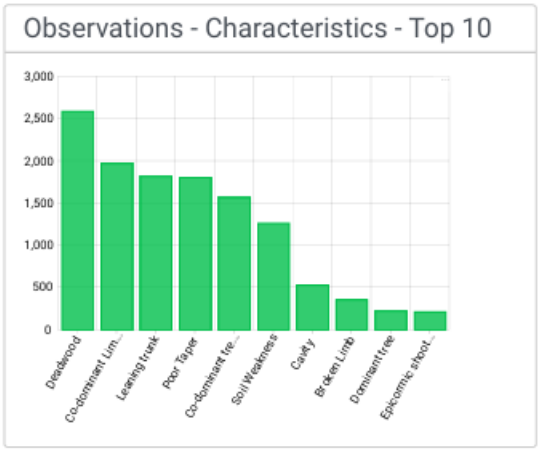


Figure 47 Tree Size Locations

Characteristics

Data results of observation characteristics allow clear insight when evaluating a population of trees. Characteristics such as deadwood, co-dominant trees and/or limbs, broken limb, cavity, leaning trunk and more were recorded by the arborists during the inventory informing for better management decisions. Multi-stemmed have stability liabilities that single trunks are less likely to need such as cabling, or presence of deadwood informs on potential pruning operations.



Observations - Characteristics - Top 10

OBSERVATIONS-CHARACTERISTICS	COUNT	PERCENTAGE
Deadwood	2,588	21.0%
Co-dominant Limbs	1,971	16.0%
Leaning trunk	1,815	14.7%
Poor Taper	1,805	14.6%
Co-dominant tree	1,566	12.7%
Soil Weakness	1,261	10.2%
Cavity	531	4.3%
Broken Limb	353	2.9%
Dominant tree	220	1.8%
Epicormic shoots	211	1.7%

Figure 48 Observations – Top Ten Characteristics

Environmental Benefits

An ecosystem analysis was created for the overall Yale Golf Course inventoried areas. Trees inventoried within Yale Golf Course have the following annual functional value totals:

Eco Benefits and By The Numbers

Total Eco-Benefits	
Overall Monetary Benefit:	$39,785.65
Stormwater Monetary Benefit:	$9,473.42
Runoff Avoided:	8847.22 (ft³)
Interception:	56976.79 (ft³)
Air Quality Monetary Benefit:	$13,703.44
Pollutants Removed:	11024.75 (lbs)
Carbon Monetary Benefit:	$16,608.90
Carbon Storage:	16284290.00 (lbs)
CO_2 Storage:	59709032.00 (lbs)
CO_2 Sequestered:	1574416.50 (lbs)

Figure 49 Total Eco Benefits

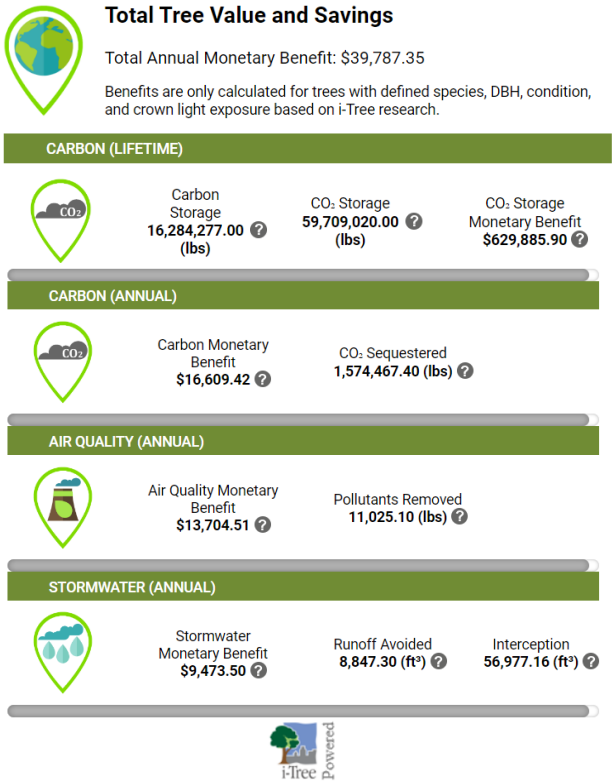


Figure 50 Eco Benefit Values

Carbon Lifetime:

- Carbon storage is All carbon stored in the urban forest over the life of the trees as a result of sequestration. This measurement is not the same as annual carbon sequestered.

- CO2 storage is all carbon dioxide stored in the urban forest over the life of the trees as a result of sequestration. This measurement is not the same as annual carbon sequestered.

- Carbon Dioxide Storage is the monetary value of the lifetime carbon stored in the tree at its current size

Carbon (Annual):

- Carbon monetary benefit is the dollar value associated with the amount of carbon stored or sequestered by trees based on calculations of the social cost of carbon.

- CO2 Sequestered is the amount of carbon annually removed from the atmosphere and stored in the canopy's biomass.

Air Quality (Annual):

Air quality monetary benefit: Trees improve air quality when air pollutants (O3, NO2, SO2, Particulate Matter) are deposited on tree surfaces and absorbed, and from reduced emissions from power plants (NO2, Particulate Matter, VOC's (Volatile Organic Compounds), SO2) due to reduced electricity use (see Energy Conservation definition). This is the monetary amount of this benefit (i-Tree 2024).

Pollutants removed: Trees improve air quality when air pollutants (O3, NO2, SO2, Particulate Matter) are deposited on tree surfaces and absorbed, and from reduced emissions from power plants (NO2, Particulate Matter, VOC's (Volatile Organic Compounds), SO2) due to reduced electricity use (see Energy Conservation definition). This is the measured amount of this benefit in pounds (i-Tree 2024).

The analysis was created using i-Tree, an open-source service that quantifies ecological benefits of trees based on collected digital data fields. Since 2006, i-Tree has been a cooperative effort between the USDA Forest Service, Davey Tree Expert Company, The Arbor Day Foundation, Society of Municipal Arborists, International Society of Arboriculture, Casey Trees, and SUNY College of Environmental Science and Forestry (i-Tree 2024).

Avoided Stormwater Runoff

Avoided storm water runoff is water that is utilized by trees before being channeled to a drainage system. Usually, the channeled water is lost or wasted as it ends up in a watercourse that drains to a large body of water such as Long Island Sound. The eco benefit i-Tree analysis only considers precipitation intercepted by leaves with trees being able to capture the most cubic feet of avoided runoff. The avoided stormwater runoff also diminishes the extent of surface erosion and soil loss.

Climate Resilience

For this report resilience is "the ability of social-ecological systems to absorb and recover from climatic shocks, stresses, and means for living in the face of long-term change and uncertainty" (Intergovernmental Panel on Climate Change) as it relates to climate conditions.

The Yale Golf Course has certain components and environmental conditions that put stress on its ability to be resilient in the face of current climate conditions. Drought, higher temperatures, severe weather, wind events, invasive pests, and invasive plants add considerable challenges to a plant's vitality and resilience.

Large areas of parking spaces and associated storm drainage system (drainage) does not allow water to permeate into the ground. Naturally occurring water is diverted from absorption into the ground due to the impermeability of the asphalt surface. At times of severe drought, it is not practical to provide enough irrigation for numerous roots that are located two feet deep and extend well past the edge of tree canopies. The current construction plans appear to be designed to capture and retain water out of storm drains or on site.

Trees have varying abilities to adapt to being resilient in the face of extreme environmental conditions. A broader range of appropriate species can help provide a broader resilience to climatic factors as well. Pest and disease resistance, heat tolerance, wind resistance can vary even within species. Diversity in species selection can increase tree population resistance and minimize reliance on dominant species planting. From the consultant's perspective, the forest and woodland areas show broad diversity within deciduous species though a certified forester's analysis is required.

Oxygen Production

Yale Golf Course trees in managed areas contribute to oxygen production released into the atmosphere. More important, the oxygen count is tied to the amount of carbon dioxide uptake and retention during photosynthesis. When carbon dioxide uptake surpasses the amount of carbon dioxide released through the process of respiration, it shows that the tree retains more carbon than released. The earth's atmosphere has substantially more oxygen in its stores even without the contribution of the earth's tree population. (Nowak, 2007).

Canopy and Air Pollution

A tree canopy is the tree's components, such as leaves, branches, and stems that cover the ground beneath the tree. The Yale Golf Course has three distinct canopy covers: managed, woodland, and forest.

The managed area canopy cover is relatively sparse in comparison to the woodland and forested areas. The managed area canopy is defined by individual trees, due to the open ground area between trees, while woodland and forest area tends to be a contiguous canopy providing overlapping branch cover between adjacent trees.

The woodland area canopy cover provides cover from heavy rains by breaking the fall of precipitation. It also provides cover from the solar rays that would otherwise heat open ground contributing to evaporation and water loss. Forest areas also provide the same benefits, with the leaf cover that protects the ground from heavy rains, as well as from solar rays that heat open ground and lead to evaporation.

Both woodland and forested within the golf course areas do not have separate inventory collection characteristics. These areas were inventoried with a full inventory, as opposed to a forest survey for trees over 4-inch DBH. This was done to address safety concerns due to intersecting cartways or accessways through woodlands or the proximity of forest edges to the field of play and likelihood personnel present.

Pruning Observations

The consultants noted characteristics and pruning actions that would mitigate poor tree conditions. These actions often improve the condition of the tree and reduce liabilities associated with such conditions.

Pruning Work

TREE WORK-PRUNING	COUNT	PERCENTAGE
Not Specified	5,362	63.0%
Deadwood	1,330	15.6%
Crown Clean	1,270	14.9%
Reduce end weight	422	5.0%
Structure Prune	44	0.5%
Crown Raise	22	0.3%
Crown Restoration	19	0.2%
Crown Reduce	18	0.2%
Clearance Prune	15	0.2%
Crown Thin	11	0.1%

Figure 51 Pruning Work Actions

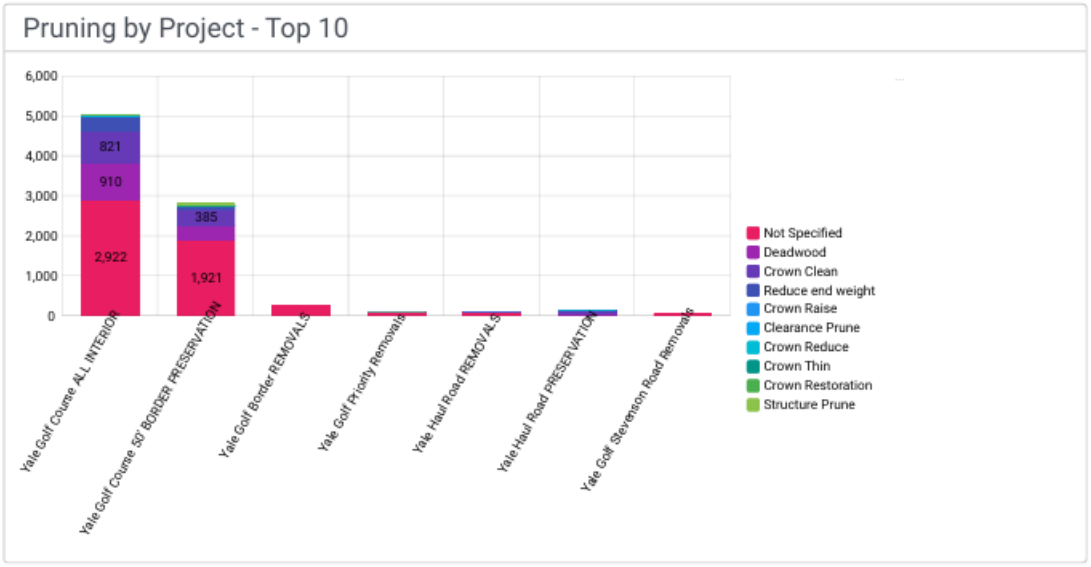
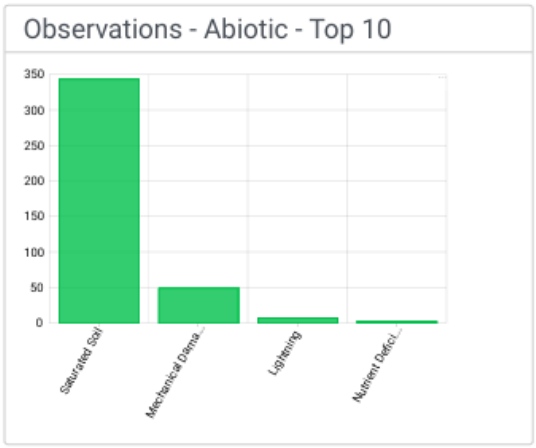


Figure 52 Pruning Project by Area

Abiotic Observations



Observations - Abiotic - Top 10

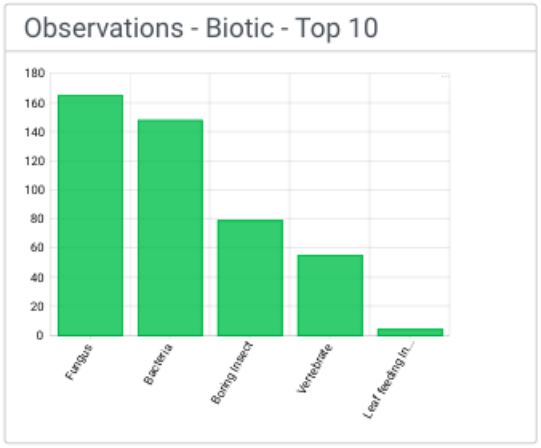
OBSERVATIONS-ABIOTIC	COUNT	PERCENTAGE
Saturated Soil	344	85.6%
Mechanical Damage	49	12.2%
Lightning	7	1.7%
Nutrient Deficiency	2	0.5%

Figure 53 Top Ten Abiotic Observations

Abiotic factors are events that can negatively affect plant health. While pests are usually more easily recognizable, they are often only present once a tree has been previously stressed by abiotic factors such as: drought, severe winter cold, summer heat, soil compaction, gridling roots, constructional grade change, or mechanical damage. Being able to recognize and assess the severity of these sorts of issues is critical for maintaining plant health.

Concern for mechanical damage is always apparent on golf courses for new and established trees. Mulch rings help to protect young trees initially and are often discontinued when they are established – usually one year for every inch DBH at planting. The damage is often underway as the young trees have the bark damaged or removed by mowers or weed whackers allowing decay, disease and insects to enter the tree system through the phloem or xylem. A ring fence system also helps prevent mechanical and deer damage (Biotic) and can be easily removed or installed.

Biotic Observations



Observations - Biotic - Top 10

OBSERVATIONS-BIOTIC PEST	COUNT	PERCENTAGE
Fungus	165	36.6%
Bacteria	148	32.8%
Boring Insect	79	17.5%
Vertebrate	55	12.2%
Leaf feeding Insect	4	0.9%

Figure 54 Top Ten Biotic Observations

Biotic Pest are living organisms that can negatively affect the tree such as bacteria, boring insects, fungus, leaf feeding insect, vertebrae, and bacteria. Being able to recognize and assess the severity of these sorts of issues is critical for maintaining plant health.

IPM

Beech Leaf Disease

Beech leaf disease was first identified in Connecticut in 2019 and is present in landscaped areas as well as forests. A foliar nematode is found between the leaf veins causing dark interveinal patching visible from below the canopy in early spring with the leaf eventually turning brown leading to premature leaf drop. Trees will produce new foliage, leading to a reduction of root resources. Repeating annual cycles will lead to additional resource depletion. Trees, especially younger ones, can become more susceptible to other pests and pathogens resulting in death in 3 years.

Little is known about the invasive disease making management difficult. Vigilance through quarantines and regulations might be used to limit the spread. Pictures below left show telltale dark foliage due to nematode in leaf and right shows banding of interveinal habitation.

Spongy Moth (not usually a problem unless three dry springs)

Spongy moths have been an invasive problem in regions of Eastern and Northern Connecticut. The moth is the adult form, but the larva is the pest. Its preferred tree is oak (*Quercus),* but it will feed on beech (*Fagus)*, birch *(Betula),* tupelo (*Nyssa),* elm *(Ulmus),* fir (*Abies),* linden (*Tilia),* maple (*Acer),* pine

Figure 55 Spongy Moth Egg Casings left and Moth right ((Clare Rutledge, CAES Ct Agricultural Extension Service 2020)

(Pinus), hemlock *(Tsuga),* and spruce (*Picea).* The adults lay egg masses on the underside of large tree branches, which overwinter and hatch mid-May. The larva feed in the canopy of the tree for the first

three instars (larval growth stages) of life. During the fourth and fifth instars, the black and red fuzzy larvae migrate up the trunk during the day for feeding and down the trunk at night to remain safe from predators. These later instars cause the most damage to the trees' foliage. Around June 1, the larva turns pupae for two weeks. Adults emerge in late June and can persist into August. The adults are recognizable by their white wings. Trees can usually tolerate one to two aggressive seasons of defoliation, but a third year can be lethal. Treatment options can prevent later instar stages of development or future reproduction.

Figure 56 Left, Fungus Maimaga and Resulting Dead Spongy Moth Caterpillars, Right Distinct U-shaped Dead Caterpillars (Clare Rutledge, CAES Ct Agricultural Extension Service 2020)

Emerald Ash Borer (Observed on Yale Golf Course campus)

The emerald ash borer is a small, green beetle that belongs to a large family of beetles known as the buprestidae, or metallic wood-boring beetles. The description is apt, as many of the adult buprestids are indeed glossy, appearing as if their wing covers are made of polished metal. The emerald ash borer, with its green, iridescent wing covers, fits right in. Adult EABs are relatively slender and between 0.3 to 0.55 inches in length—small by most standards but large compared to other buprestidae.

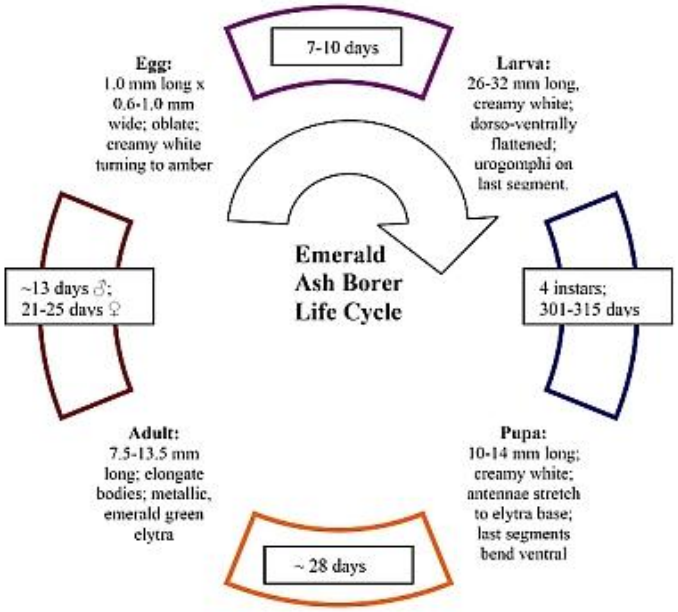
During its life cycle, EAB undergoes a complete metamorphosis. It starts as an egg, becomes a larva (alternatively called a grub), changes into a pupa, and then is an adult. The life cycle of an EAB takes either one or two years to complete. Adults begin emerging from within ash trees around the middle of June. Emergence continues for about five weeks. The female starts laying her eggs on the bark of ash trees about two weeks after she emerges. After seven to 10 days, the eggs hatch and the larvae move into the bark, to begin feeding on the phloem (inner bark) and cambium of the tree. Throughout each of its successive instars (larval growth stages), the larva continues to feed on the phloem and cambium of the tree. The larval stage may last for nearly two years. Before becoming an adult, the insect overwinters as a prepupal larva. It then pupates in the spring and emerges as an adult during the summer.

Figure 57 Emerald Ash Borer Underside

Figure 58 Top Side Emerald Ash Borer

Figure 59 D-Shaped Exit Holes on Ash

Figure 60 EAB Boring and life cycle right



Emerald Ash Borer Pupa Source: USDA Emerald Ash Borer Program Manual

EAB feeds on ash trees almost exclusively. While the larvae feed on the phloem and cambium, the adults feed on leaves. In Connecticut, there are three species of ash trees—the white ash (*Fraxinus americana*), the green or red ash (*F. pennsylvanica*), and the black ash (*F. nigra*). Despite its common name, mountain ash (*Sorbus* spp.) is not true ash and does not attract the EAB. Some inventoried species of green ash show some resistance in an otherwise infested area though it is too early to declare full resistance for the green ash population on the golf course campus.

To date, the only non-ash genus EAB is known to feed on is *Chionanthus* (fringe tree). The consultant has already identified and begun treatment of the ash population; however, host ash trees show signs of infestation, and a few were cut down while the consultants were performing the inventory.

Asian Longhorned Beetle (not identified on Yale Golf Course campus but need to monitor for)

The Asian longhorned beetle (ALB) is another pest that has garnered a lot of publicity, primarily because there is no effective treatment option and it will eat nearly any kind of hardwood, though it prefers sugar maple. This means the infected trees must be removed and the wood destroyed to prevent further spread. The species has a shiny black-and-white spotted exoskeleton and long antennae. It has been found in New York and Massachusetts, but when a population is found, it has usually already been present for several years because it prefers treetops.

The adult female lays a single egg in the burrowed-out bark. She may do this up to 90 times a season. The larva hatches and burrows into the heartwood, where it overwinters. The larva pupates the following summer and will emerge as an adult in the fall. When they emerge, they leave ½-inch exit holes. The beetles are poor flyers, so they tend to re-infest the same tree year after year, which leaves pockmarks on the bark where the female bores into the wood.

The trees are usually slow to show symptoms of failing health. It is important to regularly check pruned branches for exit holes and pockmarks, as the infestation begins near the top of the tree. In nearly every instance where ALB was discovered in the United States, it was because a concerned citizen called it in. While there have been no cases in Connecticut up until this point, an infestation would be devastating.

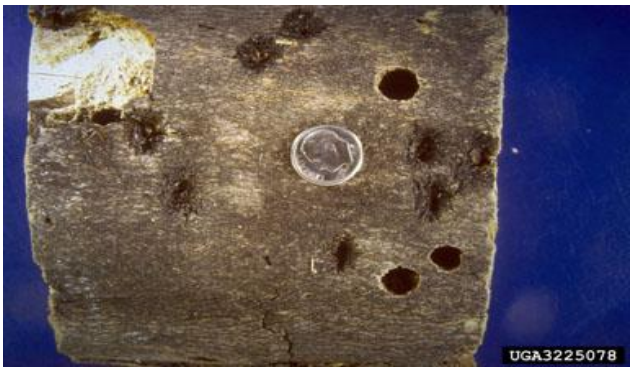


Figure 61 Asian longhorned Beetle Exit Holes, Photo: E. Richard Hoebeke, Cornell University

The nearly perfect circles are fresh exit holes. The scarred circles near the top of the image are the previous season's exit holes, while the vertical ovals are previous season's egg deposits.

Figure 62 Adult Asian Longhorned Beetle, *Photo: Joe Boggs, Ohio State University*

Spotted Lanternfly (not observed on Yale Golf Course campus but need to monitor for)

The spotted lanternfly is another pest that should be considered during monthly inspections, despite not having reported cases in Connecticut. Like ALB, the lanternfly does not have a host plant and there are no known treatment options yet. It is a major concern for Connecticut because 47 percent of Connecticut's forests are susceptible to the pest. The nymphs and flies suck the sugary sap from the trees, which depletes the plants' resources. It also leaves plants susceptible to sooty mold, as the sugar sap is a perfect opportunity for fungal growth. The mold is not life threatening, but it is unsightly anywhere, especially on campus trees. While more research is needed, there is a suspicion that part of the reproductive cycle requires access to the invasive tree, tree-of-heaven (*Ailanthus altissima).* By removing the plant population, the spread of the pest can be largely prevented. Additionally, if there is an outbreak, sticky bands placed four inches from the base of trees can prevent the pest from moving up and down.

Figure 63 Adult Spotted Lanternfly

Figure 64 Adult Spotted Lanternfly

Figure 65 Spotted Lanternfly Egg Casings, Photo: Lawrence Barringer, Pennsylvania Department of Agriculture

Figure 66 Adult Flies Feeding on Sap

Figure 67 Nymphs Feeding on Young Wood

Photos: Emilie Swackhamer, Penn State University

Dutch Elm Disease

Dutch elm disease (*Ophiostoma ulmi* or *O. novo-ulmi*), a fungus, can occur on most elm trees and often on resistant varieties. The fungus is spread via elm bark beetles or by root grafts from adjacent trees. Symptoms develop quickly within a four- to five-week period, usually when the leaves have reached full size. The first visual symptom, usually seen within the crown of the tree, is referred to as "flagging." This occurs when one or more branches develop symptoms of wilting and/or yellowing of the leaves on an otherwise apparently healthy tree. Prior to this occurring, symptoms have developed internally and include the death of xylem cells, the loss of water-conducting ability, and the browning of the infected sapwood in narrow streaks that follow the wood grain channels. Dead branches begin to appear sporadically in parts of the crown. IPM scouting should also continue despite any fungicidal injections.

Eradicative pruning can slow the spread if there is enough clear wood between the infected area and the cut (five to 10 inches) (Northeastern Area State & Private Forestry USDA Forest Service (2020)).

Figure 68 Flagging on Elm (note discolored foliage)

Photo: Dr. Steve Katovich, USDA Forest Service USDA Forest Service (2020)

RECOMMENDATIONS

It is important to note and understand that the "cutting" or "thinning" the edges of the interior woodland and the forest preservation borders significantly alters the dynamic of the "new edge" trees. The trees were previously buffered by trees that grew and adapted to specific site wind dynamics, weather exposure (snow, ice and rain), sun exposure and hydrology.

Trees that grew within groups of trees are now exposed to more frequent and stronger forces than accustomed to leading to an increased probability of partial or full failure. The trees will now be closer to the field of play. The managers should have an elevated awareness of this dynamic when scheduling tree inspections. Tree inspections and pruning cycles should focus on all forest and woodland borders to try and identify trees with hazardous architecture tendencies.

Altered hydrology due to new drainage or irrigation patterns might unduly stress trees due to increased or decreased water supply. Inspections should monitor for such conditions ideally when the foliage is present when indicators can be more clearly apparent.

The considerable trenching and construction operations have most likely cut or torn tree roots leading to exposure to potential fungus, bacteria and instability. Often 4 -7 years can go by before signs of damage become apparent. Root areas within and adjacent to cart pathways are also prone to such damage. The safety of individuals first and property second shall always be at the forefront.

A tree rooted in the blasted rubble might tend to fail sooner than one rooted in soil. The roots could be poorly secured with fewer opportunities to anchor and spread to find necessary nutrients. These trees are more likely to be drought impacted as well. Inspections should inspect leaning trees on rocky slopes and their proximity to zones of frequent occupation such as cartways, fairways, parking areas and buildings of occupancy. Some of the woodlands or forested areas could also be occupied by golfers scouting for lost balls and should be part of inspection zones.

Trees that are potential risks should be identified through regular scheduled monitoring and felled as the edge dynamic evolves. Cut trees can remain on the ground within woodlands and forested areas to provide habitat and reduce carbon emissions.

Figure 69 Tree Uprooted in Interior Woodland

Figure 70 Basal Tree Root Fail in Interior Woodland

Tree Inspections

As noted, tree inspections provide information to monitor and manage a tree population. The following tree inspection recommendations are presented to inform the haul road overall vegetation management program. Inspections serve three primary vegetation management goals:

1. **Monitor** the tree population for short- and long-term risk issues. The former typically requires some form of mitigation which can range from deadwood pruning to whole tree removal. The

latter concerns observable issues that are not of an imminent nature which is balanced with the benefits the tree provides.

2. **Assess** the tree for overall health and vigor. The most benefits to the golf course campus are derived from trees that are healthy. A scheduled inspection that includes assessing tree health allows staff to make choices that maximize these benefits.

3. **Demonstrate** due diligence by the university by applying a regular inspection process that is uniformly applied across the total tree population.

Inspection Cycle. The consultants recommend a five-year cyclic inspection interval. This is a common inspection interval for a proactive urban forestry program in the United States. For the Yale Golf Course, this translates to approximately 20 percent of the tree population on each inventoried area being inspected annually. Certain interior forest or woodland areas may not pose any likelihood of harm to individuals due to minimal, if any, occupancy and could be considered as a lower priority for golf course management.

Inspection Type. The standard inspection should be the equivalent of an ISA Level 1–Limited Visual Inspection. This is based on the resources available and the size of the tree population requiring an inspection. A limited visual inspection should encompass a 360-degree view of the tree from the ground. If the tree presents elevated concerns to the inspector, a more advanced assessment may be required on individual trees.

Inspection Methodology. Each Level 1 inspection should include an assessment of the trunk, scaffold branches, and crown. Record keeping can consist of either working from a hard copy of an inventory-generated tree list or directly accessing the inventory via an electronic notebook. The primary issues to address are tree health and any short-term mitigation requirements. The inspector

should update the tree's diameter, condition, maintenance needs, and inspection date. Basic hand tools to be used include diameter tape, rubber mallet, and binoculars.

Inspection Scheduling. The optimum time for the inspection cycle to take place is during the summer when the trees have leaves and are fully leafed out. The optimum scheduling would have the trees that are scheduled for pruning during the forthcoming winter season be the trees scheduled for inspection during the prior summer. This would allow trees noted for removal to be mitigated before the pruning cycle begins.

Monitor Trees. Some trees have been identified as "monitor". Inspection intervals should include such trees. In "GOLF ALL INTERIOR" 300 trees were identified and in the "50' PRESERVATION BORDER" 13 were identified.

Trees Identified to Monitor Annually		
Identified Monitoring	**ALL INTERIOR**	**50" PRESERVATION BORDER**
Area Tree Count	300	13

Figure 71 Trees Identified as Monitor in 50' Border Preservation and All Interior Areas

Area-Specific Considerations. The recommendations noted above should be applied separately to the golf course. Each individual area, however, has nuances to its landscape that warrant details specific to the area. Managed areas such as the golf course mown areas have a greater intensity of use and therefore have different considerations.

Environmental Resilience

A resilient landscape is achieved through modifying best managed practices based on current research. Updating and sharing proven methods with other stakeholders is an ongoing process.

- Implement and track plant ratio minimums—10 percent of any one species, 20 percent of any one genus, or 30 percent of any one family for improved biodiversity.
- Use annual cyclic planting minimums to maintain future canopy cover.
- Use replacement planting for trees lost to damage, construction, or pests. Trunk area lost should be translated to trunk area replanting efforts. Larger trees will return environmental benefits sooner.
- Implement Integrated Pest Management (IPM) program either in house or by contract, with the goal of reducing pesticide use. Staff training and support with programs such as the International Society of Arboriculture certified arborist with continuing education requirements (CEUs) will assure long-term understanding of the campus and adoption of principles and methods.
- Encourage repurposing of wood products as the potential for lasting awareness and appreciation of campus trees such as current Yale Bowls project (yalebowls.com).
- Highlight environmental and economic benefits of individual trees by informational posting at tree. Adopt Sustainable Sites (http://www.sustainablesites.org/certification-guide) goals for the campus tree canopy as they relate to carbon sequestration, stormwater, and environmental benefits will also align with Yale's Sustainability Plan (http://www.sustainablesites.org/certification-guide, 2020).

Stormwater Retention

Existing trees can be enabled to capture stormwater runoff with mulched beds and beneficial grading. Mulch captures and slows water down, allowing it to percolate into most of the root system just beneath the surface (two to three feet). This capture removes water that otherwise would be prone to eroding valuable topsoil.

- Species that are better at Rain Garden areas can utilize trees that favor moist conditions to acquire and hold runoff without an issue. Typically, these areas are established in areas with poor drainage or in an area that runoff velocity is being reduced. (red maple, Atlantic white cedar, and red twig dogwood)

- Existing areas and future construction sites could install stormwater capture areas adjacent to parking lots, gradients in the landscape, or low points in managed areas where water is slow to infiltrate soil zones due to saturation. Plant selection is site specific, although numerous small or even large trees can accommodate successful stormwater retention goals in conjunction with smaller plant selections such as shrubs and perennials.

- Sustainability goals can also be met through stormwater retention projects. Trees and shrubs recommended for retention plantings can include red maple (*Acer rubrum*), river birch (*Betula nigra*), American hornbeam (*Carpinus caroliniana*), hackberry (*Celtis occidentalis*), Eastern redbud (*Cercis canadensis*), and black gum (*Nyssa sylvatica*) (UConn Plant Database, 2020).

Carbon Sequestration and Storage

The larger the tree, the greater the amount of carbon sequestered. The large trees can be invasive, native, or desirable but still have positive storage results. It is important to realize the benefits when evaluating the environmental contributions of all trees.

When considering carbon sequestration and storage, the golf campus should acknowledge the significant red oak carbon benefits, though there is a need to increase its diversity with the tree population and consider planting larger quantities of smaller-sized trees in variety and increase diversity in larger tree species. Such diversity in species and size is scheduled as part of the renovation (Tighe & Bond, 2023).

COMPREHENSIVE PRUNING

Comprehensive pruning refers to trees under a cyclic pruning cycle or any tree that may require corrective pruning due to storm, disease, or insect damage.

Interior and 50' Preservation Border

Pruning Work		
TREE WORK-PRUNING	COUNT	PERCENTAGE
Not Specified	4,843	61.6%
Deadwood	1,267	16.1%
Crown Clean	1,206	15.3%
Reduce end weight	418	5.3%
Structure Prune	43	0.5%
Crown Raise	20	0.3%
Crown Restoration	19	0.2%
Crown Reduce	17	0.2%
Clearance Prune	15	0.2%
Crown Thin	11	0.1%

Figure 72 Pruning Actions for All Interior and 50' Preservation Border

A significant number of Interior and 50' Border Preservation trees (1206 total trees or 16.1%) were noted for A300 deadwood crown cleaning. The amount of deadwood identified usually correlates with this action being assigned. A crown cleaning is the removal of all dead, diseased, and crossing limbs above a specified diameter size. Crown cleaning can be incorporated into cyclic pruning operations with a priority for pruning of dead wood and broken or hanging branches in areas of higher traffic prioritized for work first. Some trees may be outside areas of concern (lack of human occupancy or property) by Yale Golf Management and deferred or left in a natural state.

All Interior Pruning

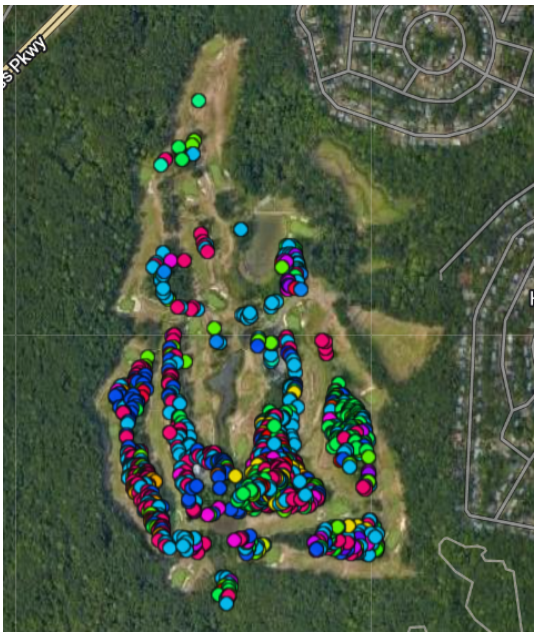


Figure 73 Interior Trees Color Coded by Species

Pruning Work

TREE WORK-PRUNING	COUNT	PERCENTAGE
Not Specified	2,922	58.0%
Deadwood	910	18.1%
Crown Clean	821	16.3%
Reduce end weight	335	6.7%
Crown Raise	15	0.3%
Clearance Prune	12	0.2%
Crown Reduce	10	0.2%
Crown Thin	4	0.1%
Crown Restoration	3	0.1%
Structure Prune	2	0.0%

Figure 74 Pruning Identified for Interior Trees

50’ Preservation Border Pruning

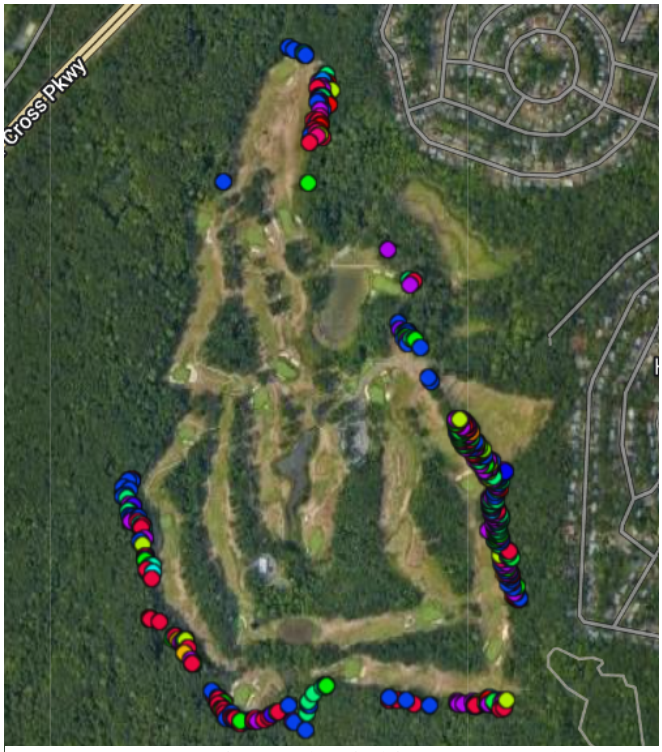


Figure 75 Locations of Trees Identified for Pruning Work in 50' Preservation Border

Pruning Work

TREE WORK-PRUNING	COUNT	PERCENTAGE
Not Specified	1,921	68.0%
Crown Clean	385	13.6%
Deadwood	357	12.6%
Reduce end weight	83	2.9%
Structure Prune	41	1.5%
Crown Restoration	16	0.6%
Crown Thin	7	0.2%
Crown Reduce	7	0.2%
Crown Raise	5	0.2%
Clearance Prune	3	0.1%

Figure 76 Tree Work Actions

Stump grinding may or may not be a priority to be completed after tree removal based on site use, accessibility, and aesthetics and should be evaluated on a case-by-case basis as determined by the Yale Golf Course representative. If any cabling or cable inspections were needed or observed, they were noted on ArcGIS records as "cable."

Pruning provides many benefits for a tree. First and foremost, it serves to maintain a tree in a healthy and safe state, while promoting longevity. From early structural pruning to maintenance pruning over a tree's mature life, golf course management can play a large role in increasing a tree's age and minimizing the reactive cost of future care such as storm damage. A regular pruning cycle is a critical component of an effective forestry program. Golf course areas will derive the following benefits from maintaining the cyclic maintenance program.

- Simply by pruning dead wood, the condition ratings will be upgraded for many of the golf course trees.
- Reactive requests and storm damage will be reduced.
- Cyclic maintenance guarantees that every tree on managed grounds will be regularly inspected by staff and/or contractors.
- Yale Golf can demonstrate that it is exhibiting "reasonable care" in maintaining its forest and woodlands. The notion of "reasonable care" is the strongest defense the golf course has in litigation due to a tree or tree part failure.
- Pruning specifications need to include manager notification by inspector/pruner of any additional observation of concern: decay, cracks, broken branches, etc.

In the United States, most system-level forestry programs try to implement a five- to eight-year pruning cycle. The consultants recommend a five-year pruning cycle for the golf course. The overall objective is to achieve a cyclic pruning program within fiscal and human resource constraints.

All pruning activity should follow the current American National Standard for Pruning (ANSI A300)—specifically for crown cleaning and raising. These pruning operations are best performed during winter months.

Crown Cleaning–The removal of defective limbs that are broken, diseased, dying, broken, structurally unstable and rubbing. This process improves tree health, reduces branch failures, and improves aesthetics.

Crown Thinning–The selective removal of branches to increase light penetration and air movement in the crown, or canopy, of a tree.

Crown Raising –The removal of lower branches. Crown raising is frequently done to allow foot or vehicle traffic or lawn mowers under the tree. Street trees require at least 16 feet of clearance for trucks. Lawn trees need eight feet of clearance for foot traffic. Trees used for screening or windbreak can be allowed to have branches near the ground.

Crown Reduction–The proper removal of upper branches when the tree has become too tall. When a tree is too tall, it is better to remove it. **Never top (removing large branches or/and trunks from treetops, leaving stubs, and not making proper pruning cuts) a shade tree to control its size**. The number of trees requiring crown cleaning varies throughout the golf course campus. Some form

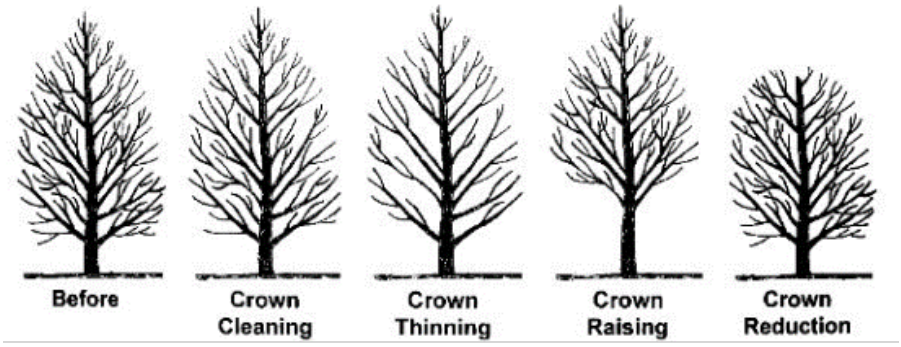


Figure 77 Types of Pruning (BP Tree Service)

of cyclic inspection and pruning program should be a primary maintenance goal for golf course management. A five-year cycle is the consultant's recommendation. Several approaches can be considered to meet this goal. The most efficacious approach will be informed by the following factors:

- Establish the area degree that a Yale Golf representative or staff can carry out pruning. Staff should be able to prune trees under 12 feet and/or under 12-inch caliper if supervised by an onsite Connecticut licensed arborist. It is important to note that this is driven by Connecticut

state law and should conform to those requirements (Ct Arborist Law Sections 23-61a through 23-61f of Ct State Statutes). This determination should consider current operational needs and staff ability to annually prune a portion of the 20 percent of the trees six inches or less in diameter in managed areas as recommended for other Yale campus designations.

- A larger-size diameter class could be considered for in-house pruning if capability is met with training and supervision under a Connecticut licensed arborist (otherwise, outside licensed contractors would also function as a pruning source).
- Some trees within the cycle may not require pruning, but inclusion in the pruning cycle guarantees that a regular inspection, as a minimum, occurs for the tree.
- Will require Yale Golf representative/contractor or staff training in structural pruning.
- Will require Yale Golf representative or staff training on maintaining pruning/inspection records.
- Contract pruning 20 percent of the balance of trees within desired area (recommend all edge trees within approx. 75' of managed area on an annual basis. This number will be considerably less than the full population.
- Pruning to A300 standards. Includes crown cleaning and crown raising during winter months.
- Yale Golf representative or staff to identify the 20 percent to be inspected/pruned for that season. Selection should evenly distribute trees across size classes to guarantee uniform annual budget requirements.
- Inspection in the fall by the Yale Golf representative or staff of the 20 percent of trees to be pruned that season. The purpose of the inspection is to note any specific pruning requirements, update tree conditions, identify any removals, and identify any trees that do not require pruning.
- Provide a methodology and protocol for updating pruning/inspection records such as the Yale University Landscape and Grounds ArcGIS platform.
- Potentially create a field in the tree inventory for assigning a tree to a cycle to allow an easily retrievable project list.
- Develop a tree inspection methodology for Yale Golf representative or staff.
- Develop pruning specifications to be used across golf course by both contractor and staff (reference A300 pruning standards).

- The current tree inventory GIS platform should be updated with regards to trees cyclically pruned and when by Yale Golf staff or contractor or consulting arborist.
- Completed construction footprints, removals; all IPM priority tree actions and plantings should also be recorded and inventoried and updated by the Yale Golf representative or other.

REMOVALS

The list below shows the count of all removals by the 7 areas. Of all areas, the identified 97 "high" priority trees should be considered first for action. This list and data points were submitted prior to the submission of this report with some removals completed. The trees can be dead, in poor condition, or a healthy tree in fair or good condition with a structural defect leading to potential instability.

Trees that are in woodland areas or forested areas away from foot or vehicular traffic would not usually be recommended for removal but some trees within such areas are adjacent to interior pathways, cart ways parking lots and roadways or are located near fairways, greens and tees. Other interior woodland or forest trees without as high a frequency of occupation have also been noted for removal but are labeled as "low" or "medium priority". They have been identified as hazardous and should be considered for removal (dropped and left in place) by authorized Yale Golf Course after evaluation.

Total Tree Removals by Area

Yale Golf ALL INTERIOR (3925 Trees)	(172 Recommended for Removal)
Yale Golf 50' BORDER PRESERVATION (2384 Trees)	(116 Recommended for Removal)
Yale Haul Road REMOVALS (98 Trees)	(98 Remove per plans)
Yale Golf PRIORITY Removals (97 Trees)	(97 Remove per High PRIORITY)
Yale Golf Border REMOVALS (per construction documents and reference layer)	(272 Remove per plans)
Yale Golf Stevenson Road REMOVALS (49 Trees)	(49 Remove per plans)
	804 Total Trees for Removals

Stump grinding may or may not be a priority to be completed after tree removal based on site use, accessibility, and aesthetics and should be evaluated on a case-by-case basis as determined by the management.

All Interior Removals

Edge trees that might fall into adjacent tees, fairways, clubhouse, parking areas and cart paths have been identified as "high "priority and should be removed. Interior woodland trees with little or no cart/foot traffic have reduced frequency of targets. The trees are usually a lower priority removal and perhaps even unnecessary to remove in interior less occupied areas but have been identified as unstable. They could also be cut back to a lower height and saved as wildlife habitats.

Other Work

TREE WORK-OTHER	COUNT	PERCENTAGE
Not Specified	3,752	94.6%
Remove	172	4.3%
Stump Grind	42	1.1%

Figure 78 All Interior Removal Count

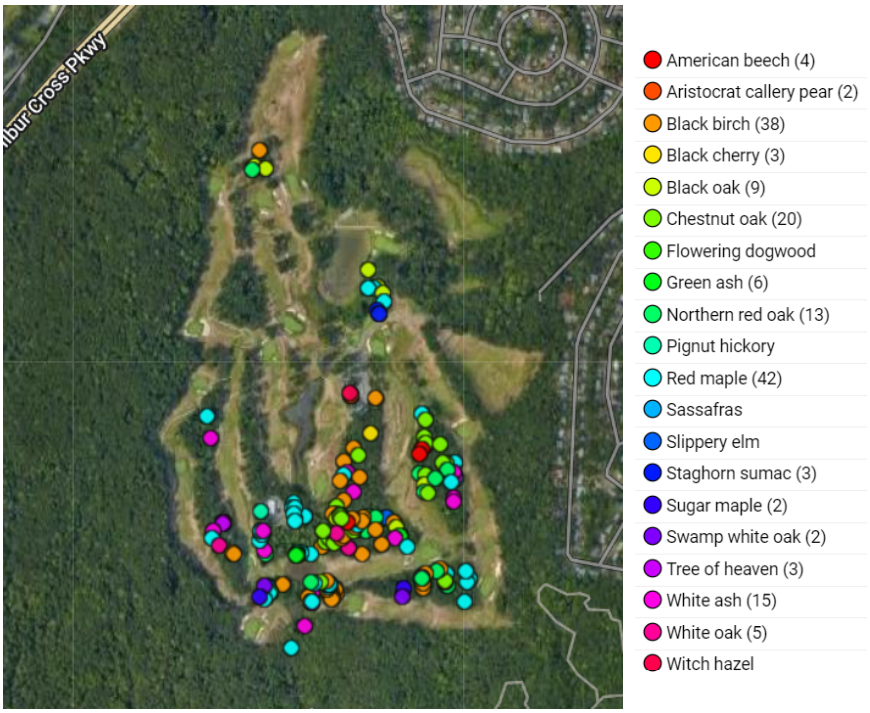


Figure 79 Interior Removal Locations Color Coded by Specie, Percentages and Count

50' Preservation Border Removals

Border trees that might fall into adjacent tees, fairways, clubhouse, parking areas and cart paths have been identified as "high "priority and should be removed. Border forest trees with little or no cart/foot traffic have reduced frequency of targets. The trees are usually a lower priority removal and perhaps even unnecessary to remove in interior less occupied areas but have been identified as unstable. They could also be cut back to a lower height and saved as wildlife habitats.

Other Work		
TREE WORK-OTHER	COUNT	PERCENTAGE
Not Specified	2,268	95.0%
Remove	116	4.9%
Stump Grind	3	0.1%

Figure 80 Border Preservation Removals

Figure 81 50' Border Preservation Removal Locations Color Coded by Species, Percentages and Count

High Priority Removals

Trees that have been identified as having a high likelihood of failure within or adjacent to areas of occupancy are considered "high" priority removals.

Other Work		
TREE WORK-OTHER	COUNT	PERCENTAGE
Remove	95	90.5%
Stump Grind	8	7.6%
Not Specified	2	1.9%

Figure 82 High Priority Removals

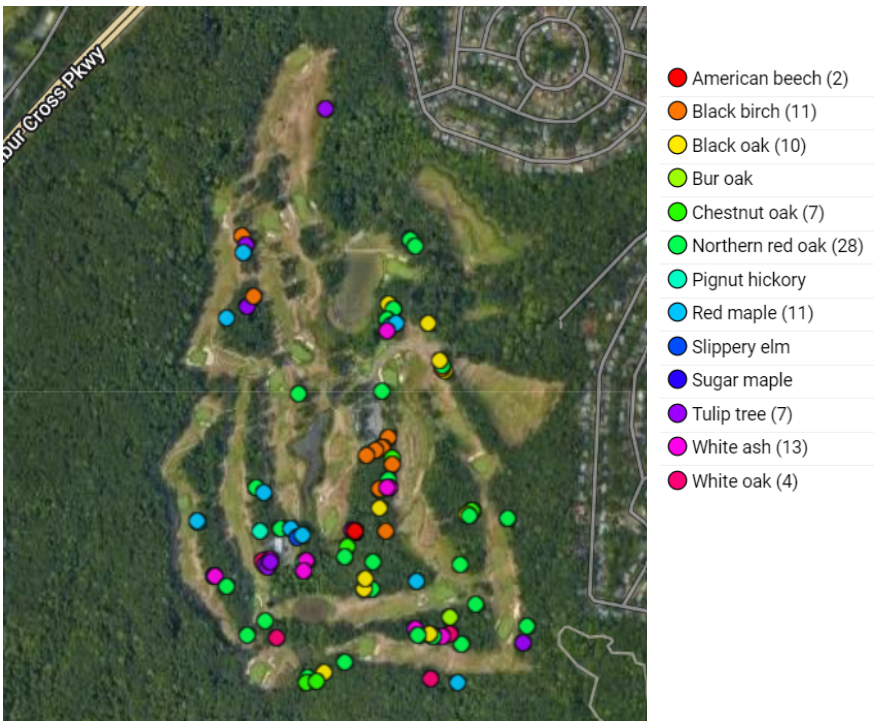


Figure 83 High Priority Locations, Percentages and Count

PLANTINGS

Tree planting recommendations that have been made to the other Yale University campus areas in Treefoil's 2020 Yale Tree Management Plan have different considerations when making recommendations for planting quantities, locations species and diversity. Urban areas within the Yale campus designations have tight space considerations: tree size in relation to buildings, sidewalks, streets, rooftops of underground educational facilities, access and scarce soils in planting spaces. Often, non-native species were selected to broaden the palette of available species.

The Yale Golf Course is undergoing an extensive course renovation inspired by its original 1920's design and construction. Specific needs like frequent and sometimes daily mowing, irrigation, drainage, agronomy supplementation, golf cart and pedestrian access, light requirements, field of play, difficulty of play, duration of play are unique to the golf course setting. The natural self-seeding of trees,

uninformed prior planting by beautification committees and fairway woodland tree expansion are realities that the professional golf course staff need to consider. The consultant is not qualified nor informed to gauge the current tree population's impact on such details, and it's best left to the designer's and professional staff recommendations.

It is important to note that a significant number of perennial, shrub and tree plantings consisting of native species are scheduled to be planted at various locations throughout the golf course per construction mitigation plans. (Tighe & Bond, Golf Course Restoration Project, Mitigation Part Plan, Sheets C 700-783, 9/20/2023). The lists are aligned with low percent quantities of low species planting percents (20%) which align and complement the consultant's collected data results.

INVASIVE COUNT

The recorded number of inventoried invasive trees was very low (see count below) considering the woodlands and forested areas had long lengths of exposed edges where invasive are more likely to take hold. The low count could be attributed to the edge border maintenance such as weed whacking or mowing. The edge transitional areas ("rough") were most often occupied by various grasses because of such maintenance. Species such as Russian olive (*Elageanus angustifolia*) were surprisingly absent as well.

Figure 84 Cleared Areas Are Highly Prone to Invasive Species

The current restoration has opened the forest and woodland edges and exposed the previously shaded surface below encouraging invasive plant growth. Some golf course edges currently have isolated pockets of such growth. Species such as barberry (*Berberis thunbergiana*), burning bush (*Euonymous alatus*), bittersweet *(Celastrus orbiculatus*), poison ivy (*Toxicodendron radicans*) and honeysuckle (*Lonicera japonica*) and green brier (*Smilax glauca*) are likely to move into the exposed woodland and forest border areas. The consultant recommends monitoring and continuing mechanical or hand-pulling maintenance of such areas, however, a certified forester would be a more proper source of recommendations.

Yale Golf Course Inventoried Areas Invasive Tree Count

Norway maple (*Acer platanoides*)	2
Amur maple (*Acer ginnala*)	1
Sycamore maple (*Acer pseudoplatanus*)	1
Black locust (*Robinia pseudoacacia*)	4
Total Invasive Tree Population	**14**

TREE PROTECTION

The Yale Golf Course tree protection is specific and unique. The considerable ongoing drainage and utility trenching throughout the site is often within proximity of fairways, greens, cartways and roadways. These activities can be inside the critical root zone (CRZ) of trees. Many trees have been removed to make room for trenching or expansion of the course field of play as decided by the golf course architect. For a full guide to tree protection, a critical reference is published by *The Yale Office of Facilities, Guideline for Tree Protection and Preservation for Planners and Project Managers* guidance for tree protection standards (Yale Facilities, 2021) for such work.

The consultants have previously found critical root zones (CRZ's) within Yale University's Facilities tree inventory ArcGIS platform. A tree with a diameter of 20", as measured at a height of 4.5' above

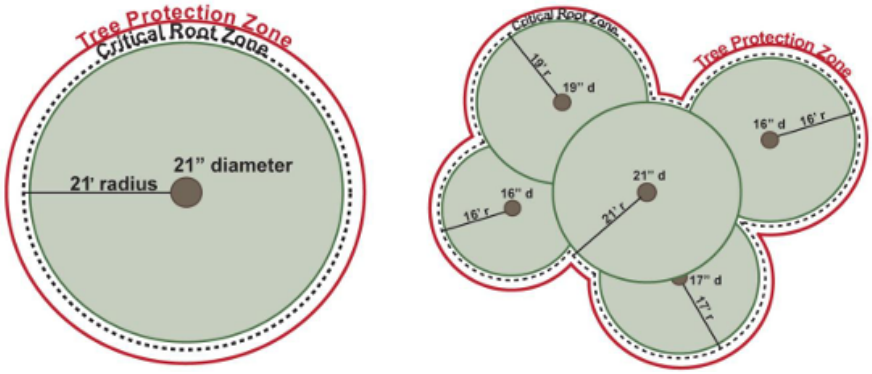


Figure 85 Plan View of Example CRZ based on 1:1 ratio

grade, would be multiplied by 1.33 to set up a radius measurement for a CRZ or 26.6' radius from the trunk. This would be a *minimum* area to set up a tree protection zone that is secured by chain link fencing with prohibited activities such as trenching, excavation, vehicular or machine access to prevent root damage.

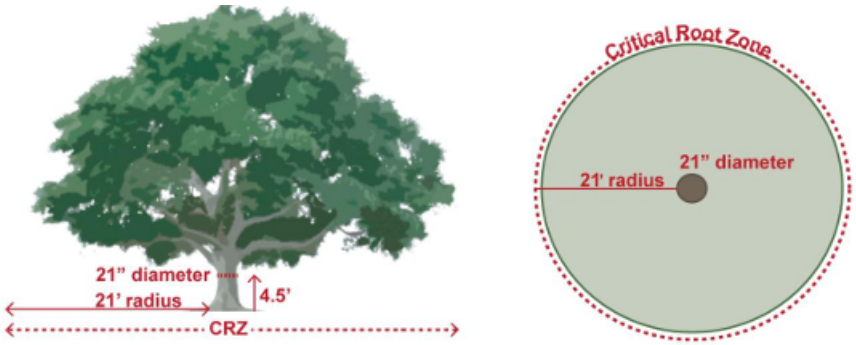


Figure 86 Elevation View Based On 1:1 Ratio

Remaining trees, especially along forest and woodland edges or lone trees in managed lawn areas should be the focus of tree protection during construction and future monitoring efforts. Trunks that have been buried or scarred and roots that have been torn or cut with machinery, especially inside the CRZ, are more prone to bacterial and fungal root decay potentially leading to initial or delayed branch or tree failures. Clean hand sawn cuts of roots over 1" will ease compartmentalization of decay and bacteria. Stability threatening root and internal decay of trees is often difficult to diagnose and best prevented.

A six-month cyclical inspection is recommended for border trees found in woodland and forest areas, particularly those that have had cutting or filling activities within their CRZ. Foliage was not evident during the consultant's winter and early spring inventory.

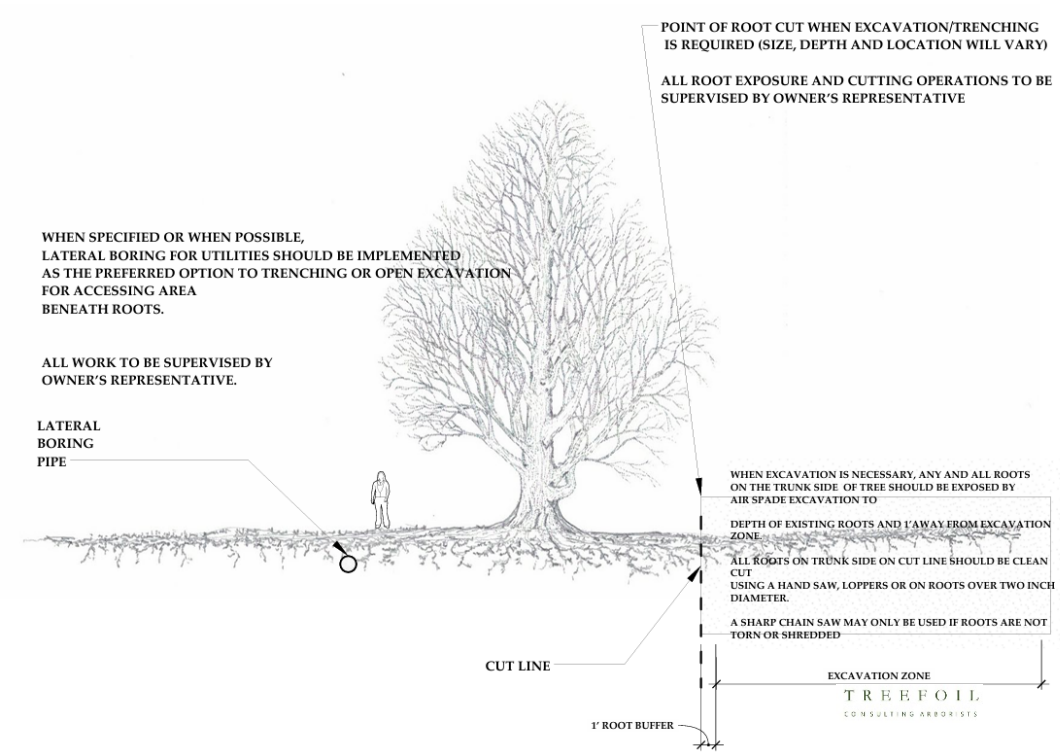


Figure 87 Elevation Profile of Trenching Options Within CRZ (Not to Scale)

Figure 88 Trunk Scarring of Bark

Figure 89 Example of Trunk Protection to Prevent Damage in Construction Zones

Figure 90 New Cartway Within CRZ

Figure 91 Workers Clean Cutting Roots in Trench

CONCLUSION

The current focus of the Yale Golf Course renovation requires daily monitoring as multiple trades schedule and coordinate their work. The dust will settle with a shift in focus to the complex and dynamic business management of the renovated golf course. The new interface of the non-managed woodland and forest areas with that of a highly managed course areas is seperated by a small area of "rough" and should be included in the management discussion. Prioritizing order tree zones with regular border cylical pruning and monitoring will be a key part successful management.

GLOSSARY

10-20-30 guideline for planting a diverse urban forest wherein a single species should make up no more than 10 percent of the tree population, a single genus no more than 20 percent, and a single family no more than 30 percent (Santamour, 1990)

abiotic disorder – plant ailment caused by nonliving, environmental, or man-made agents. (ISA, 2020).

absorbing roots: – fine roots with functional root hairs that are responsible for the uptake of water and minerals. (ISA, 2020).

absorption: take up (contrast with adsorption). (ISA, 2020).

acceptable risk – a degree of risk that is within the tolerance or threshold of the owner, manager, or controlling authority. (ISA, 2020).

acceptable risk threshold: highest level of risk that does not exceed the owner/manager's tolerance. (ISA, 2020).

action threshold –1) pest population or plant damage level that requires action to prevent irreversible or unacceptable physiological and/or aesthetic harm. (see *economic threshold*) 2) point at which the level of incompatible plant species, density, height, location, or condition threatens the stated management objectives and requires implementation of a control method (s). (ISA, 2020).

adaptability – genetic ability of plants and other living organisms to adjust or acclimate to different environments. (ISA, 2020).

adaptive growth: see *response growth.* (ISA, 2020).

advanced assessment: assessment performed to provide detailed information about specific tree parts, defects, targets, or site conditions. Specialized equipment, data collection and analysis, and/or expertise are usually required. (ISA, 2020).

aerial inspection: inspection of parts of a tree not visible from the ground, including the trunk and branches; typically done by climbing or from an aerial lift. Aerial inspection may include evaluation of internal decay. (ISA, 2020).

air-excavation device, air excavator – device that directs a jet of highly compressed air to excavate soil. Used to avoid or minimize damage to tree roots, or underground structures such as pipes and wires. May also reduce hazards associated with excavation near pipes or wire. (ISA, 2020).

allée: two parallel rows of trees, usually of the same species, form and age, often having canopies that have grown together. (ISA, 2020).

American National Standards Institute (ANSI): a private, nonprofit organization that oversees the development of voluntary consensus standards by accredited representatives of government agencies, industry, and other stakeholders (see *ANSI A 300*, *ANSI Z133*, and *ANSI Z60.1*) (ISA, 2020).

anaerobic – without – or with a restricted supply of – air. Process that occurs in the absence of oxygen. (ISA, 2020).

analysis: detailed examination of the elements or structure of something. (ISA, 2020).

ANSI: acronym for American National Standards. (ISA, 2020).

ANSI A300 – in the United States, industry-developed, national consensus standards of practice for tree care. (ISA, 2020).

ANSI Z133.1 – in the United States, industry-developed, national consensus standards of practice for tree care. (ISA, 2020).

ANSI Z60.1: in the United States, industry-developed, national consensus standards for nursery stock. (ISA, 2020).

appraisal (valuation): 1) act or process of developing an opinion of value, cost, or some other specified assignment result. 2) a report stating an opinion of appraised value. 3) particularly outside the United States, an evaluation of nonmonetary landscape or plant characteristics. (ISA, 2020).

approved – in the contest of guidelines, standards, and specifications, that which is acceptable to federal, state, provincial, or local enforcement authorities or is an accepted industry practice. (ISA, 2020).

arboriculture –the practice and study of the care of trees and other woody plants in the landscape. (ISA, 2020).

arborist: professional who possesses the technical competence, through experience and related training, to provide for or supervise the management of trees and other woody plants in residential, commercial, and public landscapes. (ISA, 2020).

bacteria: minute, usually single-celled organisms having a cell wall but no organized nucleus and reproducing by fission. Some species are plan pathogens. (ISA, 2020).

balled and burlapped (B&B) – tree or other plant dug and removed from the ground for transplanting, with the roots and soil wrapped in burlap or a burlap -like fabric. (contrast with *bare root*, *container grown*, *containerized*, and *in-ground fabric-bag grown*). (ISA, 2020).

bark: protective outer covering of branches and stems that arises from the cork cambium. (ISA, 2020).

basal rot (basal decay): decay of the lower trunk, trunk flare, or buttress roots. Also called butt rot. (ISA, 2020).

basic assessment (Level 2) - detailed visual inspection of a tree and surrounding site that may include the use of simple tools. It requires that a tree risk assessor inspects completely around the tree trunk looking at the visible aboveground roots, trunk, branches, and site. (ISA, 2020).

berm: wall or mound of dirt that directs, diverts, or holds water: screens objectionable views or reduces objectionable noise: or provides additional rooting volume for trees or other plants. (ISA, 2020).

best management practices (BMPs): – best-available, industry-recognized courses of action, in consideration of the benefits and limitations, based on scientific research and current knowledge and standards. (ISA, 2020).

biological control: 1) method of managing plant pests or weeds through the use of natural predators, parasites, or pathogens. 2) biological methods – conservation of compatible, stable plant communities using plant competition, allelopathy, animals, insects, or pathogens. Cover-type conversion is a type of biological control methods. (ISA, 2020).

biomechanics: application of physical or mechanical principles to biological organisms. (ISA, 2020).

biotic: pertaining to living organisms. (ISA, 2020).

biotic disorder: – disorder caused by a living organism (contrast with *abiotic disorder*) (ISA, 2020).

buttress roots – roots at the trunk base that help support the tree and equalize mechanical stress. (ISA, 2010).

canker – localized disease area on stems, roots, and branches. Often shrunken and discolored. (ISA, 2010).

carbon sequestration – capturing and long-term storage of carbon. Most often used about the capturing of atmospheric carbon dioxide through biological, chemical, or physical processes. Trees sequester carbon through photosynthesis. (ISA, 2010).

cavity – open or closed hollow within a tree stem, usually associated with decay. (ISA, 2010).

chronic – disorder or disease occurring over a long period of time. Contrast to *acute.* (ISA, 2010).

CODIT – acronym for Compartmentalization of Decay in Trees. See *compartmentalization.* (ISA, 2010).

codominant stems – forked stems nearly the same size in diameter, arising from a common junction and lacking a normal branch union. (ISA, 2010).

compaction – see *soil compaction.* (ISA, 2010).

conk – fruiting body or nonfruiting body (sterile conk) of a fungus. Often associated with decay. (ISA, 2010).

consequences – outcome of an event affecting objectives (ISO, 2018). Effects or outcome of an event. In tree risk assessment, consequences include personal injury, property damage, or disruption of activities or services due to the event (ISA, 2011).

Council of Tree and Landscape Appraiser (CTLA) – group of representatives of several tree care and landscape associations that works to research and compile the *Guide for Plant Appraisal.* (ISA, 2010).

crown cleaning – in pruning, the selective removal of dead, dying, diseased, and broken branches from the crown. (ISA, 2010).

data – facts and statistics collected for reference or analysis

data point – an identifiable element in a data set

diameter at breast height (DBH) – a U.S. custom means of expressing a diameter of a tree, as measured 4.5 feet (or 1.37 m) above the ground. (ISA 2019).

diameter tape – a diameter tape (D-tape) is used by foresters to measure the diameter of a tree. Since trees are swelled at the base, measurements are made 4.5 feet above the ground to give an average diameter estimate.

decay – (1) (*noun*) an area of wood that is undergoing decomposition. (2) (*verb*) decomposition of organic tissues by fungi or bacteria. (ISA, 2010).

deciduous – tree or other plant that sheds all its leaves according to a genetically scheduled cycle as impacted by climate factors (usually during the cold season in temperate zones). Contrast with *evergreen.* (ISA, 2010).

defoliation – loss of leaves from a tree or other plant by biological or mechanical means. (ISA, 2010).

dieback – condition in which the branches in the tree crown die from the tips toward the center. (ISA, 2010).

drought– A period of abnormally dry weather long enough to cause a serious hydrological imbalance. Drought is a relative term (see Box 3-3), therefore any discussion in terms of precipitation deficit must refer to the precipitation-related activity that is under discussion. For example, shortage of precipitation during the growing season impinges on crop production or ecosystem function in general (due to soil moisture)

duty of care – legal obligation that requires an individual to use a reasonable standard of care when performing tasks that may potentially harm others. (ISA, 2010).

evapotranspiration (ET) – loss of water by evaporation from the soil surface and transpiration by plants. (ISA ,2010).

event – occurrence of a set of circumstances (ISA, 2018).

foliage – leaves of a plant. (ISA, 2010).

frass – fecal material and/or wood shavings produced by insects. (ISA, 2010).

frost crack – vertical split in the wood of the tree, generally near the base of the bole, caused by internal stresses and low temperatures. Radial shake. (ISA, 2010).

fruiting body – reproductive structure of a fungus. The presence of certain species may indicate decay in a tree. See *conk*. (ISA, 2010).

gall – abnormal swelling of plant tissues caused by gall wasps, mites, nematodes, and various insects and less commonly by fungi or bacteria. (ISA, 2010).

genus – taxonomic group, composed of species having similar fundamental traits. Botanical classification under the family level and above the specific epithet level. (ISA, 2010).

geographic information system (GIS) – computer application used to store, view, and analyze geographic information typically maps. (ISA, 2010).

girdling roots – root that encircles all or part of the trunk of a tree or other roots and constricts the vascular tissue and inhibits secondary growth and the movement of water and photosynthates. (ISA, 2010).

habit – characteristic form or manner of growth. (ISA, 2010).

hardiness – genetically determined ability of a plant to survive low temperatures. (ISA, 2010).

hazard – a situation or condition that is likely to lead to a loss, personal injury, property damage, or disruption of activities or services; a likely source of harm. In relation to trees, a hazard is the tree part(s) identified as a likely source of harm (ISA, 2011).

hazard tree – a tree, or tree part, identified as a likely source of significant harm (ISA, 2011).

inspection interval – time between inspections (ISA, 2011).

i- Tree – suite of software products and management tools that allows the user to inventory the urban forest and analyze its costs, benefits, and management needs. (ISA, 2010).

included bark – bark that becomes embedded in a crotch (union) between branch and trunk or between codominant stems. Causes a weak structure. (ISA, 2010).

integrated pest management (IPM) – method of controlling plant pests by combining biological, cultural, mechanical, physical, and/or chemical management strategies. (ISA, 2010).

liability – something for which one is responsible. Legal responsibility. (ISA, 2010).

likelihood – chance of something happening (ISO, 2018). Within the ISO narrative, the word "likelihood" is used "to refer to the chance of something happening, whether defined, measured or determined objectively or subjectively, qualitatively or quantitatively, and described using general terms or mathematically." The term "probability" while often having a narrower definition in English is considered an equivalent term for the purposes of the ISO narrative.

limited visual assessment (Level 1) – a visual assessment from a specified perspective such as foot, vehicle, or aerial patrol of an individual tree or a population of trees near specified targets to identify conditions or obvious defects of concern (ISA, 2017).

load – (1) general term used to indicate the magnitude of a force, bending movement, torque, pressure, etc. applied to a substance or material. (2) cargo; weight to be borne or conveyed. (ISA, 2010).

mitigation – in tree risk management, reducing, alleviating, or minimizing risk of harm (damage or injury). (ISA, 2010).

monitoring – keeping a close watch. Performing regular checks or inspections. (ISA, 2010).

native species – plants indigenous to a region. Naturally occurring and not introduced by man. (ISA, 2010).

negligence – failure to exercise due care. (ISA, 2010). (1) The failure to exercise the standard of care that a reasonably prudent person would have exercised in a similar situation (Black, 2009).

negligence, gross (Willful and Wanton) – (1) a lack of even slight diligence or care. (2) a conscious, voluntary act or omission in reckless disregard of a legal duty and of the consequences to another party.

notice – legal notification required by law or agreement or imparted by operation of law because of some fact (Black, 2009).

notice, actual – notice given directly to, or received personally by, a person (Black, 2009).

notice, constructive – notice arising by presumption of law from the existence of facts and circumstances that a party had a duty to take notice of (Black, 2009).

permit – written order granting permission to do something. (ISA, 2010).

phloem – plant vascular tissue that transports photosynthates and growth regulators. Situated on the inside of the bark, just outside the cambium. Is bidirectional (transports up and down). Contrast with *xylem*. (ISA, 2010).

Plant Health Care (PHC) – comprehensive program to manage the health, structure, and appearance of plants in the landscape. (ISA, 2010).

prevention – proactive process intended to guard against adverse impact by avoiding or reducing the risk of its occurrence. (ISA, 2010).

raising – selective pruning to provide vertical clearance. (ISA, 2010).

reduction – pruning to decrease height and/or spread of a branch or crown. (ISA, 2010).

reduction cut – pruning cut that reduces the length of a branch or stem back to a lateral branch large enough to assume apical dominance. (ISA, 2010).

restoration – (1) pruning to improve the structure, form, and appearance of trees that have been improperly trimmed, vandalized, or damaged. (2) management and planting to restore altered or damaged ecosystems or landscapes. (ISA, 2010).

risk – (1) The uncertainty of a result, happening, or loss; the chance of injury, damage, or loss (Black, 2009). - effect of uncertainty on objectives (ISO, 2018).

The ISO provides several relevant considerations to this definition. These include: "An effect is a deviation from the expected. It can be positive, negative or both, and can address, create or result in opportunities and threats." And "risk is usually expressed in terms of risk sources, potential events, their consequences and their likelihood. the combination of the likelihood of an event and the severity of the potential consequences." (ISA, 2011).

risk, inherent – (2) A common risk that people bear whenever they decide to engage in a certain activity (Black, 2009).

risk analysis – the systematic use of information to identify sources and to estimate risk exposure (ISA, 2011).

risk assessment – process of evaluating what unexpected things could happen, how likely they are to happen, and what the likely outcomes are. In tree management, the systematic process to determine the level of risk posed by a tree, tree part, or group of trees. (ISA, 2010) and/or the process of risk identification, analysis, and evaluation (ISA, 2011).

risk evaluation – the process of comparing the assessed risk against given risk criteria to determine the significance of the risk (ISA, 2011).

risk management – coordinate activities to direct and control an organization about risk (ISO, 2018). The application of policies, procedures, and practices used to identify, evaluate, mitigate, monitor, and communicate risk (ISA, 2011).

root ball – soil containing all (e.g., containerized) or a portion (e.g., B&B) of the roots that are moved with a plant when it is planted or transplanted. (ISA, 2010).

root collar/root crown excavation – process of removing soil to expose and assess the root collar (root crown) of a tree. (ISA, 2010).

root crown – area where the main roots join the plant stem, usually at or near ground level. Root collar. (ISA, 2010).

runoff – that part of precipitation that does not evaporate and is not transpired but flows through the ground or over the ground surface and returns to bodies of water.

rust – disease caused by a certain group of fungi and characterized by reddish brown spots on the foliage and/or the formation of stem galls. (ISA, 2010)

scaffold branches – permanent or structural branches that form the scaffold architecture or structure of a tree. (ISA, 2010).

shall – word that designates a mandatory requirement within the ANSI standards or contract documents. Contrast with *should.* (ISA, 2010).

should – word that designates an advisory recommendation in the ANSI standards or contract documents. Contrast with *shall.* (ISA, 2010).

sign – physical evidence of a causal agent (e.g., insect eggs, borer hole, frass). Contrast with *symptoms.* (ISA, 2010).

species diversity – measure of the number and variety of different species found in each area. (ISA, 2010).

specifications – detailed plans, requirements, and statements of procedures and/or standards used to define and guide work. (ISA, 2010).

stakeholder – person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or activity (ISO, 2018).

standard of care – in the law of negligence, the degree of care that a reasonable person should exercise (Black, 2009).

stormwater runoff – water originating from precipitation (rain or melting snow and ice) that flows above ground rather than infiltrating into the soil. May occur if soils are frozen or saturated or if the rate at which precipitation falls is greater than the infiltration rate of a soil. (ISA, 2010).

structural defects – any naturally occurring or secondary conditions such as cavities, poor branch attachments, cracks, or decayed wood in the trunk, crown, or roots of a tree root growth. (ISA, 2010).

structural pruning – pruning to establish a strong arrangement or system of scaffold branches. (ISA, 2010).

sustainability – the ability to maintain ecological, social, and economic benefits over time. (ISA, 2010).

symptom – plant reaction to disease or disorder (e.g., wilting, dieback). Contrast to *sign.* (ISA, 2010).

systemic – (1) substance that moves throughout an organism after it is absorbed. (2) any condition, disease, disorder, pest that affects the entire organism. (ISA, 2010).

taper – change in diameter over the length of trunks, branches, and roots. (ISA, 2010).

thinning – in pruning, the selective removal of live branches to provide light or air penetration through the tree or to lighten the weight of the remaining branches. (ISA, 2010).

threshold – (1) in Integrated Pest Management, pest population levels requiring action. (2) in hazard assessment, risk assessment, and risk management, levels of risk requiring action. (ISA, 2010).

topping – inappropriate pruning technique to reduce tree size. Cutting back a tree to predetermined crown limit, often at internodes. (ISA, 2010).

tree inventory – record of each tree within a designated population; typically includes species, size, location, condition, and maintenance requirements. (ISA, 2010).

tree protection zone (TPZ) – defined area within which certain activities are prohibited or restricted to prevent or minimize potential injury to designated trees, especially during construction or development. (ISA, 2010).

tree risk assessment – a systematic, technical process used to identify, analyze, and evaluate the risk associated with a singular tree (ISA, 2011).

trenching – linear, open excavation, often used to install utilities or structural footings. Can cause tree root damage. (ISA, 2010).

trunk flare – transition zone from trunk to roots where the trunk expands into the buttress or structural roots. Root flare. (ISA, 2010).

urban forestry – management of naturally occurring and planted trees and associated plants in urban areas. (ISA, 2010).

visual tree assessment (VTA) – method of assessing the structural integrity of trees using external symptoms of mechanical stress (such as bulges, reactive growth, etc.) and defects (cracks, cavities, etc.). (ISA, 2010).

vitality – overall health. Ability of a plant to deal effectively with stress. (ISA, 2010)

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APPENDICES

Appendix 1. Tree Condition Rating Components

Rating category	Condition components			Percent rating
	Health	Structure	Form	
Excellent	High vigor and nearly perfect health with little or no twig dieback, discoloration, or defoliation.	Nearly ideal and free of defects.	Nearly ideal for the species. Generally symmetric. Consistent with the intended use.	100%
Good	Vigor is normal for the species. No significant damage due to diseases or pests. Any twig dieback, defoliation, or discoloration is minor.	Well-developed structure. Defects are minor and can be corrected.	Minor asymmetries/deviations from species norm. Mostly consistent with the intended use. Function and aesthetics are not compromised.	61% to 80%
Fair	Reduced vigor. Damage due to insects or diseases may be significant and associated with defoliation but is not likely to be fatal. Twig dieback, defoliation, discoloration, and/or dead branches may comprise up to 50% of the crown.	A single defect of a significant nature or multiple moderate defects. Defects are not practical to correct or would require multiple treatments over several years.	Major asymmetries/deviations from species norm and/or intended use. Function and/or aesthetics are compromised.	41% to 60%
Poor	Unhealthy and declining in appearance. Poor vigor. Low foliage density and poor foliage color are present. Potentially fatal pest infestation. Extensive twig and/or branch dieback.	A single serious defect or multiple significant defects. Recent change in tree orientation. Observed structural problems cannot be corrected. Failure may occur at any time.	Largely asymmetric/abnormal. Detracts from intended use and/or aesthetics to a significant degree.	21% to 40%
Very poor	Poor vigor. Appears to be dying and in the last stages of life. Little live foliage.	Single or multiple severe defects. Failure is probable or imminent.	Visually unappealing. Provides little or no function in the landscape.	6% to 20%
Dead				0% to 5%

(Gooding, 2019)

APPENDIX 2: YALE UNIVERSITY GOLF COURSE MAP

Appendix 3: Tree Risk Management: A Detailed Overview

Yale University Tree Management Statement

Yale University has a goal of managing its tree population to optimize the sustained benefits of those trees to the Yale community. This optimization is realized through actions invoked by staff to maintain a healthy and expanding tree canopy while managing the inherent risk of those trees to a level that is reasonable, practical, and proportionate. Yale staff defines the unique context of the campus and its operations from which these management choices are assessed and acted on.

Risk Management Plan Outline

The primary goal of a tree risk management plan is to present a document that articulates an organization's policies for managing tree risk. The document serves several purposes. These are:

1. Identifies the organization's current tree risk exposure.
2. Presents an analysis that sets up the organization's risk threshold.
3. Synthesizes all tree risk management policies into one document.
4. Provides guidance that allows uniform and consistent application of tree risk management policies across all staffing levels.
5. Provides a mechanism for reviewing program policies and tree-related events to refine risk management strategies.
6. In the rare case of tree-related litigation, the document forms the basis for showing the organization's due diligence toward tree risk.

The structure of a tree risk management plan typically follows the general framework of the ISO's risk management process. It begins with a mission statement and is then followed by a process for identifying risk exposure, determining a risk threshold to manage to, developing a risk treatment strategy and outlining a process for reviewing the attainment of program goals.

1. The creation of a Tree Risk Management Group (TRMG) is the first step in the development of a tree risk management policy. The TRMG is made up of stakeholders who inform on policy development followed by annual meetings for program review. Stakeholders include staff involved with both planning, policy development and operations. Representatives from the university community additionally serve as stakeholders.

2. The first task of the TRMG is to conduct a risk assessment of the campus. This is initially informed by an understanding of the current tree resource and an analysis of past tree-related events. This analysis results in an understanding of the University's current risk exposure. Once found, the TRMG assesses strategies that can potentially reduce the identified risk exposure. Strategies can vary from enhanced staff training to more rigorous arboricultural practices and more thorough documentation processes to elevated mitigation response strategies. Each strategy should have an outcome that is quantifiable and allows the TRMG to gauge whether risk has been reduced. One outcome of the risk assessment may be that no added strategies may be required.

3. Risk treatments based on the selected risk reduction strategies are devised and implemented. Treatments can include:

- Developing a staff training log.
- Enhancing staff skill sets to differentiate between low/moderate and high/extreme risk trees.
- Developing a risk mitigation response matrix.
- Incorporating risk assessment processes in contract specifications.
- Develop a tree-event reporting form.
- Develop an agenda for the annual program review meeting.

4. The second main task of the TRMG is to have an annual review of the program. The review focuses on assessing any previous year's tree-related events and their effect on the established risk exposure and threshold, whether program goals for the year were met, and whether any new information is available that could potentially refine the University's program.

5. The final task of the TRMG is to communicate with all stakeholders about the risk management policy process.

The ISO document on risk management and the ALARP model provide important guidance on managing tree risk at a system level. The five main goals that should form the basis of a reasonable and practical tree risk management strategy for Yale include:

1. Mitigating the tree-specific issues found during the tree inventory phase.

2. Increasing staff ability to identify trees with elevated risk (provide a price for an annual staff training program as described).
3. Developing an inspection program that is proportional to the risk.
4. Developing a process for ongoing stakeholder engagement.
5. Monitoring and analyzing tree-related events.

A Yale representative (YR) should inspect and confirm all trees recommended for removal. Affirm the removals and initiate removal procedures. Trees affirmed for removal should paint an orange dot at the base of the tree to easily identify the tree for future removal operations. The YR should identify the trees, typically by size, that the in-house crews can safely remove, and which trees are to be contracted for removal. If the removal results in a stump and the tree is not in a woodland area, removing or grinding the stump should be considered an element of the removal.

Once the removal has been completed, the inventory needs to be updated with the removal date being entered and the Item Type changed from a "T" for a tree to an "R" for removed.

Each area supervisor (AS) should inspect and confirm all trees recommended for cabling for their respective campuses in coordination with the YR. If affirmed, complete the cabling mitigation and record in tree inventory. Most of the trees requiring pruning can be absorbed through the five-year pruning cycle with the first emphasis on trees noted for pruning.

Linked with the inspection program would be an emphasis on trees that remain after inventory-derived mitigations have occurred that have a condition rating of poor or worse. All the trees identified as extremely poor or dead on each campus should be removed within two years. An exception may be trees that have high wildlife or ecosystem value within the interior of woodland areas.

All university representative or operational staff should be trained in a Level 1 Limited Visual Inspection that focuses on target identification and structural defects. The purpose of this training would be to provide a formal, in-house, non-certificate training opportunity for the operational staff. The training emphasis would be placed on field exercises assessing trees with observable issues selected from the inventory. Outcomes would include more uniform and consistent application across

staffing and the Yale Golf Course. Additionally, staff would be able to apply the ALARP model more effectively in prioritizing arboricultural needs on the trees they are responsible for managing.

In addition, a protocol for a Level one inspection must be developed that includes the field process, data management, and mitigation response strategy.

Those performing the inspections should track all significant tree-part failures. Information would include species, DBH, tree part, tree-part size, structural issues, contributing factors, weather at the time of the event, consequences, and financial cost of consequences. The number of annual tree part failures eventually will aid in quantifying the university's tree risk exposure. Recorded events would include those that produce no negative consequences along with those that may have caused property damage or physical harm.

Appendix 4. Arborist Disclosure Statement and Limiting Conditions

Arborists are tree specialists who use their education, knowledge, training and experience to examine trees, recommend measures to enhance the beauty and health of trees, and attempt to reduce the risk of living near trees. Clients may choose to accept or disregard the recommendations of the arborist or seek additional advice.

Arborists cannot detect every condition that could possibly lead to the structural failure of a tree. Trees are living organisms that may fail in ways we do not fully understand. Conditions are often hidden within trees and below ground. Arborists cannot guarantee that a tree will be healthy or safe, or fail for that matter, under all circumstances, or for a given period of time. Likewise, remedial treatments, like any medicine, cannot be guaranteed. The trees were not in leaf at the time of the inventory limiting visual assessment of health evident by trees in leaf.

Treatments, pruning and removal of trees may involve considerations beyond the scope of the arborist's services such as property boundaries, property ownership, sight lines, disputes between neighbors, landlord-tenant matters, etc. Arborists cannot take such issues into account unless complete and accurate information is given to the arborist. The person hiring the arborist accepts full responsibility for authorizing the recommended treatment or remedial measures.

Trees can be managed, but they cannot be controlled. To live near a tree is to accept some degree of risk. The only way to eliminate all risks is to eliminate all trees.

This consultant does not verify the safety or health of any tree for any period of time.

Construction activities are hazardous to trees and cause many short and long-term injuries, which can cause trees to die or topple. Any changes to an established tree's environment can cause its decline, death and/or structural failure.

Even when every tree is inspected, inspection involves sampling; therefore, some areas of decay or weakness may be missed. Weather, winds and the magnitude and direction of storms are not predictable, and some failures may still occur despite the best application of high professional standards.

Appendix 5. Arborist Certificate of Inspection

Certification of Inspection *I, Bradley Painter, Arborist, certify:*

- That I have personally inspected the Yale University Golf Course trees as noted for removal/preservation and/or the property referred to in this report, and have stated my findings accurately. The extent of the evaluation is stated in the attached report and the Terms of Assignment;

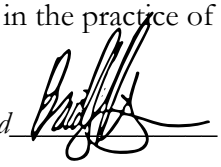
- That I have no current or prospective interest in the vegetation or the property that is the subject of this report, and I have no personal interest or bias with respect to the parties involved;

- That the analysis, opinions and conclusions stated herein are my own, and are based on current scientific procedures and facts;

- That my compensation is not contingent upon the reporting of a predetermined value or direction in value that favors the cause of the client or any other party, the attainment of stipulated results, or the occurrence of any subsequent events;

- That my analysis, opinions and conclusions were developed, and this report has been prepared according to the procedures recommended by the American Society of Consulting Arborists, and commonly accepted arboricultural practices;

- That no one provided significant professional assistance to the inspector, except as indicated within the report. I further certify that I am a member of the American Society of Consulting Arborists, and acknowledge, accept, and adhere to the ASCA Standards of Professional Practice. I am an ASCA TPAQ Registered Consulting Arborist, a Connecticut and Rhode Island Licensed arborist, a Tree Risk Assessment Qualified (TRAQ) International Society of Arboriculture Certified Arborist, and have been involved in the practice of arboriculture and the study of trees for over 25 years.

Signed  *Date:* June 12, 2024

Appendix 6 & 7: Previous Reports: Haul Road and Stevenson Road

THE YALE UNIVERSITY GOLF COURSE "HAUL ROAD" TREE INVENTORY REPORT

YALE UNIVERSITY
NEW HAVEN, CONNECTICUT
APRIL 3, 2024

Submitted by:

Bradley R. Painter

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ACKNOWLEDGEMENTS

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ABBREVIATIONS

ANSI	American National Standards Institute
ANSI A300	United States, industry-developed, national consensus standards of practice for tree care.
ANSI Z133.1	United States Safety standards for arborists
BMP	best management practice
DBH	diameter at breast height
D-tape	diameter tape
GIS	geographic information system
ISA	International Society of Arboriculture
ISA LEVEL 1	International Society of Arboriculture Level 1 (limited visual assessment, see glossary)
ISA LEVEL 2	International Society of Arboriculture Level 2 (basic assessment, see glossary)
RCA	Registered Consulting Arborist
TMP	Tree Management Plan
TRAQ	Tree Risk Assessment Qualified by ISA

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The Yale University Golf Course has been planning a renovation of its historic 1926 course and now, with various and extensive approvals, golf course staff and contractors are busy coordinating the first phases of the project. One of the approved and engineered aspects of the project was to establish access from the north end through a portion of forested Yale Preserve from Fountain Street.

Yale University's Office of Facilities, Associate Director, Planning, Mr. Jeromy Powers requested a tree inventory and Tree Management Plan for the Yale Golf Course and, separately, a tree assessment and inventory for the Yale Preserve access road referred to as the "haul road". This report conveys the data collected for trees for removal, trees for preservation and associated tree protection recommendations for the haul road area.

A total of 98 trees were designated for removal. The four most common trees were 13 red maple (*Acer rubrum*), and 11 each of black birch (*Betula lenta*), black maple (*Acer nigrum*), and tulip tree (*Liriodendron tulipifera*). Most of these trees fell within the interior area of the haul road or were in very poor or dead condition and adjacent to the haul road borders. 7 of the dead trees were white ash (*Fraxinus americana*) and most likely had succumbed or will succumb to emerald ash borer (*Agrilus planipennis).*

A total of 71 trees were evaluated for preservation. Two of the trees were within a foot or two of the proposed haul road and were able to be salvaged with 1-2' adjustments. The three most common species were 13 Tulip tree (*Liriodendron tulipifera*) followed by 12 Northern red oak (*Quercus rubra*) and thirdly 11 red maple (*Acer rubrum*).

Trees within 4' of the haul road have been designated as trees requiring trunk tree protection and should be identified and field verified with the team prior to any installation.

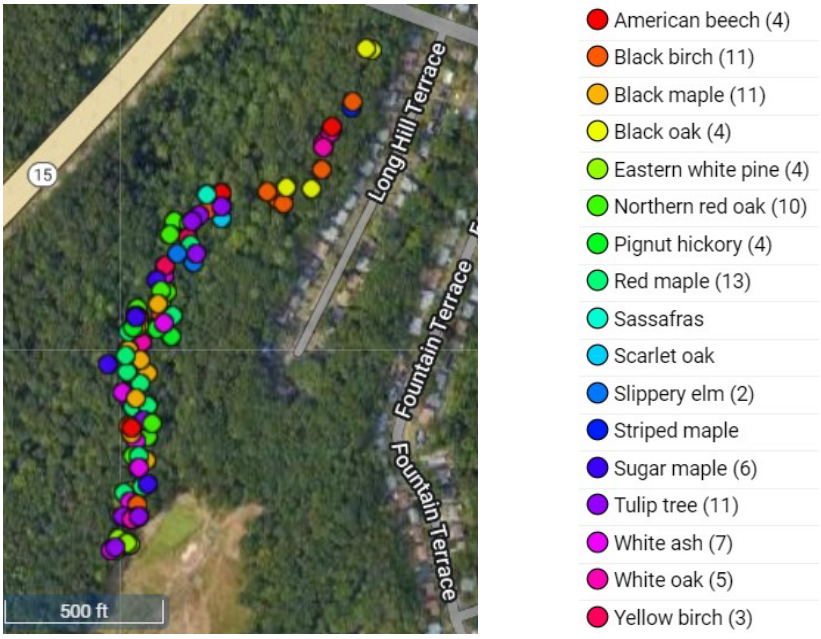


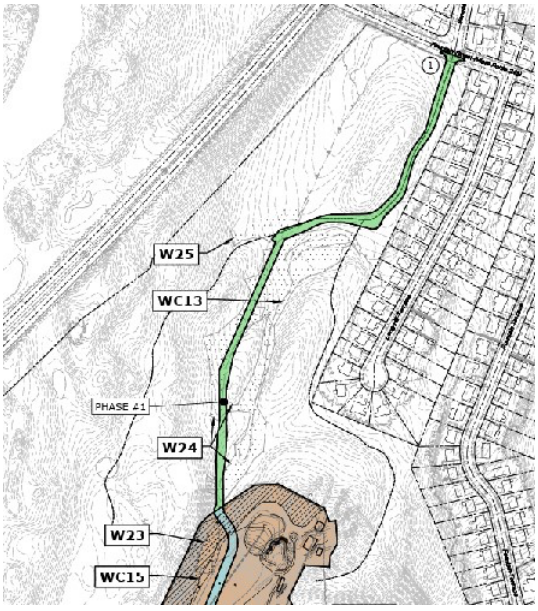
Figure 1: 98 Trees were noted for removal as they fell within proposed haul road and associated species color codes

Figure 2: 71Trees noted for preservation and species color codes

INTRODUCTION

The Yale University Golf Course Construction Access "Haul Road"

Treefoil, LLC, a consulting arborist company, was contacted in early November 2023 by Mr. Jeromy Powers, an Associate Director of Yale University Planning Department. Mr. Powers was seeking a tree management plan for the Yale University Golf Course. A critical part of such a plan is identifying species, geo-location, size, condition, and management needs of individual trees while quantifying aspects of the entire site tree population such as size, health, and species diversity. The Yale University Golf Course had been planning a renovation of its historic course over the past few years. Yale received approvals for the project which included the installation of an access or "haul road" bordering Fountain Street (Connecticut State Route 243) located within the northern portion of Yale Nature Preserve. A separate aspect of the golf course tree management plan was to inventory and assess trees over 4" diameter at 4.5' above grade (DBH) for preservation or removal within the haul road. A tree protection plan and associated recommendations also support tree protection efforts for the haul road.



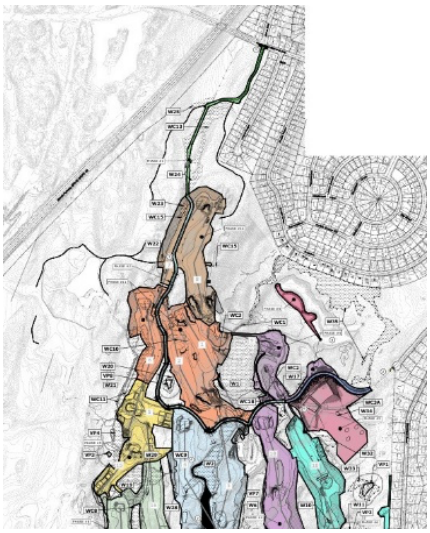


Figure 3 Left closeup of graphic of haul road by Tighe and Bond and right upper north end of golf course (both Tighe & Bond 2024)

The consultant met with Dr. Canavan of Tighe and Bond, the Yale Golf Course General Manager, Mr. Peter Palacios, and Yale Golf Course Superintendent, Mr. Jeffrey Austin, as well as Dr. Marlyse Duguid of Yale School of Environment and Forestry, and Ms. Amber Garrard, Director of Yale University Office of Sustainability who provided valuable independent perspectives and insights at an onsite meeting on January 11, 2024. An additional follow up meeting on February 6, 2024, with Mr. Palacios, Mr. Austin, Mr. Edward Grant of K&J Tree Service, and Ms. Laura Green, a Yale University Research and Extension Forester and Principal Consultant at Green Fieldwork who also provided helpful independent insight shortly after initial work had begun.

The haul road soil and erosion control plan by Tighe and Bond (sheet C511, C521 dated January 2, 2024, Project # Y5000-088) shows the road length approximately 2000 linear feet and of varying width from 16'- 40'. The centerline for the haul road was established by wooden stakes by others and reviewed by the team prior to inventorying. The proposed road started off from the golf course adjacent to hole #7 at the north end of the Yale Golf Course and sloped down from a somewhat wet terrain occupied by varied and predominantly mixed hardwood species. The understory was predominantly open amongst the hardwood except for small patches of invasive barberry *(Berberis)* species as the proposed road leveled off and ended adjacent to Fountain Street.

The haul road provides construction access to the golf course while minimizing disturbance to the adjacent forest. The golf course is a heavily managed area (mowing, pruning, plant health care, etc.) while the haul road seeks to minimize such management needs.

The consultants evaluated trees within the proposed haul road for possible preservation by slightly altering the proposed path no more than 3-4'. Trees noted for removal within the proposed road layout were inventoried and marked with pink spray paint on the lower trunk of the north side of the tree. It is important to acknowledge that deciduous trees were not in leaf and canopy assessment primarily associated with health was not possible nor necessary considering their proposed removal.

The consultants also evaluated trees approximately 10' of either side (east and west) of the haul road edge for preservation. The trees were marked with white spray paint on the north side of the lower trunk and field identified with numbered brass tags, also placed on the north side. Trees in the preservation area were then evaluated as to the need for tree protection and any associated construction protection recommendations.

The consultants began inventorying trees for removal on the northern end of the haul road on January 26, 2004, and completed haul road trees for preservation on the southern end of the haul road on January 29, 2024.

Treefoil LLC staff initially involved with the project was senior consultant Bradley Painter, a Connecticut licensed arborist (S-6397), International Society of Arboriculture certified arborist (6931-A) and ISA Tree Risk Assessment Qualified, and American Society of Consulting Arborist registered consulting arborist (RCA), # 634. The support team included experienced arborist technicians with various roles ranging from tagging, technical assistance, and inventorying.

The consultant and Mr. Jeromy Powers, Associate Director Planning at Yale University, agreed that the inventory be supported by numbered tags affixed to trees and recorded with GPS location, size, condition, and species on the consultant's ArcGIS digital platform with final content delivered as a CSV file. The data would also be exported as separate dxf and shapefiles to be delivered for the ArcGIS platform for use by Yale University staff. Trees for removal were inventoried and spray-painted pink denoting removal.

The Treefoil consultants referenced numerous sources for information such as: the Connecticut Agricultural Extension Service, Dirr's *Manual of Woody Plants*, International Society of Arboriculture (ISA) publications and the University of Connecticut Plant Database (see sources). The consultants also drew on their experience to assess any subjective data collection pertaining to interpreting tree architecture, health, conditions, and future prognosis.

METHODOLOGY

The overall proposed Golf Course Tree Management project has been separated by Treefoil into two phases: Phase I – The Haul Road Tree Inventory and Phase II – The Golf Course Inventory and Tree Management Plan.

This report is focused solely on the haul road tree inventory.

Haul Road Inventory Phase for Removal and Preservation Trees

Tree inventorying and data collection began with trees for removal on the north end of the haul road on January 26, 2004, and concluded on the southern end of the haul road on January 29, 2024. All trees within the proposed access road area were inventoried, digitally mapped and spray-painted pink on the north trunk side denoting it a tree for removal.

Figure 4 Numerical brass tags consistent with previous tree inventory (Treefoil, LLC)

Trees for preservation were identified within approximately 10' of the outside haul road borders (considered within the preservation area) were assessed with a Level I visual assessment to identify any risk issues of imminent concern, tagged, inventoried, and sprayed with white paint denoting tree to be preserved. Post data processing began February 1, 2024, and was completed February 9, 2024.

Treefoil consultants used diameter tapes (D-tapes), clinometers, and proprietary software and GPS collectors on iPhones and iPads to assess, collect and record data. Collection was performed using pole mounted Juniper Geode GNS3S single frequency GNSS receivers. Global positioning locations were recorded on the unit and relayed via Bluetooth to the collector's iPhone or iPad and uploaded to the proprietary software site via cellular connections. Sub-meter accuracy is anticipated though not guaranteed with such collection.

Figure 5 Geode external GPS receivers used by inventory team

The data were downloaded, post-processed, edited, and support this report separately as an attachment in the form of csv, dxf and shapefiles.

Figure 6 GPS receiver leaning on a tree adjacent to the haul road border to golf course

Data Collection Fields

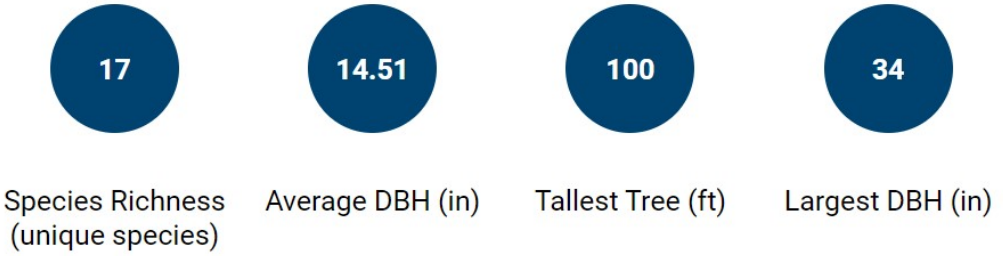
The following are the data fields the project team agreed to have collected during the haul road inventory phase. Fields that did not apply to the tree were not checked and remained blank. Deciduous trees were not foliated due to seasonal leaf drop so canopy assessment was limited.

1. Inventory Date – Date the assessment occurred for the subject tree.
2. Assessor Name – Full name of the person assessing the tree.
3. Id Number – A unique ID number assigned to each tree.
4. Tag Number (trees for preservation only) – trees have a unique number and are labeled with a numerical brass tag.
5. Diameter – measured at 4.5' above ground (DBH).
6. Species – Common and Latin name of tree.
7. Condition – Condition assigned based on *The Guide for Plant Appraisal 10th Second Edition* of the International Society of Arboriculture plant appraisal guide: Excellent, Good, Fair, Poor, Very Poor and Dead.
8. Maintenance Needs – Picklist of short and long-term maintenance needs.
9. Status Level – A picklist that identifies trees as "memorial", "specimen", "size" (for planting zone info).
10. Attributes – Picklist of distinct observable features of the subject tree.
11. Defects. A defect is a visible flaw or an aberration that causes an item to be less than perfect.
12. Cavity/Decay. Cavity/decay is the deterioration of wood by a decay fungi.
13. Recommended maintenance actions. The selections included: Prune, Removal, and Grind Stump.
14. Prune. If Prune was selected, a specific type of pruning was noted in this field of all A300 recommended pruning: Cleaning, Clearance, Reduction and Structural.
15. Monitor. Tree had some structural aberration that requires a shorter inspection interval.
16. Observations – Biotic Pest signs such as bacteria, boring, fungus, leaf feeding insect, vertebrae.

17. Observations – Abiotic such as lightning, mechanical damage, nutrient deficiency phytotoxicity, saturated soil and underwatered.
18. Latitude. 1984 State Plane Coordinates—Connecticut
19. Longitude. 1984 State Plane Coordinates—Connecticut
20. Comments. Field for additional details to be recorded.

INVENTORY RESULTS

Trees for Removal



The consultants were focused on assessing trees within the proposed haul road layout for removal. There were no notable trees identified for such preservation in the general area of the haul road. All trees within the road identified for removal were inventoried and spray-painted pink.

Figure 7 Tree marked for removal with pink spray paint

Species Distribution

A total of 98 trees were designated for removal. Most of these trees fell within the interior area of the haul road or were in very poor or dead condition and adjacent to the haul road borders. 6 of the 10 dead trees were white ash (*Fraxinus americana*) and most likely had succumbed to emerald ash borer (*Agrilus planipennis).*

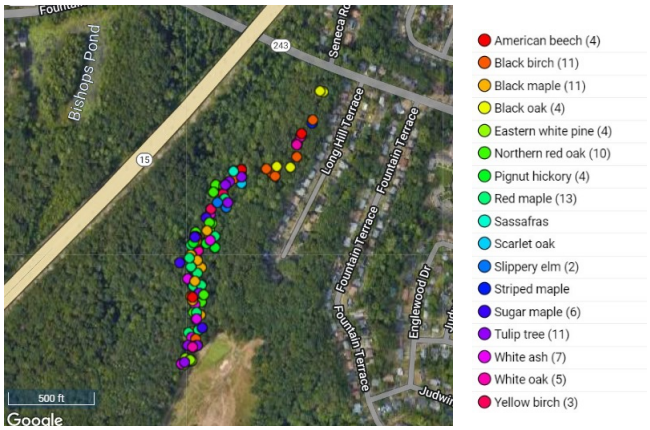


Figure 8 Removal tree layout and corresponding color code

The assessed species distribution of trees identified for removal was balanced and diverse. The removal area is a relatively narrow band of limited length and unrepresentative of overall adjacent forest health and species balance. The consultants are not certified foresters and not qualified to gauge forest health but noted the general diversity of native species and lack of invasives a positive.

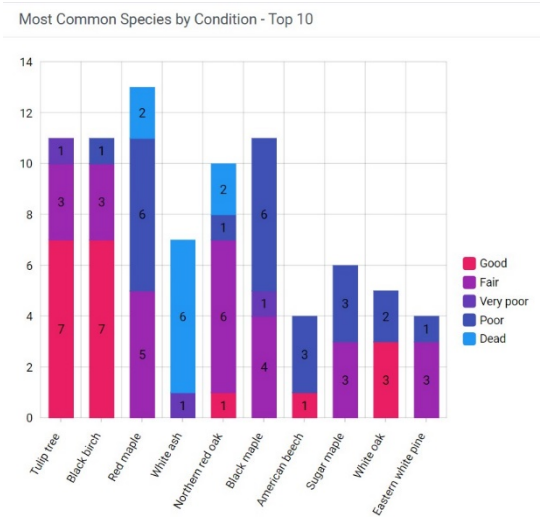
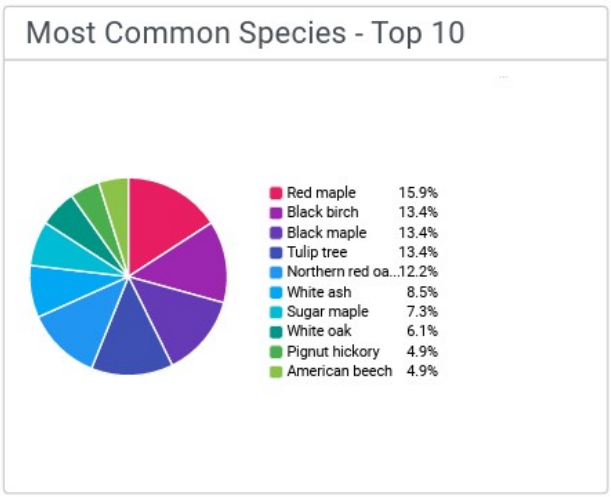


Figure 9 Top ten species and condition



Most Common Species - Top 10

COMMON NAME	COUNT	PERCENTAGE
Red maple	13	15.9%
Black birch	11	13.4%
Black maple	11	13.4%
Tulip tree	11	13.4%
Northern red oak	10	12.2%
White ash	7	8.5%
Sugar maple	6	7.3%
White oak	5	6.1%
Pignut hickory	4	4.9%
American beech	4	4.9%

Figure 10 Top ten most common species and percent makeup within count

Condition

25 of the trees identified for removal were in "good" condition with the remainder falling into fair to dead condition. Growing conditions are challenging as trees compete for scarce sunlight leading to poor architecture such as tapered leaders and overextended branching. A portion of the haul road also appears to traverse an old trail or road where compacted soils might be found. Compacted soil conditions restrict tree root spread leading to limited resource availability and resulting instability possibly accounting for less than "good" condition ratings.

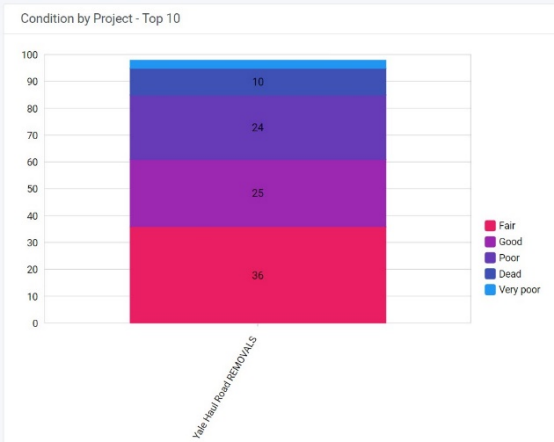


Figure 11 Condition distribution within removal tree count

Size Distribution

Trees identified for removal also showed a pattern of the largest number of trees falling within the smallest measured diameter. 33 trees, or 33.7% of removal trees were within a 6-12" diameter while the largest diameter trees measured between 24-30" were 3 count or 3.1% of the trees for removal. There are a greater number of smaller trees available at this point to replace larger mature trees that may be experiencing senescence. There was one tree that was in the haul road zone that was smaller than 4" but was identified for removal and shows as "N/A" on the chart below.

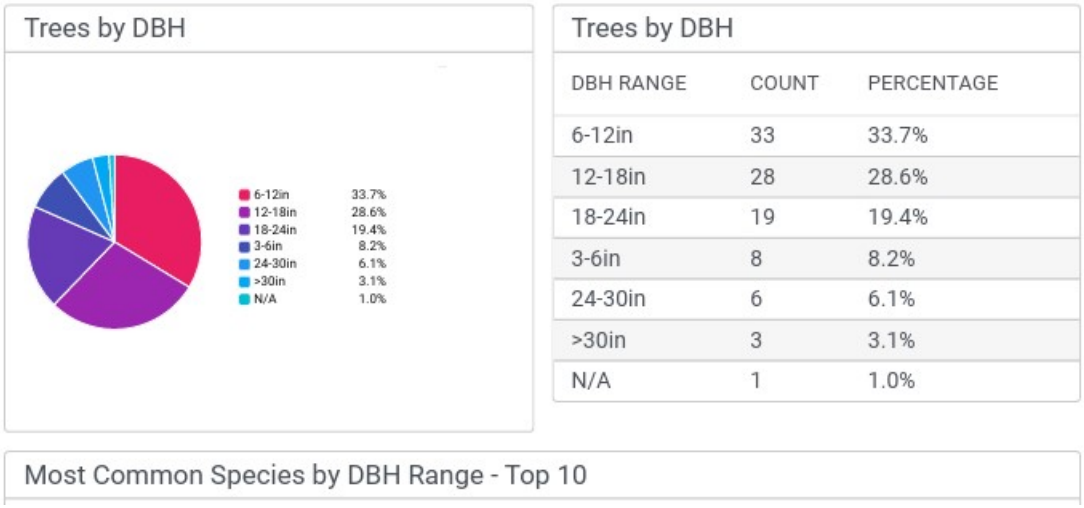


Figure 12 Preservation tree size distribution

Environmental Benefits

The following categories quantify the 98 inventoried trees benefits lost due to their removal. The benefits are determined by iTree (iTree 2024) and are based on tree species, condition, size, height, and canopy spread.

Eco Benefits and By The Numbers

Total Eco-Benefits	
Overall Monetary Benefit:	$554.42
Stormwater Monetary Benefit:	$83.90
Runoff Avoided:	78.35 (ft^3)
Interception:	671.65 (ft^3)
Air Quality Monetary Benefit:	$224.57
Pollutants Removed:	164.44 (lbs)
Carbon Monetary Benefit:	$245.95
Carbon Storage:	253870.95 (lbs)
CO_2 Storage:	930860.25 (lbs)
CO_2 Sequestered:	23314.10 (lbs)

Figure 13 Eco-benefits chart as based on i-Tree

One of the helpful suggestions by Dr. Duguid and Ms. Laura Green was to recommend any trees cut down be safely stockpiled adjacent to where they were felled and allowed to break down. This would reduce emissions created through transfer and allow the carbon to remain on site while contributing to wildlife habitat and helping to minimize forest floor disturbance.

Figure 14 Felled removal trees to remain

Trees for Preservation

The consultants identified trees within 10' of both the east and west side haul road outside borders and evaluated them for preservation. Some trees were dead or in very poor condition and spray-painted pink for removal. Trees for preservation were spot sprayed white and tagged with numerical brass tags and inventoried. A total of 71 trees were identified for preservation adjacent to the haul road.

Figure 15 Trees designated for preservation were marked with north side white paint for easy identification

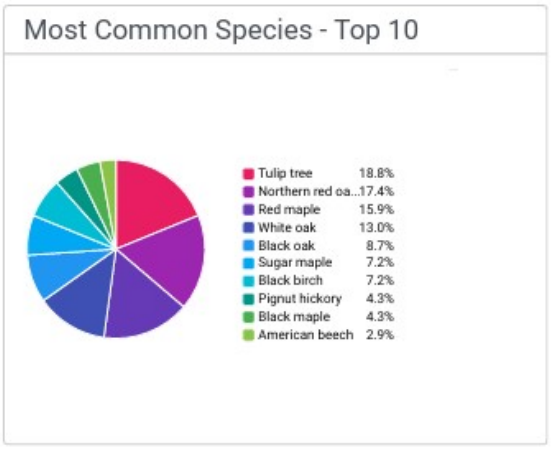
American beech (2)
Black birch (5)
Black maple (3)
Black oak (6)
Northern red oak (12)
Pignut hickory (3)
Red maple (11)
Slippery elm
Sugar maple (5)
Tulip tree (13)
White oak (9)
Yellow birch

Figure 16 Preservation tree species distribution along haul road

Species Distribution

The assessed species distribution of trees identified for preservation is also balanced and healthy. The preservation areas are two relatively narrow bands with limited length and unrepresentative of overall adjacent forest health and species balance. Urban forestry practice often recommends 10-20-30 guideline when one species species would not account for more than 10 percent of the tree population, one genus not more than 20 percent, and a single family not more than 30 percent (Santamour, 1990). The consultants are not certified foresters and not qualified to gauge present or future forest health as it pertains to species diversity. It is apparent that the very small area sampling of preservation trees has a large percentage of Tulip tree, red oak and red maple.

A total of 13 distinct species were identified for preservation. The ten most common species were 13 Tulip tree (*Liriodendron tulipifera*) followed by 12 Northern red oak (*Quercus rubra*) and thirdly 11 red maple (*Acer rubrum*).



Most Common Species - Top 10

COMMON NAME	COUNT	PERCENTAGE
Tulip tree	13	18.8%
Northern red oak	12	17.4%
Red maple	11	15.9%
White oak	9	13.0%
Black oak	6	8.7%
Sugar maple	5	7.2%
Black birch	5	7.2%
Pignut hickory	3	4.3%
Black maple	3	4.3%
American beech	2	2.9%

Figure 17 Preservation tree species distribution chart and count

Condition

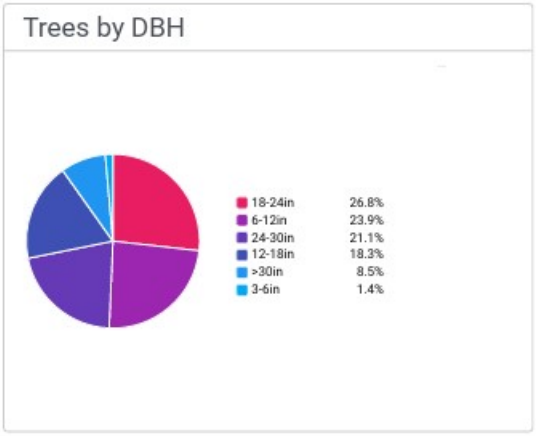
55 of the trees identified for protection were in "good" condition, 13 in "fair" condition, and 3 in "poor" condition. Overall, the trees identified for protection were in better shape than the removal count. This is partially due to trees identified for removal in the protected areas also counted as removals. Trees for preservation also tended to be outside of compacted soil trail zones.

Figure 18 Preservation tree species condition distribution

Size Distribution

Trees identified for protection varied in their size distribution. The greatest count of trees at 19 were in the 18-24" DBH range or 26.8%. with 17 trees within a 6-12" diameter, or 23.9% with the largest diameter trees measured greater than 30" DBH were 6 count or 8.5% of the trees.

There are a greater number of larger trees in the preservation area than the removal area. This is consistent with the team wanting to preserve bigger trees in a broader species range as well as in better condition when compared with the removal tree set.



Trees by DBH

DBH RANGE	COUNT	PERCENTAGE
18-24in	19	26.8%
6-12in	17	23.9%
24-30in	15	21.1%
12-18in	13	18.3%
>30in	6	8.5%
3-6in	1	1.4%

Figure 19 Preservation tree size range distribution

The chart below also shows that the largest size DBH trees are Tulip tree first, followed by northern red oak. Both trees are considered native and desirable from a preservation standpoint.

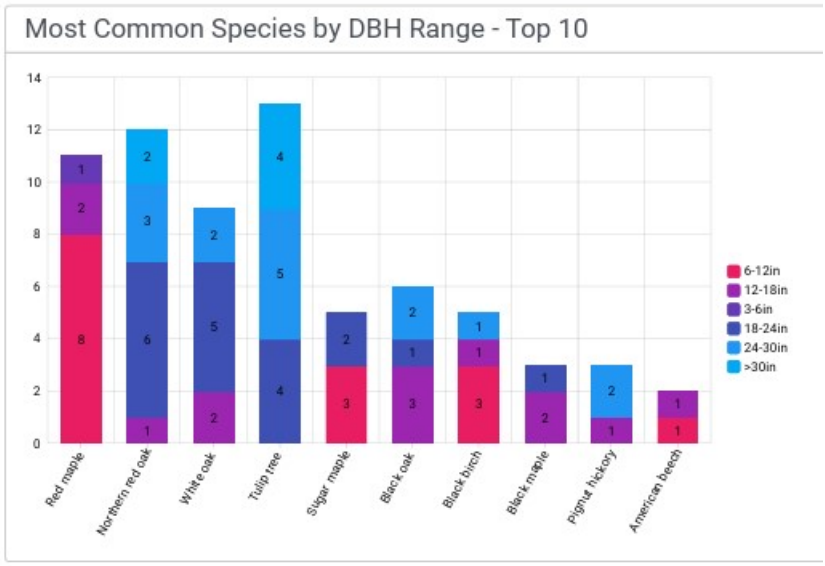


Figure 20 Species size distribution chart

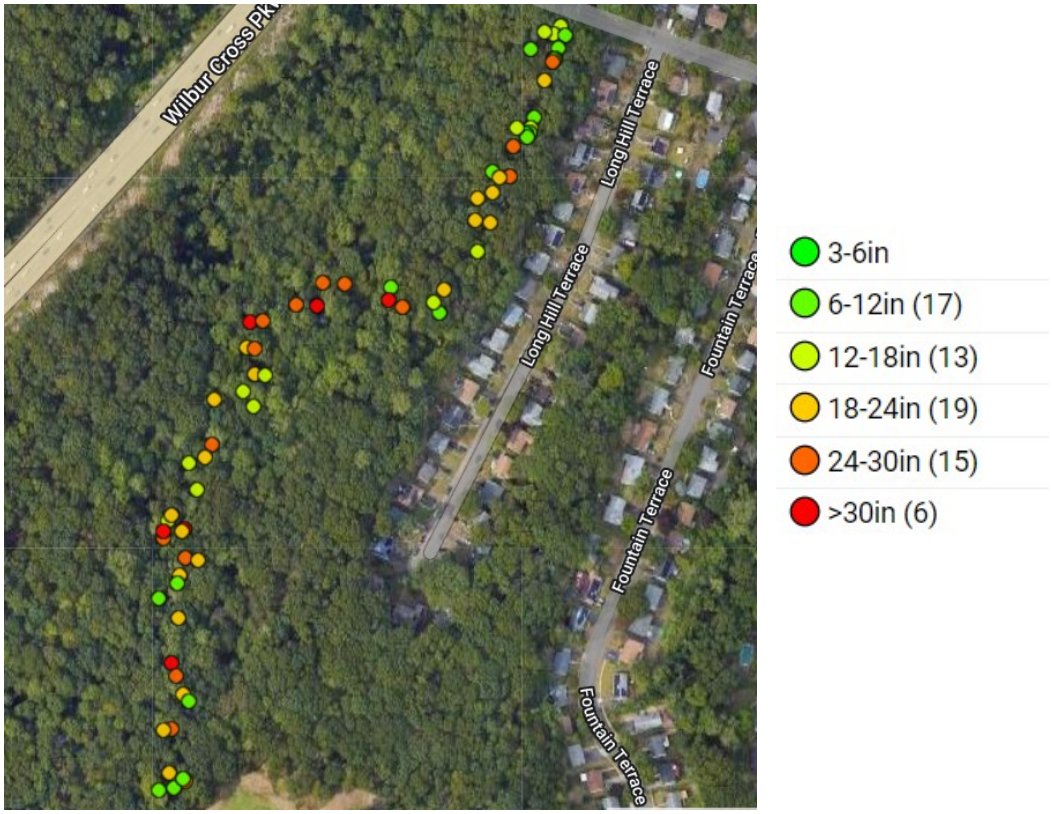


Figure 21 Preservation tree size range and approximate location

Environmental Benefits

The following categories quantify the 71 inventoried trees benefits for preserved trees (iTree 2024). Trees for preservation have more benefits despite the smaller tree count. This is due to the better condition, larger size DBH and crown in combination with better overall condition.

Total Eco-Benefits	
Overall Monetary Benefit:	$676.65
Stormwater Monetary Benefit:	$122.82
Runoff Avoided:	114.70 (ft³)
Interception:	955.12 (ft³)
Air Quality Monetary Benefit:	$278.91
Pollutants Removed:	210.74 (lbs)
Carbon Monetary Benefit:	$274.92
Carbon Storage:	365058.94 (lbs)
CO_2 Storage:	1338549.80 (lbs)
CO_2 Sequestered:	26060.81 (lbs)

Figure 22 Eco-benefits for trees of preservation (i-Tree)

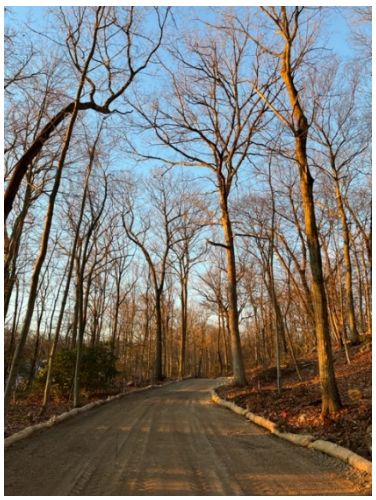
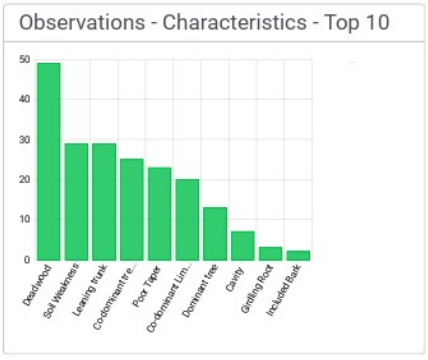


Figure 23 Preservation trees and proximity to haul road

Characteristics

Preservation trees were additionally assessed for projected maintenance needs, unlike removal trees. These characteristics give insight into the susceptibility of some trees to drought, storms, pestilence, structural deficiency and more. This is helpful to know when anticipating current and future care from a management standpoint.

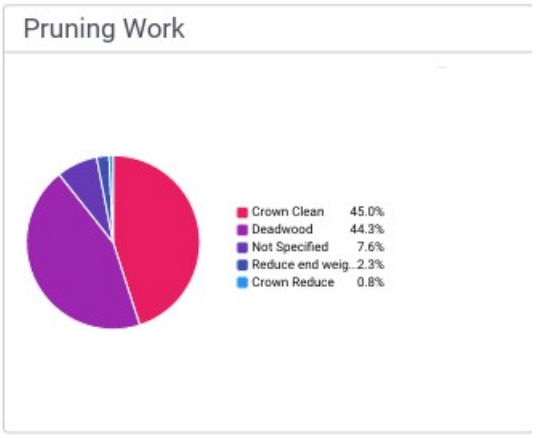


Observations - Characteristics - Top 10		
OBSERVATIONS-CHARACTERISTICS	COUNT	PERCENTAGE
Deadwood	49	24.5%
Soil Weakness	29	14.5%
Leaning trunk	29	14.5%
Co-dominant tree	25	12.5%
Poor Taper	23	11.5%
Co-dominant Limbs	20	10.0%
Dominant tree	13	6.5%
Cavity	7	3.5%
Girdling Root	3	1.5%
Included Bark	2	1.0%

Figure 24 Observation characteristics graph and count

Pruning

Pruning work for preservation trees was also noted during the inventory. Most or all these trees have not been maintained as far as pruning and other arboricultural care found in more typically managed areas. This leads to an accumulation of deferred maintenance leading to higher initial needs such as dead branches or hung-up deadwood.



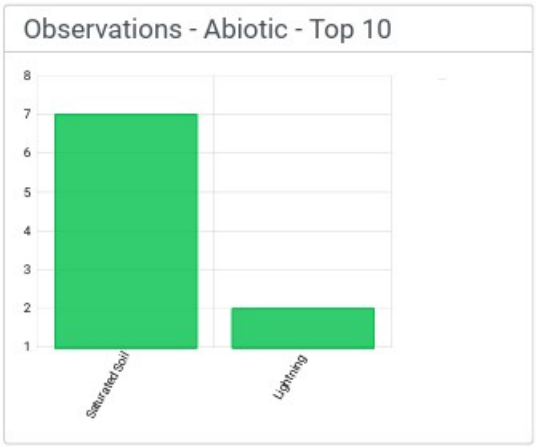
Pruning Work

TREE WORK-PRUNING	COUNT	PERCENTAGE
Crown Clean	59	45.0%
Deadwood	58	44.3%
Not Specified	10	7.6%
Reduce end weight	3	2.3%
Crown Reduce	1	0.8%

Figure 25 Pruning tasks and count

Abiotic Observations

Abiotic observations were noted for some trees for preservation. These are maladies caused by non-living conditions (lightning, mechanical damage, etc.). Saturated soil was the most common with 7 trees observed under that condition and 2 trees with lightning damage. These trees haven't been exposed to typical mechanical damage associated with abiotic disorders in managed areas such as mower or weedwhacker injury.

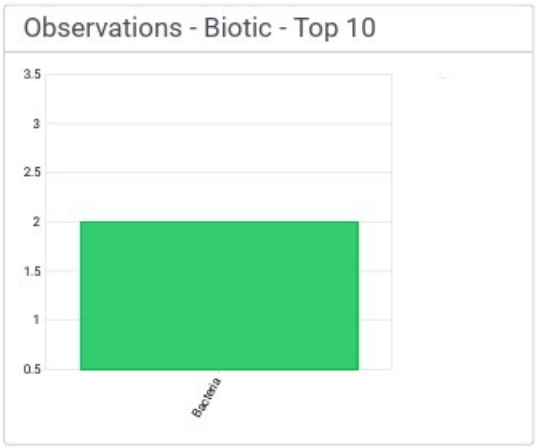


Observations - Abiotic - Top 10		
OBSERVATIONS-ABIOTIC	COUNT	PERCENTAGE
Saturated Soil	7	77.8%
Lightning	2	22.2%

Figure 26 Abiotic observations and count

Biotic Observations

Biotic observations were made on 2 trees. These observations usually are more prevalent during active life stages of insects, fungus, or bacteria. Most of the signs of such living agents are more active and apparent during warmer seasons.



Observations - Biotic - Top 10		
OBSERVATIONS-BIOTIC PEST	COUNT	PERCENTAGE
Bacteria	2	100.0%

Figure 27 Biotic observations and count

RECOMMENDATIONS

It is currently unknown to the consultant how long or often the haul route will be used by pedestrians and vehicles. The following recommendations are based on frequent occupancy and are intended to align with previous recommendations to Yale University as well as anticipated golf course use.

Tree Inspections

As noted, tree inspections provide information to monitor and manage a tree population. The following tree inspection recommendations are presented to inform the haul road overall vegetation management program. Inspections serve three primary vegetation management goals:

1. **Monitor** the tree population for short- and long-term risk issues. The former typically requires some form of mitigation which can range from deadwood pruning to whole tree removal. The latter concerns observable issues that are not of an imminent nature which is balanced with the benefits the tree provides.
2. **Assess** the tree for overall health and vigor. The most benefits to the university community are derived from trees that are healthy with expanding canopies. A scheduled inspection that includes assessing tree health allows staff to make choices that maximize these benefits.
3. **Demonstrate** due diligence by the university by applying a regular inspection process that is uniformly applied across the total tree population.

Inspection Cycle. The consultants recommend a five-year cyclic inspection interval. This is a common inspection interval for a proactive urban forestry program in the United States. For the Yale Golf Course, this translates to approximately 20 percent of the tree population on each inventoried campus area being inspected annually.

Inspection Type. The standard inspection should be the equivalent of an ISA Level 1–Limited Visual Inspection. This is based on the resources available and the size of the tree population requiring an inspection. A limited visual inspection should encompass a 360-degree view of the tree from the ground. If the tree presents elevated concerns to the inspector, a more advanced assessment may be required on individual trees.

Inspection Methodology. Each Level 1 inspection should include an assessment of the trunk, scaffold branches, and crown. Record keeping can consist of either working from a hard copy of an inventory-generated tree list or directly accessing the inventory via an electronic notebook. The primary issues to address are tree health and any short-term mitigation requirements. The inspector should update the tree's diameter, condition, maintenance needs, and inspection date. Basic hand tools to be used include a diameter tape, rubber mallet, and binoculars.

Inspection Scheduling. The optimum time for the inspection cycle to take place is during the summer when the trees have leaves and are fully leafed out. The optimum scheduling would have the trees that are scheduled for pruning during the forthcoming winter season be the trees scheduled for inspection during the prior summer. This would allow trees noted for removal to be mitigated before the pruning cycle begins.

Monitor Trees. No haul road trees have been identified as requiring monitoring.

Area-Specific Considerations. The recommendations noted above should be applied separately to the haul road and the golf course. The following recommendations apply separately to the haul road. Each individual area, however, has nuances to its specific landscapes that warrant details specific to the area. Managed areas such as the golf course have a greater intensity of use and therefore have different considerations than the haul road area.

Comprehensive Pruning

Comprehensive pruning refers to trees under a cyclic pruning cycle or any tree that may require corrective pruning due to storm, disease, or insect damage.

Pruning provides many benefits for a tree. First and foremost, it serves to maintain a tree in a healthy and safe state, while promoting longevity. From early structural pruning to maintenance

pruning over a tree's mature life, the university can play a large role in increasing a tree's age and minimizing the reactive cost of future care such as storm damage. A regular pruning cycle is a critical component of an effective forestry program. The haul road area will derive the following benefits from maintaining the cyclic maintenance program.

- Simply by pruning dead wood, the condition ratings will be upgraded for many of the campus trees.
- Reactive requests and storm damage will be reduced.
- Cyclic maintenance guarantees that every tree on managed grounds will be regularly inspected by staff and/or contractors.
- Yale Golf can demonstrate that it is exhibiting "reasonable care" in maintaining its forest. The notion of "reasonable care" is the strongest defense the golf course has in litigation due to a tree or tree part failure in the specifically addressed haul road area.
- Pruning specifications need to include manager notification by inspector/pruner of any additional observation of concern: decay, cracks, broken branches, etc.

In the United States, most system-level forestry programs try to implement a five- to eight-year pruning cycle. The consultants recommend a five-year pruning cycle for the campus. The overall objective is to achieve a cyclic pruning program within fiscal and human resource constraints.

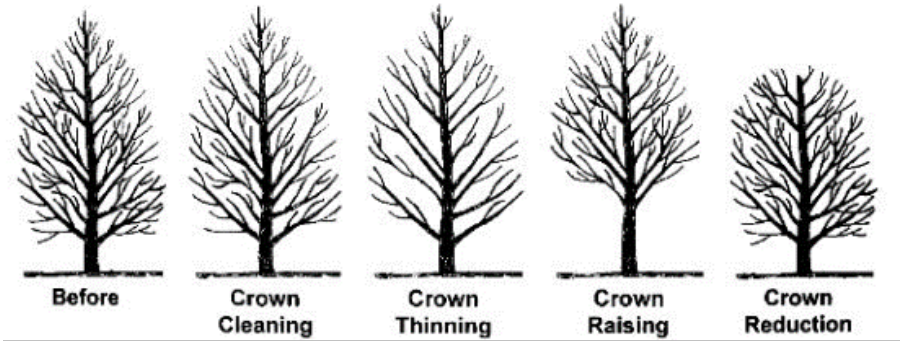
All pruning activity should follow the American National Standard for Pruning (ANSI A300)—specifically for crown cleaning and raising. These pruning operations are best performed during winter months.

Crown Cleaning–The removal of defective limbs that are broken, diseased, dying, broken, structurally unstable and rubbing. This process improves tree health, reduces branch failures, and improves aesthetics.

Crown Thinning–The selective removal of branches to increase light penetration and air movement in the crown, or canopy, of a tree.

Crown Raising –The removal of lower branches. Crown raising is frequently done to allow foot or vehicle traffic or lawn mowers under the tree. Street trees require at least 16 feet of clearance for trucks. Lawn trees need eight feet of clearance for foot traffic. Trees used for screening or windbreak can be allowed to have branches near the ground.

Crown Reduction–The proper removal of upper branches when the tree has become too tall. When a tree is too tall, it is better to remove it. **Never top (removing large branches or/and trunks from treetops, leaving stubs, and not making proper pruning cuts) a shade tree to control its size**. Credit Below: BP Tree Services



The number of trees requiring crown cleaning varies on the haul road. Some form of cyclic inspection and pruning program should be a primary maintenance goal. A five-year cycle is the consultant's recommendation. Several approaches can be considered to meet this goal. The most efficacious approach will be informed by the following factors:

- Establish the degree that a Yale Golf representative or staff can carry out pruning. Staff should be able to prune trees under 12 feet and/or under 12-inch caliper if supervised by an onsite Connecticut licensed arborist. It is important to note that this is driven by Connecticut state law and should conform to those requirements (Ct Arborist Law Sections 23-61a through 23-61f of Ct State Statutes). This determination should consider current operational needs and staff ability to annually prune a portion of the 20 percent of the trees six inches or less in diameter in managed areas.
- A larger-size diameter class could be considered for in-house pruning if capability is met with training and supervision under a Connecticut licensed arborist (otherwise, outside licensed contractors would also function as a pruning source).
- Some trees within the cycle may not require pruning, but inclusion in the pruning cycle guarantees that a regular inspection, as a minimum, occurs for the tree.
- Will require Yale Golf representative/contractor or staff training in structural pruning.

- Will require Yale Golf representative or staff training on maintaining pruning/inspection records.
- Contract pruning 20 percent of the balance of trees for the haul road on an annual basis.
- Pruning to A300 standards. Includes crown cleaning and crown raising during winter months.
- Yale Golf representative or staff to identify the 20 percent to be inspected/pruned for that season. Selection should evenly distribute trees across size classes to guarantee uniform annual budget requirements.
- Inspection in the fall by the Yale Golf representative or staff of the 20 percent of trees to be pruned that season. The purpose of the inspection is to note any specific pruning requirements, update tree conditions, identify any removals, and identify any trees that do not require pruning.
- Provide a methodology and protocol for updating pruning/inspection records such as the Yale University Landscape and Grounds ArcGIS platform.
- Potentially create a field in the tree inventory for assigning a tree to a cycle to allow an easily retrievable project list.
- Develop a tree inspection methodology for Yale Golf representative or staff.
- Develop pruning specifications to be used across campuses by both contractor and staff (reference A300 pruning standards).
- The current tree inventory GIS platform should be updated with regards to trees cyclically pruned and when by Yale Golf staff or contractor or consulting arborist.
- Completed construction footprints, removals; all IPM priority tree actions and plantings should also be recorded and inventoried and updated by the Yale Golf representative or other.

Pruning, Cabling and Removals

A significant number of trees at the haul road (59 total trees) require A300 crown cleaning. The amount of deadwood identified correlates with this action being assigned. A crown cleaning is the removal of all dead, diseased, and crossing limbs above a specified diameter size. Crown cleaning

can be incorporated into cyclic pruning operations with a priority for pruning of dead wood and broken or hanging branches in areas of higher traffic prioritized for work first.

Stump grinding may or may not be a priority to be completed after tree removal based on site use, accessibility, and aesthetics and should be evaluated on a case-by-case basis as determined by the Yale Golf Course representative.

If any cabling or cable inspections were needed or observed, they were noted on ArcGIS records as "cable." The haul road had none recommended for cabling.

TREE PROTECTION

The haul road tree preservation circumstances are unique and require site specific solutions for such preservation. The access road is in the northern reaches of the Yale Preserve with little if any previous vehicular access routes to the Yale Golf Course. Construction during the initial 1925 project may have had access through the same or different route but is unknown to the consultant.

The construction of the access haul road installs road materials over the tops of roots. Though not ideal for roots, it is far better than excavating into grades and disturbing root systems and leaving torn roots which are more susceptible to pathogens and tree instability.

Figure 28 Photo taken mid -March after inventory work showing timber mat haul road

The consultants have previously identified critical root zones (CRZ's) within Yale University's Landscape and Grounds Maintenance (YLGM) tree inventory ArcGIS platform. A tree with a diameter of 20", as measured at a height of 4.5' above grade, would be multiplied by 1.33 to establish a radius measurement for a CRZ or 26.6' radius from the trunk. This would be a *minimum* area to establish a tree protection zone that is secured by chain link fencing with prohibited activities such as trenching, excavation, vehicular or machine access to prevent root damage.

This is not practical or recommended for the haul road. There are several trees that are within a foot or two of the access road. All 71 trees identified for preservation have a significant portion of the haul road well within their critical root zones.

The portion of the preservation trees that is practical to protect under such challenging circumstances is the trunk and overhead branches. The trunks near the road are prone to trunk damage from vehicles or machinery. Damaged trunks can lead to decay or reduced vigor and increased mortality often not apparent until years after the event. Any overhead branching that is likely to encounter construction vehicles should be removed.

Trunk Protection: During construction activities in tight spaces, it will be necessary to protect the trunk and buttress roots without the advantage of a standard Tree Protection Zone. All tree trunks within 4' of the outside of the haul road edges shall have trunk protection as defined below:

- A minimum of 4 layers of orange plastic snow fencing, then a layer of 2X4 planks set on end, edge-to-edge and wrapped with a minimum of 4 additional layers of orange plastic snow fencing and sandbags on the roadside half of the buttress roots.

- All vehicular traffic must stay within the road course. Any turning around or parking on surfaces other than the roadbed is prohibited. This is to eliminate compaction or crushed roots and reduce any disturbed soil creating any erosion.

- Contractor to coordinate with the Owner's Representative.

Trunk protection must be kept in place no longer than 12 months. If construction requires work near a particular tree to continue longer than 12 months, the wire shall be inspected every six months and loosened if it is found to have become tight.

Figure 29 Trunk protection concept for haul road trees falling within potential impact zone (approx. 4') (photo by C.Pepper 2018)

Figure 31 Exposed tree trunk needing protection on exposed on current haul road

Figure 30 Tree trunk needing protection on current haul road

GLOSSARY

10-20-30 guideline for planting a diverse urban forest wherein a single species should make up no more than 10 percent of the tree population, a single genus no more than 20 percent, and a single family no more than 30 percent (Santamour, 1990)

abiotic disorder – plant malady caused by nonliving, environmental, or fabricated agents. (ISA, 2010).

ANSI A300 – in the United States, industry-developed, national consensus standards of practice for tree care. (ISA, 2010).

ANSI Z133.1 – in the United States, industry-developed, national consensus standards of practice for tree care. (ISA, 2010).

approved – in the contest of guidelines, standards, and specifications, that which is acceptable to federal, state, provincial, or local enforcement authorities or is an accepted industry practice. (ISA, 2010).

arboriculture – practice and study of the care of trees and other woody plants in the landscape. (ISA, 2010).

basic assessment (Level 2) - detailed visual inspection of a tree and surrounding site that may include the use of simple tools. It requires that the assessor inspect completely around the tree trunk looking at the visible aboveground roots, trunk, branches, and site.

best management practices (BMPs) – best-available, industry-recognized courses of action, in consideration of the benefits and limitations, based on scientific research and current knowledge. (ISA, 2010).

biotic disorder – disorder caused by an infectious living agent. (ISA, 2010).

canker – localized disease area on stems, roots, and branches. Often shrunken and discolored. (ISA, 2010).

carbon sequestration – capturing and long-term storage of carbon. Most often used about the capturing of atmospheric carbon dioxide through biological, chemical, or physical processes. Trees sequester carbon through photosynthesis. (ISA, 2010).

cavity – open or closed hollow within a tree stem, usually associated with decay. (ISA, 2010).

codominant stems – forked stems nearly the same size in diameter, arising from a common junction and lacking a normal branch union. (ISA, 2010).

compaction – see *soil compaction*. (ISA, 2010).

conk – fruiting body or nonfruiting body (sterile conk) of a fungus. Often associated with decay. (ISA, 2010).

Council of Tree and Landscape Appraiser (CTLA) – group of representatives of several tree care and landscape associations that works to research and compile the *Guide for Plant Appraisal,10th, 2nd Edition.* (ISA, 2019).

crown cleaning – in pruning, the selective removal of dead, dying, diseased, and broken branches from the crown. (ISA, 2010).

data – facts and statistics collected for reference or analysis.

data point – an identifiable element in a data set.

diameter at breast height (DBH) – a U.S. custom means of expressing a diameter of a tree, as measured 4.5 feet (or 1.37 m) above the ground. (ISA 2019).

diameter tape – a diameter tape (D-tape) is used by foresters to measure the diameter of a tree. Since trees are swelled at the base, measurements are made 4.5 feet above the ground to give an average diameter estimate.

decay – (1) (*noun*) an area of wood that is undergoing decomposition. (2) (*verb*) decomposition of organic tissues by fungi or bacteria. (ISA, 2010).

deciduous – tree or other plant that sheds all its leaves according to a genetically scheduled cycle as impacted by climate factors (usually during the cold season in temperate zones). Contrast with *evergreen*. (ISA, 2010).

defoliation – loss of leaves from a tree or other plant by biological or mechanical means. (ISA, 2010).

dieback – condition in which the branches in the tree crown die from the tips toward the center. (ISA, 2010).

drought– A period of abnormally dry weather long enough to cause a serious hydrological imbalance. Drought is a relative term (see Box 3-3), therefore any discussion in terms of precipitation deficit must refer to the precipitation-related activity that is under discussion. For example, shortage of precipitation during the growing season impinges on crop production or ecosystem function in general (due to soil moisture)

duty of care – legal obligation that requires an individual to use a reasonable standard of care when performing tasks that may potentially harm others. (ISA, 2010).

event – occurrence of a set of circumstances (ISA, 2018).

foliage – leaves of a plant. (ISA, 2010).

fruiting body – reproductive structure of a fungus. The presence of certain species may indicate decay in a tree. See *conk*. (ISA, 2010).

gall – abnormal swelling of plant tissues caused by gall wasps, mites, nematodes, and various insects and less commonly by fungi or bacteria. (ISA, 2010).

genus – taxonomic group, composed of species having similar fundamental traits. Botanical classification under the family level and above the specific epithet level. (ISA, 2010).

geographic information system (GIS) – computer application used to store, view, and analyze geographic information typically maps. (ISA, 2010).

girdling roots – root that encircles all or part of the trunk of a tree or other roots and constricts the vascular tissue and inhibits secondary growth and the movement of water and photosynthates. (ISA, 2010).

growth rate – speed at which something grows. (ISA, 2010).

habit – characteristic form or manner of growth. (ISA, 2010).

hardiness – genetically determined ability of a plant to survive low temperatures. (ISA, 2010).

hazard – a situation or condition that is likely to lead to a loss, personal injury, property damage, or disruption of activities or services, a likely source of harm. In relation to trees, a hazard is the tree part(s) identified as a likely source of harm (ISA, 2011).

hazard tree – a tree, or tree part, identified as a likely source of significant harm (ISA, 2011).

hybrid – plant resulting from a cross between two or more other plants that are alike. (ISA, 2010).

inspection interval – time between inspections (ISA, 2011).

i- Tree – suite of software products and management tools that allows the user to inventory the urban forest and analyze its costs, benefits, and management needs. (ISA, 2010).

included bark – bark that becomes embedded in a crotch (union) between branch and trunk or between codominant stems. Causes a weak structure. (ISA, 2010).

infectious – capable of being spread to plants from other plants or organisms. (ISA, 2010).

integrated pest management (IPM) – method of controlling plant pests by combining biological, cultural, mechanical, physical, and/or chemical management strategies. (ISA, 2010).

leaf spot – patches of disease or other damage on plant foliage. (ISA, 2010).

likelihood – chance of something happening (ISO, 2018). Within the ISO narrative, the word "likelihood" is used "to refer to the chance of something happening, whether defined, measured or determined objectively or subjectively, qualitatively or quantitatively, and described using general terms or mathematically." The term "probability" while often having a narrower definition in English is considered an equivalent term for the purposes of the ISO narrative.

limited visual assessment (Level 1) – a visual assessment from a specified perspective such as foot, vehicle, or aerial patrol of an individual tree or a population of trees near specified targets to identify conditions or obvious defects of concern (ISA, 2017).

lion tailing (lion's tailing) – poor pruning practice in which an excessive number of branches are thinned from the inside and lower part of specific limbs or a tree crown, leaving mostly terminal foliage. Results in poor branch taper, poor wind load distribution, and a higher risk of branch failure. (ISA, 2010).

monitoring – keeping a close watch. Performing regular checks or inspections. (ISA, 2010).

monoculture – cultivation or planting of a single species on agricultural land, in a forest setting or within an urban landscape. (ISA, 2010).

native species – plants indigenous to a region. Naturally occurring and not introduced by man. (ISA, 2010).

pathogen – causal agent of disease. Usually refers to microorganisms. (ISA, 2010).

phloem – plant vascular tissue that transports photosynthates and growth regulators. Situated on the inside of the bark, just outside the cambium. Is bidirectional (transports up and down). Contrast with *xylem*. (ISA, 2010).

prevention – proactive process intended to guard against adverse impact by avoiding or reducing the risk of its occurrence. (ISA, 2010).

raising – selective pruning to provide vertical clearance. (ISA, 2010).

reduction – pruning to decrease height and/or spread of a branch or crown. (ISA, 2010).

reduction cut – pruning cut that reduces the length of a branch or stem back to a lateral branch large enough to assume apical dominance. (ISA, 2010).

restoration – (1) pruning to improve the structure, form, and appearance of trees that have been improperly trimmed, vandalized, or damaged. (2) management and planting to restore altered or damaged ecosystems or landscapes. (ISA, 2010).

runoff – that part of precipitation that does not evaporate and is not transpired but flows through the ground or over the ground surface and returns to bodies of water.

scaffold branches – permanent or structural branches that form the scaffold architecture or structure of a tree. (ISA, 2010).

shall – word that designates a mandatory requirement within the ANSI standards or contract documents. Contrast with *should.* (ISA, 2010).

should – word that designates an advisory recommendation in the ANSI standards or contract documents. Contrast with *shall.* (ISA, 2010).

sign – physical evidence of a causal agent (e.g. insect eggs, borer hole, frass). Contrast with *symptoms*. (ISA, 2010).

site considerations – factors that must be considered when assessing a site for planting, tree conservation, or preservation or any operation. (ISA, 2010).

soil compaction – compression of the soil, often because of vehicle or heavy-equipment traffic, that breaks down soil aggregates and reduces soil volume and total pore space, especially macropore space. (ISA, 2010).

species – taxonomic group of organisms composed of individuals of the same genus that can reproduce among themselves and have similar offspring. (ISA, 2010).

species diversity – measure of the number and variety of different species found in each area. (ISA, 2010).

specifications – detailed plans, requirements, and statements of procedures and/or standards used to define and guide work. (ISA, 2010).

stakeholder – person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or activity (ISO, 2018).

stormwater runoff – water originating from precipitation (rain or melting snow and ice) that flows above ground rather than infiltrating into the soil. May occur if soils are frozen or saturated or if the rate at which precipitation falls is greater than the infiltration rate of a soil. (ISA, 2010).

structural defects – any naturally occurring or secondary conditions such as cavities, poor branch attachments, cracks, or decayed wood in the trunk, crown, or roots of a tree root growth. (ISA, 2010).

structural pruning – pruning to establish a strong arrangement or system of scaffold branches. (ISA, 2010).

sustainability – the ability to maintain ecological, social, and economic benefits over time. (ISA, 2010).

taper – change in diameter over the length of trunks, branches, and roots. (ISA, 2010).

thinning – in pruning, the selective removal of live branches to provide light or air penetration through the tree or to lighten the weight of the remaining branches. (ISA, 2010).

topping – inappropriate pruning technique to reduce tree size. Cutting back a tree to predetermined crown limit, often at internodes. (ISA, 2010).

tree inventory – record of each tree within a designated population; typically includes species, size, location, condition, and maintenance requirements. (ISA, 2010).

tree risk assessment – a systematic, technical process used to identify, analyze, and evaluate the risk associated with a singular tree (ISA, 2011).

trunk flare – transition zone from trunk to roots where the trunk expands into the buttress or structural roots. Root flare. (ISA, 2010).

urban forestry – management of naturally occurring and planted trees and associated plants in urban areas. (ISA, 2010).

vigor – overall health. Capacity to grow and resist stress. Sometimes limited to reference to genetic capacity. (ISA, 2010).

visual tree assessment (VTA) – method of assessing the structural integrity of trees using external symptoms of mechanical stress (such as bulges, reactive growth, etc.) and defects (cracks, cavities, etc). (ISA, 2010).

vitality – overall health. Ability of a plant to deal effectively with stress. (ISA, 2010)

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APPENDICES

Appendix 1. Tree Inventory Condition Reporting

Rating category	Condition components			Percent rating
	Health	Structure	Form	
Excellent	High vigor and nearly perfect health with little or no twig dieback, discoloration, or defoliation.	Nearly ideal and free of defects.	Nearly ideal for the species. Generally symmetric. Consistent with the intended use.	100%
Good	Vigor is normal for the species. No significant damage due to diseases or pests. Any twig dieback, defoliation, or discoloration is minor.	Well-developed structure. Defects are minor and can be corrected.	Minor asymmetries/deviations from species norm. Mostly consistent with the intended use. Function and aesthetics are not compromised.	61% to 80%
Fair	Reduced vigor. Damage due to insects or diseases may be significant and associated with defoliation but is not likely to be fatal. Twig dieback, defoliation, discoloration, and/or dead branches may comprise up to 50% of the crown.	A single defect of a significant nature or multiple moderate defects. Defects are not practical to correct or would require multiple treatments over several years.	Major asymmetries/deviations from species norm and/or intended use. Function and/or aesthetics are compromised.	41% to 60%
Poor	Unhealthy and declining in appearance. Poor vigor. Low foliage density and poor foliage color are present. Potentially fatal pest infestation. Extensive twig and/or branch dieback.	A single serious defect or multiple significant defects. Recent change in tree orientation. Observed structural problems cannot be corrected. Failure may occur at any time.	Largely asymmetric/abnormal. Detracts from intended use and/or aesthetics to a significant degree.	21% to 40%
Very poor	Poor vigor. Appears to be dying and in the last stages of life. Little live foliage.	Single or multiple severe defects. Failure is probable or imminent.	Visually unappealing. Provides little or no function in the landscape.	6% to 20%
Dead				0% to 5%

(Gooding, 2019)

Appendix 2. Arborist Disclosure Statement

Arborists are tree specialists who use their education, knowledge, training and experience to examine trees, recommend measures to enhance the beauty and health of trees, and attempt to reduce the risk of living near trees. Clients may choose to accept or disregard the recommendations of the arborist or seek additional advice.

Arborists cannot detect every condition that could possibly lead to the structural failure of a tree. Trees are living organisms that may fail in ways we do not fully understand. Conditions are often hidden within trees and below ground. Arborists cannot guarantee that a tree will be healthy or safe, or fail for that matter, under all circumstances, or for a given period of time. Likewise, remedial treatments, like any medicine, cannot be guaranteed.

Treatments, pruning and removal of trees may involve considerations beyond the scope of the arborist's services such as property boundaries, property ownership, sight lines, disputes between neighbors, landlord-tenant matters, etc. Arborists cannot take such issues into account unless complete and accurate information is given to the arborist. The person hiring the arborist accepts full responsibility for authorizing the recommended treatment or remedial measures.

Trees can be managed, but they cannot be controlled. To live near a tree is to accept some degree of risk. The only way to eliminate all risks is to eliminate all trees.

This consultant does not verify the safety or health of any tree for any period of time.

Construction activities are hazardous to trees and cause many short and long-term injuries, which can cause trees to die or topple.

Even when every tree is inspected, inspection involves sampling; therefore, some areas of decay or weakness may be missed. Weather, winds and the magnitude and direction of storms are not predictable, and some failures may still occur despite the best application of high professional standards.

Appendix 3. Arborist Certificate of Inspection

Certification of Inspection *I, Bradley Painter, Arborist, certify:*

- That I have personally inspected the Yale Preserve haul road trees for removal/preservation and/or the property referred to in this report, and have stated my findings accurately. The extent of the evaluation is stated in the attached report and the Terms of Assignment;

- That I have no current or prospective interest in the vegetation or the property that is the subject of this report, and I have no personal interest or bias with respect to the parties involved;

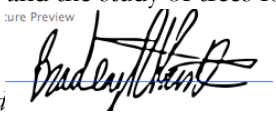
- That the analysis, opinions and conclusions stated herein are my own, and are based on current scientific procedures and facts;

- That my compensation is not contingent upon the reporting of a predetermined value or direction in value that favors the cause of the client or any other party, the attainment of stipulated results, or the occurrence of any subsequent events;

- That my analysis, opinions and conclusions were developed, and this report has been prepared according to the procedures recommended by the American Society of Consulting Arborists, and commonly accepted arboricultural practices;

- That no one provided significant professional assistance to the inspector, except as indicated within the report. I further certify that I am a member of the American Society of Consulting Arborists, and acknowledge, accept, and adhere to the ASCA Standards of Professional Practice. I am a Registered Consulting Arborist, a Connecticut and Rhode Island Licensed arborist, a Tree Risk Assessment Qualified (TRAQ) International Society of Arboriculture Certified Arborist, and have been involved in the practice of arboriculture and the study of trees for over 25 years.

ture Preview

Signed  *Date:* March 31, 2024