The Ecology, Geology, and History of Inwood Hill Park in Northern Manhattan, New York County, New York

by

JUDITH M. FITZGERALD

A dissertation submitted to the Graduate Faculty in the Biological Sciences in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

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Date	Chair of Examining Committee Dr. Steven E. Clemants
Date	Executive Officer Dr. Richard L. Chappell

Dr. Dominick V. Basile, Lehman College

Dr. Jack G. Valdovinos, Lehman College

Dr. Robert E. Loeb, Pennsylvania State University

Dr. Susan E. Yost, Delaware State University

Dr. Margaret R. Basile, Lehman College

Supervising Committee

The City University of New York

Abstract

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Judith M. Fitzgerald

Advisor: Dr. Steven E. Clemants

Inwood Hill is geomorphically made of two main ridges which parallel the Hudson River with a valley (clove) between the ridges. Four locations were selected for study: Valley-Clove forest, East Ridge and slopes forest, Ridge Tops (east and west) forests, and the West Ridge and slopes forest. There were 77 species (n=4070 woody stems including trees, shrubs and vines) identified in 51 genera and 28 families in 45 10 X 10 m^2 quadrats. The 12 top taxa were weighted by their importance value (IV), which included basal area, percent of quadrat representation, and number of stems assigned to each species. The findings revealed *Quercus rubra* (n=121) (IV = 48.69%) as the top ecologically dominant species out of all woody taxa. *Liriodendron tulipifera* (n=34) (IV = 25.55%) ranked second, and *Lindera benzoin* (n=760) (IV = 23.75%), ranked third. Following were *Viburnum acerifolium* (n=618) (IV = 19.07%), *Prunus serotina* (n=286) (IV = 15.15%), and *Lonicera maackii* (n=269) (IV = 9.78%). *Quercus rubra* (n=121) (IV = 60.13%) was the top dominant out of 44 tree species, with a collectively combined basal area of 23.09 m^2 (230973 cm^2), and 78% quadrat representation. Of the 77 woody species, 50 were native, 10 were nonnative, and 17 were invasive. The top 3 invasive species were *Lonicera maackii* (n=269), *Rosa multiflora* (n=186), and *Celastrus orbiculatus* (n=181). Herbaceous taxa (n=2842), in 45 2 x 2 m^2 quadrats, represented

96 species in 76 genera and 41 families.

Human use and abuse, along with fire and vandalism, have taken their toll on Inwood Hill. Where these fires have occurred, hundreds of small seedlings of *Prunus serotina* have taken root, perhaps indicating the forest composition of the future. Inwood Hill is very much a forest in transition, particularly on the West Ridge. The Valley-Clove seems not to have changed since Loeb (1986) and Graves (1930) reported their findings. However, there is a dearth of saplings for *Liriodendron tulipifera*, the dominant canopy tree, as there is for *Betula lenta* and understory tree, *Cornus florida*. Also, *Rosa multiflora* is spreading rather rapidly into the Clove.

Dedication

I dedicate this dissertation to my late and dearest friend for 45 years, L. M. Lewis (1927-2004), whose encouragement and support of my efforts through the good and the very lean years, have finally come to fruition. And to the wonderful and faithful companionship I shared with my cat for 20 years, Pumpkin McTabby-Tortie (1984-2004), who now lies buried in Inwood Hill Park.

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I. Chapter 1. Introduction

Inwood Hill Park in northern Manhattan, New York County, is a truly unique urban forest of 196 acres out of the entire New York City designated parkland acreage of 28,846 (11,673.9 ha) with 12,000 acres (4,856.4 ha) delimited as natural areas. In Manhattan alone, just 671 acres of precious natural areas exist out of a total of 2,700 acres in the borough (NYC DPR 2004, Borough Statistics: CMAP Census 2000).

At the northernmost part of Manhattan, this park is isolated, away from a crowded metropolis, where a dense, secondary forest still survives from the crushing onslaught of bull-dozing developers that have destroyed so much of New York City's earlier history. How it survived from the earliest times of the first European settlers in the 1600's to its present state is one small miracle. It is a testament to those individuals, such as the archaeologist and historian Reginald Pelham Bolton (1856-1942), who had the foresight to preserve and document, intact, the rich legacy of an earlier PaleoIndian culture dating from the Late Woodland Period (100 B.C. - 1,600 A.D.), and whose remains dating from 700 A.D., were found in nearby Isham Park and Inwood Hill Park. There were other individuals who fought to preserve the botanical richness of the forest of Inwood Hill from being developed, such as Andrew H. Green, an early Parks Commissioner, who first proposed the acquisition of Inwood Hill in 1895 for the newly formed New York City Parks Department. In a speech given on October 30, 1912 beneath the Great Tulip tree in Inwood, Nathaniel Lord Britten, the New York Botanical Garden's first director, spoke of the many native species still extant in Inwood and the need to preserve them. Members of the Torrey Botanical Club's field trip committee made numerous notations of existing plant species in and around the Inwood area in the late 1880s that later were extirpated as

New York City rapidly developed land for housing and subway construction.

When the first European settlers arrived, they encountered a loosely banded group of Native American Indians called the Rechgawawanacs (Manhattan Indians) whose ancestors, for nearly 700 years, had lived, hunted, and fished in an area of Inwood Hill known as Shorakapkok, or Sitting Place. The Europeans brought with them a culture that was unknown to the Native Americans, and it was not long afterward that the culture and ancestral lands of the Native American Indians began to disappear, supplanted by the Dutch and later, English settlers.

The newly arrived colonists brought not only their culture, but introduced into the landscape of North America, their Old World trees, plants, and animals, some of which have become today's noxious and invasive species threatening the native populations of indigenous plants. Prior to the arrival of the Europeans in Manhattan, introductions of exotics to the New World actually began with Columbus' second voyage in 1493, on which he brought seeds and cuttings of a variety of crop plants, probably a few weeds, and livestock animals to the island of Espanola, in the West Indies (Cox 1999).

In the 1600's, establishment of the Dutch and English colonies brought rapid change to the eastern seaboard, as forests were cleared and farms established. To this disturbed landscape, came a host of farm and garden weeds, some so early that their acquired names imply that they are North American natives, such as common dandelion and common plantain (Foy et al. 1983). Piotr Dyckman, Jan Nagel, Jan Vermilyea, and Jonas Bronck, all had extensive farms in the Inwood section of Manhattan on which they planted orchards and herbs, cutting much of the timber forest of Inwood. Later, during the Revolutionary War, both the Americans and British burned the forests of Inwood.

In the 1800's and on onto the 1900's as New York City was being paved over, Inwood Hill lost a good portion of its acreage, which was once continuous with what is now Riverside Drive. When Robert Moses became Commissioner of the New York City Department of Parks in 1934, he oversaw the park department's total acreage in all five boroughs. He built the Westside Highway and cut many mature tulip trees in Inwood, some dating back to the Revolutionary War, to make room for the highway and further reducing the amount of acreage until Inwood was just a vestige of its original composition and size.

Many estates dotted the picturesque landscape of Inwood Hill in the latter part of the 1800's before Inwood was acquired as a park. The legacy of these estates, prior to their demolishment as the city began incorporation of Inwood Hill into the park system, was the introduction of exotic and invasive species of plants from their extensive gardens, such as *Lonicera japonica, L. maackii*, *Celastrus orbiculatus*, *Ampelopsis brevipedunculata*, *Wisteria floribunda, W. sinensis*, *Helix hedera*, and many others that now threaten the native species of this magnificent urban forest.

This thesis is a three-part document. In the first part, the ecology of Inwood was established by a woodland census in which 45 10 X 10 m^2 (each quadrat = 107,643 $ft.^2$) permanent quadrats were set up during late Fall 2001 through Fall of 2002, and the vegetation sampled, recorded, and graphed, noting number of native, nonnative, and invasive species. Herbaceous taxa were also sampled in the 45 2 X 2 m^2 quadrats nested within each of the larger plots. Inwood Hill Park has one of the last remaining salt marshes in Manhattan. An additional five 2 X 4 m^2 plots were set up to record all taxa within these quadrats, noting bloom times, number of native, nonnative, and invasive species.

In the second part, the geology of Inwood is considered: how it formed, providing the bedrock foundation upon which all current vegetation now resides, and how the metamorphic rock structures composed of schist, gneisses, and Inwood marble have contributed to the soils of Inwood. Unique from a geological perspective is the fact that 480 million years ago, during the Ordovician Period of early Paleozoic times, Manhattan Island, one of a series of volcanic arcs that formed a chain during a massive continental collision, became the most expensive real estate property in the world.

The third part is a land-use history of Inwood starting with historical references of PaleoIndian occupation in New York State through to the arrival of the European settlers, Revolutionary War activities, and their impact on Inwood Hill. Later historical references describe how Inwood was incorporated into the New York City Parks Department system, the Robert Moses years, the building of the Harlem Ship Canal and the Henry Hudson Memorial Bridge, up to present day.

Ecological Background of New York City

New York City's urban forests are complex ecosystems created by the interaction of anthropogenic and natural processes. Management of the entire urban forest ecosystem requires information on all vegetation and other attributes of the system across the urban landscape. Very few forests containing large, and dense secondary mature trees in heavily populated human settlements still exist today such as Inwood Hill Park in northern Manhattan.

New York City Parks include 12,000 acres (4,856.4 ha) of natural areas out of a total of 28,846 acres (11,673.9 ha) representing about 14% of parkland allotted across the five boroughs of the entire 205,952 acres (or 83,348.7 ha) that comprises New York City. The borough of Manhattan in New York County claims 671 acres of natural areas out of a total of 2,700 acres devoted to parks with the borough of Bronx parks containing 2,596 acres. The borough ranking on a scale of 1 to 5 (1 = most parkland) of acreage devoted to parks gave Manhattan 3, and the nearby Bronx 1, by way of comparison, with Staten Island Parks at 2, Queens 4, and Brooklyn at 5. In Manhattan, residents per acre of parkland is 569 and the parkland ranking is 5 (1 = least residents per acre) out of a population of 1.5 million (NYC DPR 2004, Borough Statistics: CMAP; Census 2000). Of the 12,000 acres classified as undeveloped for recreation, 8,000 acres (or approximately 3,237.6 ha) remain forested, existing as the most prominent natural resource compared to other remaining community types: naturalized meadows, wetlands and marshes, and areas in transition within the park system (Sisinni and Emmerich 1995). The natural forested areas of New York City share a commonality in plant species composition (Yost et al. 1991), and pollen analysis from historical periods have reflected vegetational changes since the arrival of European people (Loeb 1992, 1998). Until European settlement, a mixed hardwood forest consisting primarily of oaks (*Quercus* spp.), hickories (*Carya* spp.), chestnut (*Castanea dentata*), maples (*Acer* spp.), ashes (*Fraxinus* spp.), cherries (*Prunus* spp.), sweetgum (*Liquidambar styracifolia*), and tulip trees *(Liriodendron tulipifera*) covered much of this and other parts of New York City (Greller 1972, 1975; Russell 1980, 1981; Stalter 1981; Loeb 1987, 1992, 1998; Sisinni and Emmerich 1995). This vegetation is very much like that found in New York City Parks today. However, none of the primeval forest survived human settlement and the gradual development of the city. Native Americans cut and, to an uncertain extent, burned the forest for agriculture, fuel and timber, and also cleared the understory with fire to create game parks (Day 1953; Russell 1983). European colonists and other later Americans imitated the native people but on a much larger scale (Greller 1975; Loeb 1989; Abrams and Nowacki 1992). However, ecological disturbances did not end when the land was acquired for public parks. The era of decorative landscape design and development that followed (and which continues today) created a legacy of invasive exotic plants that greened up the environment very efficiently but impoverished it botanically.

Documenting long term forest changes in urban parks can provide a window of opportunity to study and observe the effects of intense human disturbances on these urban woodlands. The collection of data and assessment of what species currently exist and what species will survive, depends in part, upon the comparison of data collected from past historical records. However, interpretation of the effects on urban forest development from written historical information is difficult as the records are few, hence, analysis of change in forest composition can be done only by comparing data from time periods available rather than examining forest development as a continuous process (Loeb 1992).

Documentation of the Flora of New York City: The Historical Investigators and Later Ecologists

Documenting and analyzing the vegetation of New York City in the past century was done by very few workers, mainly those who had a long term interest in preserving these remnant forests and plant communities from further human disturbance, and to take a census of what remained, if any, of the original forest composition. Harper (1917a, b) was first to describe and comment on the plant communities throughout all of Queens County, but it is not known how much of the vascular flora had been extirpated due to the loss of natural areas and land development (Glaeser 2004).

Ahles' base-line study of the flora of Pelham Bay Park in Bronx County compiled in 1946-47 in which he collected 1531 specimens was never officially published. No comprehensive flora of PBPK had ever been published and no systematic plant collections had been made in fifty years until recently by DeCandido (2001). Of the 668 plant species in 108 families that Ahles collected, the vast majority of these were native species (71.4%), while 188 (28.1%) were non-native (alien) species. In the intervening fifty-one years, plant diversity in Pelham Bay Park had changed significantly (DeCandido 2001). By 1998, 792 species from 117 families were documented, and of these, 440 species (55.6%) were considered native and 302 (38.1%) considered non-native. This showed a net increase of 136 non-native species (+37.1%) and a net loss of 141 native species (- 25.3%) with a vast majority of extirpated native species being herbaceous plants such as wildflowers, grasses, sedges and rushes (DeCandido 2001).

On Staten Island, New York, three consecutive floristic censuses were analyzed to determine vascular plant species gains and losses over 112 years (1879-1991), the extent of increases in non-native species, and the ecological features that characterize those species that were lost (Robinson et al. 1994). These investigators found that over 40% out of the original 53% of regionally rare and endangered native species are presently missing, as these losses occurred during an acceleration period of suburbanization over the last 60 years. In the same time period, the authors noted an increase in the proportion of non-native species from 19% to > 33% of the flora, while average abundances of most native species apparently declined. Two ecological features were examined statistically which correlated with the missing species: (1) herbaceous species were more vulnerable than woody plants and, (2) species reported to be uncommon in a previous census were more likely to be absent in the next. These two factors have similar patterns to those reported by DeCandido (2001) in which plant species extirpated were herbaceous species primarily from meadow-type habitats rather than woody plants. These causes share the same pattern of loss due to over-development in natural areas, placement of landfills, recreational areas, parking lots, and to a lesser degree, ecological succession.

In 1987, a vegetation survey was conducted of the natural area at Wave Hill, a New York City-owned cultural and environmental center in the Riverdale section of Bronx County (Yost et al. 1991). The three ha natural woodland area on the 11 ha grounds of Wave Hill is on the southwest facing slope of Riverdale Ridge, 400 meters east of the Hudson River, and approximately 7 miles north of Inwood Hill Park in Manhattan. The natural area is a long, and narrow urban woodland comprised of a variety of plant communities ranging from open areas to relatively mature woods. Based on importance values (IV) in 238 10 X 10 m quadrats, the survey showed that the most important arborescent species were *Robinia pseudoacacia*, *Quercus rubra*, and *Acer platanoides*. The most important non-arborescent species were *Ampelopsis brevipedunculata*, *Lonicera maackii*, and *Alliaria petiolata*. All of these are considered to be serious non-native, invasive species with the exception of *Q. rubra*. The authors found 276 species of vascular plants in 206 genera and 85 families which included 50 trees, 35 shrubs, 20 vine and 171 herb species. Of the total number of species, 132 (48%) were not native to New York with non-native tree species comprising 44% of the 50 trees recorded. This high percentage (48%) and importance of non-native species is related to Wave Hill's urban location and land-use history of anthropogenic disturbances (Yost et al. 1991).

Historically, some of the earliest known records of the flora of Inwood were collected and recorded by W. W. Denslow around 1863. Denslow was then a resident of the Inwood section of Manhattan and was able to make an extensive study of the plants in that vicinity. In the autumn of 1867, the year the Torrey Botanical Club became established, several orchid species were noted growing around Spuyten Duyvil and on the slopes of the West Ridge of Inwood (Denslow 1924). The orchids in bloom in that September of 1867 were few in number but very memorable (using the nomenclature of Denslow): *Spiranthes gracilis* and *S. cernua*, found on the slopes near Kingsbridge Road (prior to the building of the Harlem Ship Canal), and *Corallorhiza odontorhiza* in the nearby woods of Inwood. *Liparis liliifolia* was also found in fruit, and seen during the same month. In one spot, on the bank beside a road (most probably Bolton Road) through the woods on the west and north face of the West Ridge of Inwood, was a small colony of *Tipularia discolor*. The discovery in the preceding year of this beautiful species was a memorable event and the small colony was cherished and scrupulously cared for. The species was considered rare in this vicinity of Inwood, although it was later found and collected in Bedford Park and was still abundant at an earlier date on Staten Island (Denslow 1924).

W. W. Denslow had found other orchids in 1865, and in the summer of 1867. The list of specimens (in the Herbarium of Amherst Agricultural College at that time) included two of the less common species of *Habenaria*, *H. lacera* and *H. flava*, the latter being found in the salt marshes near Spuyten Duyvil around Inwood, and the former, ragged orchis, near High Bridge. Other discoveries in the Inwood area included *Spiranthes latifolia*, the larger coral root, *Corallorhiza maculata*, in both Inwood and Washington Heights, and the tway-blade, *Liparis loeselii*, in the same neighborhoods (Denslow 1924). Showy orchis, *Orchis spectabilis*, was one of the earliest discoveries found in May of 1866 (and again in 1887), and rattlesnake plantain, *Goodyera pubescens*, had already been collected by August, 1863, near Kingsbridge Road. Almost all of the species that had been reported in Manhattan and nearby Westchester County (now Bronx County) by W. W. Denslow had disappeared by the turn of the 20th century due to the rapid expansion of New York City and the incorporation of Inwood Hill into the beginnings of the New York City Parks Department (Denslow 1924, 1927). Only one species of orchid, *Epipactis helleborine*, a native of Europe, now resides in Inwood Hill Park.

During the 1930s, 40, and 50s, members of the Torrey Botanical Club's field trip committee made numerous notations of plant species no longer extant in Inwood Hill Park. The committee members also noted the diminishing number of plants that were left of Blue cohosh (*Caulophyllum thalictroides*) in the Park's extensive rich, moist woods, as well as Skunk cabbage (*Symplocarpus foetidus*), during the advanced stage of the building of the Harlem Ship Canal.

Graves (1930) also described some common plants in certain sections of Inwood Hill Park, and compiled a list of 70 woody taxa growing without cultivation, 20% of which were introduced. He also noted that the orchids which Denslow had described and recorded in 1867 were now extirpated, and that *Vaccinium corymbosum* was no longer growing naturally in the park. *Rubus phoenicolasius* was reported as "rare" in 1930, however it had increased from being rare to being the most common *Rubus* species found throughout the park (Loeb 1986). In this current research, *Rubus phoenicolasius* is considered an invasive species, forming dense, almost impenetrable, stands, particularly in the southern perimeter of the park along Dyckman Street.

Small (1937) listed 76 species of native trees and shrubs growing naturally, and 33 naturalized species of trees and shrubs introduced and planted, some of which have become the invasives of today. Later, Metzner (1942), had identified 3 species of saltwater algae, and by 1974, Stone had compiled a species list of 250 plants. Other botanists also recorded many species of plants that were not officially published (Friends of Inwood Hill Park 1976).

Topographic Mapping and the Vegetation Research of Parklands

During the depression years, the public works projects (WPA) of 1933 focused on the development of parklands under Parks Commissioner Robert Moses, and extensive surveys and mapping of trees within wooded areas throughout New York City took place.

The quantification of taxa in New York City parklands began only in the 1970s by several workers but methodologies utilized were inconsistent (Glaeser 2004). A partial taxonomic record of all woody floras and woodland composition of all local wooded parks, including Inwood Hill Park, was performed during the 1935-37 WPA projects under the Robert Moses Administration (New York City Department of Parks and Recreation Mapping Division 1936). This census has been used comparatively by several authors. Tree censuses occurred in many wooded parklands, including Inwood Hill Park, during a period when the last of the "open spaces" were being developed for housing and industry, or for recreation (Stalter 1981; Loeb 1982; Rudnicky and McDonnell 1989). However, the reliability of the NYC DPR topographic inventories has been questioned and tree identification was often only to genus (Loeb 1983) as these contour maps contain spatial point patterns, or dot maps, of all arborescent taxa measured at ≥7.6 cm DBH (3.00 inches) and nothing below this cut-point.

In the latter part of the century, the DPR wooded parklands were, once again, under investigation by local ecologists that resulted in floristic inventories in the Bronx (Loeb 1982; Profous and Loeb 1984; Rudnicky and McDonnell 1989; Yost et al.1991; Loeb 1992, 1998; Sisinni and Emmerich 1995; DeCandido 2001), in New York County (Loeb 1986, 1993), in Queens County (Greller 1972; Lefkowitz and Greller 1973; Greller 1975; Greller 1977a, 1977b; Greller et al.1979; Greller 1979; Stalter 1981; Loeb 1982;

Greller 1985; Greller and Garcia 1986; Greller et al.1991; Glaeser 2004)), in Staten Island (Buegler and Parisio 1981; Robinson et al.1994), and more recently, a continuing citywide floristic survey, The New York City Metropolitan Flora Project (Moore, et al. 2002).

Not until 1985 had a systematic study been conducted to sample the taxa of Inwood Hill. During the months April-May, Loeb (1986) constructed a transect across the two ridges of Inwood Hill Park going from the playgrounds on the east to the ballfields on the west side to document the flora, and sample soils, of Inwood Hill. Using descriptions of the forests in the Park provided by Arthur Graves in 1930, the past 55 years of vegetational changes in the plant communities and their historical development were analyzed. Loeb (1986) documented 21 arboreal species and 35 species of herbs and shrubs in the 12 contiguous quadrats along the transect. A New York City Department of Parks Topographic Map of Inwood Hill Park (1936) recorded a number of trees that confirmed a similarity between the forest in 1986 and that reported by Graves in 1930 (Loeb 1986). Seven distinct plant communities were defined: Salt Marsh, Valley Forest, Slope Forest, North-facing Forest, Successional Forest, Successional Field, and Lawn. Correlated with vegetational changes, an extensive soil analysis was performed in each of the plant communities to show the effects of past historical disturbances (Loeb 1986).

Documentation of the local flora as surveyed and compiled by the above ecologists and other investigators in the past century resulted in a classification of New York City woodlands (Glaeser 2004), and other regionally similar naturally wooded parks, by type. The forests of Inwood are within a region characterized as being an oak-chestnut forest, placing New York City forest types along the glaciated sections as mixed oak forests (Braun 1950). Brodo (1968), referred to these forests as predominantly red oak forests, as the oaks appeared visually dominant due to their size. The unfortunate demise of chestnut (*Castanea dentata*) stands due to a canker forming fungus, *Endothia parasitica*, drastically altered the forest composition by 1917 for forests such as Inwood Hill Park and other similar woodlands (New York Department of Parks and Recreation 1990). Remnants of this magnificent tree are rare and found only as small poles with adventitious sprouts from stumps, rarely growing to heights of several meters before dieback from the canker-forming fungus.

Research Purpose

The purpose of this research of the species composition and diversity of Inwood Hill Park is an effort to contribute to the growing body of knowledge of the ecology and floristics of New York City already garnered in the past by previous workers as noted above. An additional purpose is to document and record the current woody flora of Inwood for future study using past documentation of previous workers, determine plant community structure and composition, report on the health of the forest, and note the number of native, non-native, and invasive species. I pose the following questions that I had considered before I began my research to guide current and future research projects:

(1) What is the floristic and structural composition of the areas of study?

(2) What is the population biology of nonnative, invasive trees, shrubs, and vines, and what is their influence on the local flora?

(3) Have anthropogenic disturbances such as vandalism and fires stimulated unwanted growth, and have tree falls combined with pioneer type invasive trees, shrubs, and vines changed the forest?

(4) How are taxa distributed and what are the ecologically dominant species?

(5) Do restoration efforts to replant native species succeed without carefully planned maintenence?

(6) Based on my research findings, what recommendations can I offer to NYC DPR natural resource managers?

II. Chapter 2. Setting and Methods

Project Area and Site Selection

Inwood Hill Park is a 70.32 ha (196 acre) park located in New York County, NY (40 52' 15" north latitude and 74 55' 45" west longitude). It is a multi-use park with several ball and soccer fields, tennis courts, and bicycle paths around the base of the two prominent ridges: East Ridge and West Ridge. The West Ridge is the larger and highest (230 ft. elev.) of the two ridges and acts as a natural buffer for the Valley-Clove and East Ridge. The two ridges join together at the top of the Valley-Clove near quadrat #20 (geologically called a canoe valley as the "nose of the canoe disappears" as an overturned thrust) and gradually dips down towards Dyckman Street. Paved foot paths also traverse the ridges. A natural area was designated within the Valley-Clove forest (Local Law 74, 1992 Int. No. 512 by Council Members Michels, Castaneira-Colon, and O'Donovan, District 9 New York City). Inwood Park is situated parallel to the Hudson River on the west-facing side while the northern portion of the West Ridge connects to the Henry Hudson Memorial Bridge to the Bronx mainland.

These first permanent plots set up within the 196 acre park were selected for study because of the need for long-term, quantitative ecology within such close proximity of this densely populated neighborhood, and because no other urban woodlands in Manhattan has large, and dense secondary remnant forests remaining. Many ecologists have known for some time that long-term changes in structure and composition of a woodland are best determined by periodically resampling and re-measuring permanent plots (Fain et al.1994). However, Loeb (1990) noted that resampling vegetation without using the same sampling methods and relocating the exact sampling sites is not a valid method to measure vegetation changes through time unless the variability in plant distribution is considered.

The study sites of Inwood Hill Park were selected starting in late Fall 2001 through April 2003 in four geographic locations: 11 sites in the Valley-Clove forest, 8 sites in the East Ridge and slopes forest, 8 sites on the Ridge Top (east and west) forests, and 18 sites in the West Ridge and slopes forest (Figure 2.1 Map showing the four geographic locations and numbered quadrats 1- 45, and the salt marsh quadrats 46 - 50). The topography within the 45 quadrats ranged from 10.3 m (34 ft.) to 70.1 m (230 ft.). Coordinates and elevations for each of the quadrats in the four geographic locations are listed in Tables 3.2 Valley-Clove Forest, 3.3 East Ridge and Slopes Forest, 3.4 Ridge Tops (east and west) forest, and 3.5 West Ridge and Slopes Forest.

The site selections for the Hill were based on the following criteria (a) sites least likely to have been disturbed by park users, (b) sites where the DPR Natural Resources Group woodland restoration efforts did not disturb the natural vegetation cover and, (c) sites that contained reasonable representation and homogenous canopy as signs of having a mature stand in the four separate geographic locations. Because of the ongoing restoration project established by the NRG, sites do not have an equal number of quadrats in each of the geographical locations. Large portions of the park are undergoing herbicidal treatment in an effort to rid/reduce these areas of invasive species and replant natives. In addition to the selection of the four geographic locations, five 2 X 4 m^2 plots were set up in the salt marsh adjacent to the meadow area of the northern end of Inwood Hill and a floristic inventory taken noting bloom times and number of native, nonnative, and invasive species.

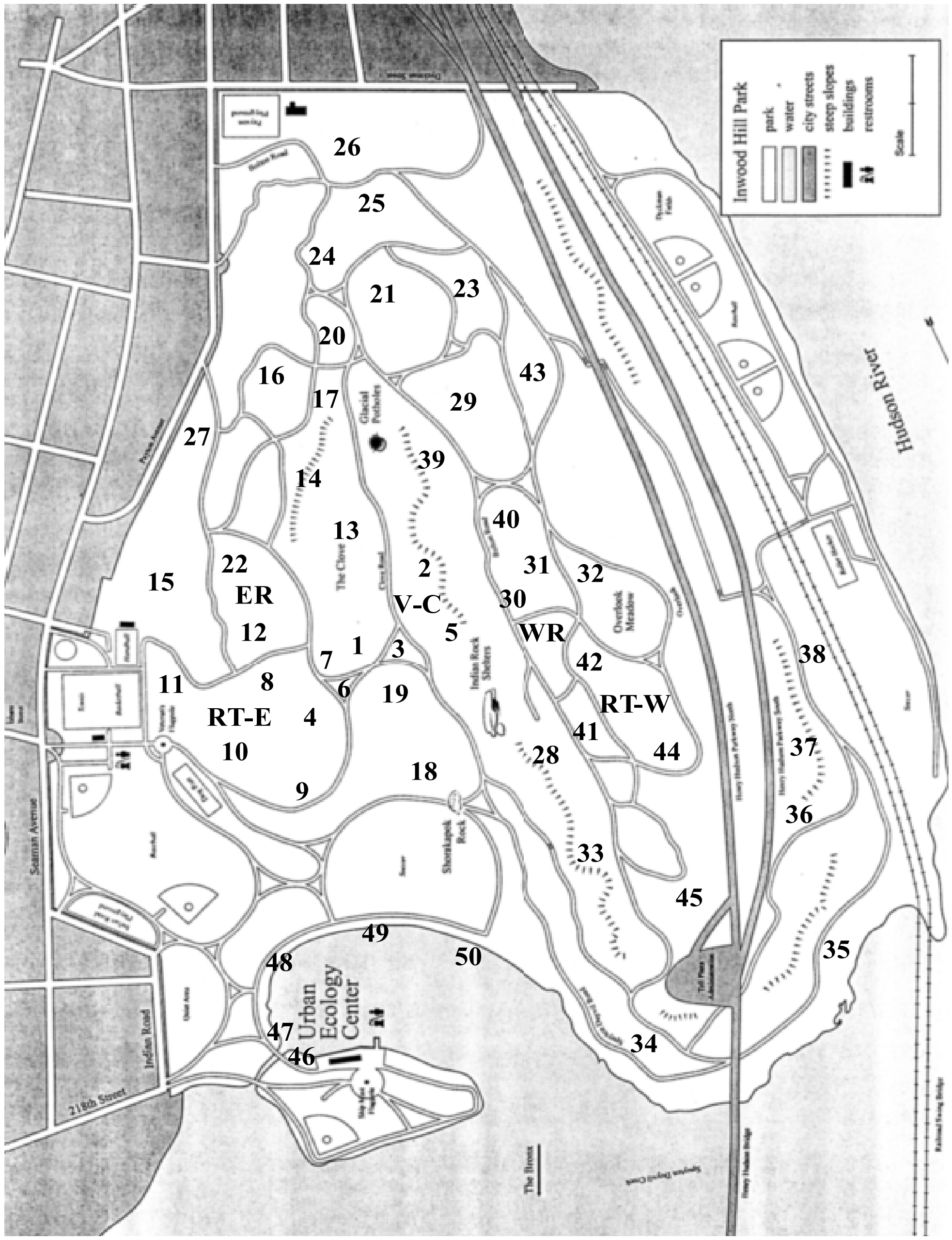


Figure 2.1 Map of Inwood Hill Park showing four geographic locations: Valley-Clove (V-C) quadrats 1, 2, 3, 5, 6, 13, 14, 17, 18, 19; East Ridge and slopes (ER) quadrats 4, 8, 9, 11, 12, 16, 22, 27; Ridge Tops (east and west) quadrats: (RT-E) 10, 15, 20; (RT-W) 21, 32, 42, 44, 45; West Ridge and Slopes (WR) quadrats 23, 24, 25, 26, 28, 29, 30, 31, 33, 34, 35, 36, 37, 38, 39, 40, 41, 43.

In 1986, Inwood Hill Park was the recipient of a grant from the Lila-Wallace Reader's Digest Fund. In conjunction with the Urban Forest and Education Program (UFEP 1991) and the City Parks Foundation, Project Manager Anthony Emmerich, along with the DPR Natural Resources Group, assessed and inventoried the vegetation of Inwood Hill. All natural areas of the park were mapped and surveyed and the results recorded on entitation sheets that were highlighted to include an evaluation of the park's land-use and vegetation history. Over 3,000 native trees and shrubs were planted and mitigation efforts were started to restore parts of the forest that had been burned through vandalism (UFEP 1994). NRG and UFEP provided me with these entitation sheets which I used to set up the quadrats where no recent planting had occurred.

During this period (2000 - 2002), the New York City area had been in a protracted drought. The precipitation mean in the New York City region for 2000-2001 was 1200 mm (normal) and 1167 mm (actual). Precipitation departures show levels in the NYC area: since November 1, 2002, precipitation at 0.03%, and departure –0.71%; (October 1) 7.93% precipitation, and departure + 3.15%; (January 1) 36.90 precipitation, and departure -0.16%; (November 1, 2001) precipitation 40.52%, and departure -4.10% (National Climactic Center) (Figure 2.2).

Edaphic Conditions

The distribution and rate of growth of forest stands are influenced by a great many soil characteristics comprised of chemical, physical, and biological factors that include bound nutrients (Forbes 1955). Other factors are disturbance, fire, compaction of soils, and invasive species. The soils of Inwood Hill Park vary as a result of differing underlying geologic formations and glaciations as well as a long history of human

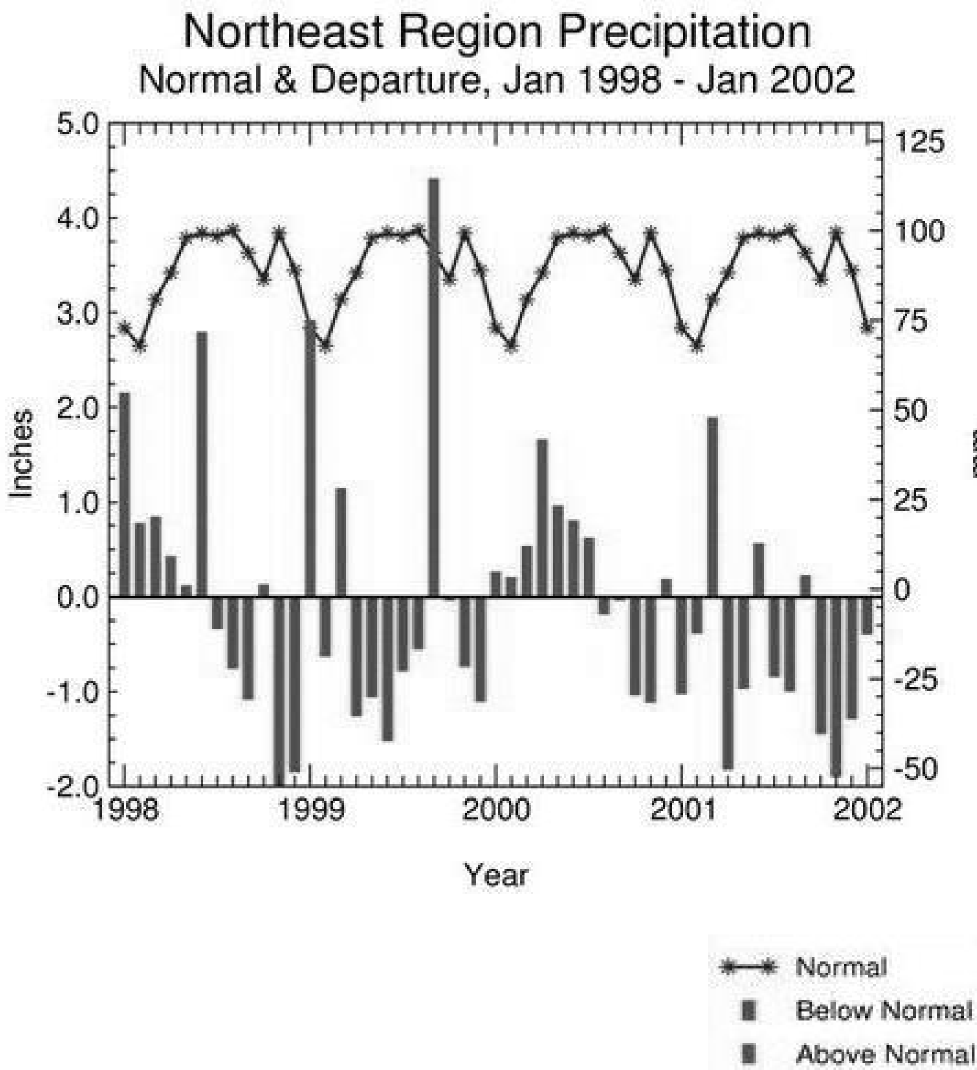


Figure 2.2 National Climactic Data Center. Climate 2002-January. Regional Drought Watch, 14 February 2002. Website: http://www.ncdc.noaa.gov/oa/climate/research/2002/jan/drought-regional-overview.html

occupation and disturbance (reviewed in Chapters 6, 7). Loeb (1986) assessed the soils of Inwood and noted that in the mature forests of the East Ridge, Ridge Top and Valley-Clove, soils are highly acidic having a pH range of 3.5 to 5.5. The West Ridge tops and west-facing slope have a near neutral pH. These findings are consistent and typical of urban forests in and near New York City. Calcium soil values, where the Park is underlain by Inwood marble, are not in excess of those in areas underlain by Manhattan schist, and have far lower values than those found on limestone stands in the region (Balter and Loeb 1983). Values for nitrates, P, and K indicated that Inwood Hill Park soils were depleted. High nitrate values on the East Ridge and slopes were due to intensive dog walking (as many owners allow their animals to roam freely through Inwood Park). Soil samples indicated that domesticated animal wastes may be enriching the N levels but accurate assessments of these relationships are difficult (Loeb 1986).

A nutrient analysis (Cornell Soils Testing Laboratory) was performed in January of 2002 (courtesy of Dr. Richard Stalter, St. John's University, Queens, New York City, NY). Results indicated soil values of the Valley-Clove area to have a pH of 6.1, very low levels of phosphorus (P) at 118, potassium (K) levels at 450, magnesium (Mg) levels at 3.75, and calcium levels at (Ca) 4610. Aluminum (Al) levels were at 49, iron (Fe) at 21, manganese (Mn) at 32, zinc (Zn) at 13.9, organic matter (%) 6.3, and nitrate (NO_3-N) at 158 (all ex. acidity ME/100g:10).

For the East Ridge, west-facing slope, soil values indicated a pH of 4.3, very low levels of phosphorus (P) at 3, potassium (K) at 195, magnesium (Mg) at 110, and calcium (Ca) at 340. Aluminum (Al) levels at 617, iron (Fe) at 597, manganese (Mn) at10, zinc (Zn) at 6.2, organic matter (%) 17.7, and nitrate (NO_3-N) at 16.

For Ridge top (east), the pH was 4.3, very low levels of phosphorus (P) at 13, potassium (P) at 335, magnesium (Mg) at 35, zinc (Zn) at 18.4, organic matter (%) 13.9, and nitrate ($NO3-N$) 14 (all ex. acidity ME/100g:10). No samples were taken of the West Ridge.With the exception of the West Ridge, these results are consistent with Loeb's findings (1986).

Methods and Materials

Forty-five rectangular, permanent quadrats measuring 10 X 10 m^2 were set up. Additionally, 45 2 X 2 m^2 quadrats nested within each of the larger quadrats were also set up for sampling the herb layer. The corners of each of the larger plots were set up with 3 ft. wooden stakes. One permanent stake was left, labeled with a metal, numbered tag, and buried below ground level. A colored tape was tied and placed next to it for later identification. The coordinates of the four corners of the quadrats were measured and points recorded using a Suunto compass. Elevations were also noted and taken from NYC DPR contour maps (New York City Department of Parks and Recreation 1968). The quadrats were further subdivided in 1 meter squares with finely wound, non-snag nylon string and marked with a colored, felt pen at 1 meter intervals. Sampling of taxa was performed in a north-south orientation along the marked intervals to reduce the accumulation of sampling error by marginal (edge) effects (Mueller-Dombois and Ellenberg 1974). A Vernier caliper was used to measure the DBH on small diameter stems, $\geq$2.0 cm to $\leq$ 3.0 cm, and a Forestry Suppliers' 10 meter (English) metric tape was used to measure larger diameter stems. Each taxon within the quadrats was identified to genus, species, and family. Nomenclature follows Gleason and Cronquist (1991).

Plot Sampling, Cut-Points, and Size Classes

The census began in late Fall 2001 and continued through Fall 2003 for the forested area of Inwood. The salt marsh quadrats were set up in the Spring of 2003 and continued through late Fall 2003**.** Much thought and consideration was given to the minimum woody stem diameter to be used. Stem diameter measurements are usually left to the discretion of the investigator, hence minimum measurements can vary. Campbell et al. (1986) and Ferreira and Prance (1998), used tree size classes of 5 cm ≤ and ≥ 10 cm DBH. Nadkarni et al. (1995) used DBH classes that included large (> 30 cm DBH), medium (10 - 30 cm DBH), and small (2 - 10 cm DBH). Loeb (1986) used tree size classes for large (> 20.0 cm DBH), saplings (2.5 -10 cm DBH), and seedlings (< 2.5 cm DBH) for Inwood Hill Park, and the same measurements in Van Cortlandt Park (1984). For studies of arborescent vegetation in Forest Park (Greller et al. 1979) and in Alley Pond Park (Stalter 1981), a measurement of ≥7.6 cm DBH was applied. In a more recent study of the arborescent vegetation in Forest Park, Glaeser (2004) used a cut-point of ≥2.00 cm DBH. Rudnicky and McDonnell (1989) used a diameter of ≥15 cm DBH for the woodland study at the New York Botanical Garden (NYBG), and Yost et al. (1991) applied three tree size classes: seedlings (< 1 m in height), saplings (≥1 m in height and DBH of < 5 cm), and trees (≥5 cm DBH) for a census of the natural area of Wave Hill in Riverdale. For this study, I measured all stems ≥ 2.0 cm at diameter breast height (1.37 m), regardless of tree, shrub, or vine characteristics.

Statistical Methods

Importance values (IV) for species and families were computed using programming supplied by Dwight Kincaid. The use of Species Importance Values (SIV) and Family Importance Values (FIV) to assess dominance hierarchy of taxa within the plant communities are common quantitative tools used by many ecologists (Mueller-Dombois and Ellenberg 1974; Greller et al.1974; Mori et al.1983; Campbell et al.1986; Yost et al. 1991; Ferreira and Prance 1998). Importance values are the summation of relative density + relative frequency + relative dominance x (100). By definition of the importance value method, the summation of importance values of all taxa within the 45

10 X 10 m^2 plots (and individually broken down into the four geographic locations) totaled 300.00 (Barbour et al.1987; Krebs 1989; Sokal and Rohlf 1995; Brower et al.1998; Smith and Smith 2000). Data was compiled and entered into Statview for Windows, Version 5.0 (SAS Institute 1992-1998), and graphs were constructed using Canvas Version 6.0 (Deneba Systems, subsidiary of ACD Systems of America, Inc. 2002).

III. Chapter 3. Results

Four thousand and seventy stems (4070) were identified that included trees, shrubs, and vines representing 51 genera and 77 species in 28 families within the 45 10 X 10 m^2 quadrats (Table 3.1). For the 45 10 X 10 m^2 quadrats overall, the mean number of species per quadrat was 1.71, and the mean number of stems was 90.4. For the four geographic locations starting with the Valley-Clove (n=790), the mean number of stems per 10 x 10 m^2 quadrat was 71.8; for the East Ridge (n=707), 88.3; for the Ridge Tops (east and west) (n=595), 74.3; for the West Ridge (n=1978), 109.8. (Tables 3.2, 3.3, 3.4, and 3.5 respectively).

The mean stem density for all trees, shrubs, and vines (n=635) measured at the cut-point of ≥ 2.0 cm DBH was 14.1 stems, and mean stem density at the cut-point of ≥10 cm DBH (n=3765) was 83.6 stems. The mean stem density per quadrat was calculated by dividing the number of stems (4070) by 45 quadrats, and individually calculated for each of the geographic locations listed above.

The frequency distribution and descriptive statistics of stem diameters (DBH) was determined for the entire dataset (Figure 3.1) and further broken down into four subsets of data for the Valley-Clove, East Ridge, Ridge Tops, and West Ridge forests (Figures 3.3, 3.5, 3.7, and 3.9 respectively). All Figures and Tables presented in this section are at the back of Chapter 3.

Stem Diameters

In stem diameters, the DBH ranged from 2.0 - 171.20 cm (mean 5.6 cm, SD 12.50) for the 45 plots overall (Figure 3.1). The largest taxa within a DBH range of 30.2 cm -171.2 cm (n=178) were the beeches and oaks (Fagaceae), followed by tulip tree

(Magnoliaceae). The Fagaceae comprised 4.8% of the sampled population in contrast to the Lauraceae, which comprised 21.1%. The largest tree was *Fagus sylvatica* (171.2 cm), a copper beech found on the West Ridge in quadrat #37, followed by *Quercus rubra* (122.6 cm), *Liriodendron tulipifera* (121.7 cm), *Quercus alba* (102.7 cm), *Aesculus hippocastanum* (93.8 cm), *Pinus nigra* (87.1 cm), *Quercus prinus* (78.0 cm), *Fraxinus americana* (75.4 cm), *Quercus velutina* (72.9 cm), *Robinia pseudoacacia* (71.5 cm), *Fagus grandifolia* (69.8 cm), *Acer saccharum* (67.8 cm), *Tilia americana* (67.7 cm.), one specimen of *Tsuga canadensis* (57.8 cm), and *Acer rubrum* (51.2 cm).

Within the DBH range of 2.0 - 12.0 cm (mean 2.7%, SD 1.2%), in the first interval bar, the smaller size stems (n=3776) represented 92.7% of the sampled population. All stems of shrub and vine species ranged within 2.00 - 4.90 cm DBH.

Among shrubs, *Lindera benzoin* (n=760) was the dominant taxon, representing 20.1% in this interval bar, followed by *Viburnum acerifolium* (n=618) (16.3%), *Lonicera maackii* (n=269) (7.1%), and *Viburnum dentatum* (n=190) (5.0%).

Next were *Rosa multiflora* (n=186), *Cornus foemina* spp. *racemosa* (n=111), *Hamamelis virginiana* (n=52), *Rubus occidentalis* (n=47), and *R. laciniatus* (n=44). Also represented, in fewer numbers, were *Rhus typhina* (n=30), *Forsythia suspensa x viridissima* (n=33), *Viburnum prunifolium* (n=28), *Rubus allegheniensis* (n=24), *Hibiscus syriacus* (n=22), *Cornus sericea* (n=21), *Rhodotypos scandens* (n=14), *Ligustrum vulgare* (n=13), *Philadelphus coronarius* (n=9), *Viburnum opulus* (n=7), *Aronia arbutifolia* (n=6), *Rhododendron periclymenoides* (n=6), *Rhus aromatica* (n=6), *Cornus amomum* (n=5), *Euonymus alatus* (n=5), *Vaccinium corymbosum* (n=4), and *Amelanchier canadensis* (n=3) in order of abundance.

Among vines, *Celastrus orbiculatus* (n=181) was the dominant taxon representing 4.7%, followed by *Toxicodendron radicans* (n=43) (1.1%), and *Ampelopsis brevipedunculata* (n=36) (0.1%). *Vitis* was represented by *V. riparia* (n=17) (0.45%), *V. labrusca* (n=14) (0.37%), and *V. aestivalis* (n=5) (0.13%), followed by *Wisteria sinensis* (n=5) (0.13%) in order of abundance.

Among trees in the same interval bar, *Prunus serotina* (n=277) was dominant taxon representing 7.3%, followed by *Sassafras albidum* (n=96) (2.5%), *Fraxinus americana* (n=94) (2.4%), *Carya cordiformis* (n=86) (2.3%), *Acer rubrum* (n=83) (2.1%) and *A. saccharum* (n=48) (1.2%), *Ailanthus altissima* (n=46) (1.2%), and *Betula lenta* (n=41) (1.0%). Also represented, in fewer numbers, were *Gymnocladus dioica* (n=26), *Celtis occidentalis* (n=23), *Pinus strobus* (n=15), *Quercus rubra* (n=14), *Morus alba* (n=13), *Fagus grandifolia* (n=12), *Carya tomentosa* (n=11), *Cornus florida* (n=9), *Liriodendron tulipifera* (n=8), *Robinia pseudoacacia* (n=8), *Aesculus hippocastanum* (n=7), *Acer pseudoplatanus* (n=6) and *A. platanoides* (n=5), *Pyrus baccata* (n=5), *Quercus alba* (n=5), *Catalpa bignonioides* (n=4), *Quercus prinus* (n=3), *Tilia americana* (n=3), *Quercus velutina* (n=2), *Carya ovata* (n=2), *Phellodendron amurense* (n=2), *Prunus avium* (n=2), and *Pyrus malus* (n=2) in order of abundance. The remaining stems (n=4) were all singletons: *Cercis canadensis*, *Crataegus* spp., *Fagus sylvatica*, and *Pyrus communis.*

Valley-Clove Stem Diameters

The Valley-Clove forest (n=790) had 29 species in 19 families. Quadrat #7 had the greatest density with 102 stems (Figure 3.2 View of the Valley-Clove portion of the park). The dominant family was Lauraceae (72.6%) represented largely by *Lindera*

Figure 3.2 View of the Valley-Clove forest in the Fall of 2002 from the top of the East Ridge and facing northwest. The Valley-Clove canopy is dominated by mature species of *Liriodendron tulipifera* and *Quercus rubra*. Note the dense understory dominated by the shrub, *Lindera benzoin*. The background shows the east-facing slope of the West Ridge.

benzoin. Stem diameters ranged from to 2.00 – 126.6 cm DBH (mean 6.22 cm, SD 15.86) for the 11 plots (Figure 3.3).

The first interval bar within the DBH range of 2.0 cm - 12 cm (mean 2.7 cm, SD 0.83), the smaller size stems (n=743), represented 94.1% of the sampled population. Among shrubs, *Lindera benzoin* (n=572) was the dominant species represented by 76.9% of the sampled population, followed by *Rosa multiflora* (n=40) (5.3%), *Viburnum dentatum* (n=24) (3.2%) and *V. acerifolium* (n=12) (1.6%). Next were *Hamamelis virginiana* (n=10) (1.3%), *Viburnum prunifolium* (n=10) (1.3%) and *V. opulus* (n=7) (0.9%) in order of abundance.

Among tree stems in this same interval bar, *Acer rubrum* (n=13) was dominant, representing 1.7% of the population. Next were *Celtis occidentalis* (n=11) (1.4%), *Carya cordiformis* (n=8) (1.1%), *Acer saccharum* (n=6) (.8%), *Fraxinus americana* (n=5) (0.6%), and *Prunus serotina* (n=4) (0.5%). *Tilia americana* (n=3), *Morus alba* (n=3), *Carya ovata* (n=2), and *Sassafras albidum* (n=2) had negligible percents. A number of singletons (n=6) were represented by *Ailanthus altissima*, *Crataegus* spp., *Cercis canadensis*, *Cornus florida*, *Liriodendron tulipifera*, and *Quercus rubra*. Vines were negligible with *Celastrus orbiculatus* (n=4) and *Vitis labrusca* (n=2).

The second interval bar (12.0 - 22.0 cm DBH) drops considerably and represents 0.6% of the sampled stems (n=5) that are all singletons: *Acer saccharum*, *Carya cordiformis*, *Celtis occidentalis*, *Tilia americana*, and *Quercus rubra.*

The third interval bar (22.0 - 32.0 cm DBH) had only 7 stems and represents 0.1% of the sampled taxa. These were represented by *Liriodendron tulipifera* (n=3), and four singletons: *Carya cordiformis*, *C. ovata*, *Morus alba*, and *Quercus rubra*. The 7 stems would have been designated as mid-size class trees, but there were not enough of them to be statistically relevant.

Within the DBH range of 30.0 cm - 122.6 cm (mean 68.3 cm, SD 29.1) (n=40) of the bar interval, the largest taxa were the oak and tulip trees. *Quercus rubra* (n=7) represented 17.5% of the sampled population, the largest (122.6 cm) found in quadrat #17, followed by *Liriodendron tulipifera* (n=19) representing 47.5% of the sampled taxa, the largest (121.7 cm) found in quadrat #5. Following were *Fraxinus americana* (n=2) (5.0%), the largest (75.4 cm) in quadrat #19; *Tilia americana* (n=1) (5.0%), the largest singleton (67.70 cm) in quadrat #14; an invasive tree, *Paulownia tomentosa* (n=1) (61.9 cm) (2.5%) was found in quadrat #19. One very mature (in senescence) *Betula lenta* (58.6 cm) (2.5%) was found in quadrat #6, and one *Ulmus americana* (58.5 cm) (2.5%) in quadrat #1. Others included *Acer saccharum* (n=2) (5.0%) the largest (52.60 cm) in quadrat #18 on a small hill underlain by Inwood marble. The soils here are calcareous due to extensive oyster shell remains from the time the Rechgawawane (Manhattan Indians) and later settlers occupied the site. Others of lesser diameters were *Carya cordiformis* (n=2) (5.0%), the largest (36.70 cm) also in quadrat #18, *Carya ovata* (n=1) (2.5%) (31.20 cm) in quadrat #2, and the largest black cherry, *Prunus serotina* (n=1) (2.5%) (33.00 cm) in quadrat #17 at the top of the Clove.

East Ridge Stem Diameters

The East Ridge and slopes forest (n=707) had 33 species in 20 families (Figure 3.4 View of the East Ridge (west-facing slope) depicts an abundant understory dominated by *Viburnum acerifolium*). Quadrat #16 had the greatest density with 125 stems. The dominant family was Adoxaceae (53.1%) represented by two species of *Viburnum,*

Figure 3.4 View of the East Ridge (west-facing slope) depicting an abundant understory dominated by the shrub, *Viburnum acerifolium,* blooming in quadrat #12. *Dennstaedtia punctiloba* and *Thelypteris noveboracensis* are depicted in the foreground. Spring, 2003.

V. acerifolium, and *V. dentatum*. Stem diameters ranged from 2.0 ~ 87.7 cm DBH, (mean 5.33%, SD 11.66%) for 8 plots (Figure 3.5).

In the first interval bar within the DBH range of 2.0 - 12 cm (mean 2.7 cm, SD 1.3), small stems (n=661) represented 93.5% of the sampled population. Among shrubs, *Viburnum acerifolium* (n=368) was the dominant species representing 52.1% of the sampled population, followed by *Rosa multiflora* (n=46) (6.5%), *Hamamelis virginiana* (n=29) (4.1%), and *Lindera benzoin* (n=29) (4.1%). *Rosa multiflora* is highly invasive and prevalent throughout the southwestern portion of the Park. In the East Ridge forest, it was found in quadrats #16 and 27. Another invasive, *Lonicera maackii* (n=9) (1.2%), also was found in quadrat #27. Of note, *Vaccinium corymbosum* (n=4), a native species thought to have been extirpated by Graves (1930), was found in quadrat #8.

Among trees in the same interval bar, *Acer rubrum* (n=46) was the dominant, representing 6.6% of the population, followed by *Prunus serotina* (n=31) (4.3%), *Sassafras albidum* (n=15) (2.4%), *Acer saccharum* (n=9) (1.4%), and *Betula lenta* (n=9) (1.2%). Next, in fewer numbers, were *Fraxinus americana* (n=5), *Morus alba* (n=5), *Cornus florida* (n=4), *Fagus grandifolia* (n=4), *Ailanthus altissima* (n=3), *Carya tomentosa* (n=2), and *Catalpa bignonioides* (n=2). The rest of the species consisted of singletons (n=1) represented by *Acer platanoides*, *Celtis occidentalis*, *Liriodendron tulipifera*, *Quercus alba*, *Q. rubra*, and *Q. prinus* in order of abundance.

Vines were represented by two invasive species, *Celastrus orbiculatus* (n=8) (1.1%) and *Ampelopsis brevipedunculata* (n=6) (0.8%), both in quadrat #27. A native species, *Vitis labrusca* (n=8) (1.1%), was found in quadrats #8 and also #27.

The second interval bar (12.0 - 22.0 cm DBH) drops considerably and represents

1.8% of the sampled stems (n=13), comprised of *Ailanthus altissima* (n=6) followed by *Cornus florida* (n=2), and *Quercus alba* (n=2). The remaining stems are all singletons: *Acer platanoides*, *A. rubrum*, and *Celtis occidentalis*.

The third interval bar (22.0 - 32.0 cm DBH) drops lower than the second interval bar with just 7 stems representing 0.9% of the sampled taxa. These were represented by *Quercus rubra* (n=4), *Q. alba* (n=1), *Q. prinus* (n=1), and *Sassafras albidum* (n=1). Within the DBH range of 30.0 - 88.0 cm bar interval (n=29), the largest taxa were the oaks represented by *Quercus rubra* (87.7 cm) in quadrat #12, followed by *Q. prinus* (78.0 cm), *Q. alba* (69.7 cm), *Q. velutina* (42.8 cm), and *Q. coccinea* (36.7 cm). One very mature *Pinus nigra* (87.1 cm) was found in quadrat #27 on the east-facing slope. Two species of fern were present on the East Ridge, especially near quadrat #12, *Dennstaedtia punctilobula,* and *Thelypteris noveboracensis*.

Ridge Tops Stem Diameters

The Ridge Tops (east and west) forests (n=595) had 40 species in 21 families (Figure 3.6 View of Ridge Top east). Quadrat #20 had the greatest density with 133 stems. The dominant family was Adoxaceae (19.4%) closely followed by Rosaceae (19.3%). Stem diameters ranged from 2.0 - 100.2 cm DBH (mean 6.53 cm, SD 13.12) for 8 plots (Figure 3.7).

In the first interval bar within the DBH range of 2.0 - 12 cm (mean 2.7 cm, SD 1.1), small stems (n=532) represented 89.4% of the sampled population. Among shrubs, *Viburnum acerifolium* (n=70) was dominant, representing 13.1% of the population. Following were *V. dentatum* (n=46) (8.6%), *Lonicera maackii* (n=33) (0.5%), *Rosa multiflora (n=19) (3.5%), Philadelphus coronarius (n=9) (1.6%), and Rubus*

Figure 3.6 View of the Ridge Top (east) forest (facing northwest), depicts *Acer rubrum*, and five species of oak, *Quercus alba*, *Q. coccinea*, *Q. prinus*, *Q. rubra*, and *Q. velutina* in the background. In the foreground, glacial erratics of diabase from the Palisades (on the New Jersey side of the Hudson River). The grasses *Schizachyrium scoparium* and *Danthonia spicata*, are mixed in with the haircap and rock mosses, *Polystichum* spp. and *Dicranum* spp. near quadrat #10, Fall, 2002.

occidentalis (n=9) (1.6%). Two species of *Rhus* (Anacardiaceae) were found and counted as shrubs: *R. typhina* (n=10) (1.8%) and *R. aromatica* (n=6) (1.1%), followed by *Euonymus alatus* (n=5) (0.9%), and *Amelanchier canadensis* (n=3) (0.5%).

Among trees, *Prunus serotina* was dominant (14.0%) with many small stems (n=75) in this interval bar. Next were *Fraxinus americana* (n=43) (8.0%), *Sassafras albidum* (n=40) (7.5%), *Carya cordiformis* (n=37) (6.9%), *Betula lenta* (n=13) (2.4%), *Acer saccharum* (n=10) (1.8%), *Ailanthus altissima* (n=4) (0.7%), *Carya tomentosa* (n=4) (0.7%), *Morus alba* (n=3) (0.5%), *Catalpa bignonioides* (n=2) (0.3%), *Celtis occidentalis* (n=2) (0.3%), *Pyrus baccata* (n=2) (0.3%), *P. malus* (n=2) (0.3%), and *Quercus prinus* (n=2) (0.3%) in order of abundance. *Cornus florida* (n=1) and *Acer rubrum* (n=1) were both singletons.

Vines were represented by *Celastrus orbiculatus* (n=63), comprising 11.8% of the sampled taxa, followed by *Toxicodendron radicans* (n=10) (1.8%), *Wisteria sinensis* (n=4) (0.7%), and *Ampelopsis brevipedunculata* (n=4) (0.7%).

The second interval bar (12 .0 - 22.0 cm DBH) drops considerably and has only 11 stems representing 1.8% of the sampled taxa. It was largely represented by *Prunus serotina* (n=4), followed by *Quercus rubra* (n=2). The rest of the tree species were singletons (n=1) represented by *Aesculus hippocastanum*, *Betula lenta*, *Carya cordiformis*, *Fraxinus americana*, and *Liriodendron tulipifera*.

West Ridge Stem Diameters

The West Ridge and slopes forest (n=1978) had 62 species in 26 families (Figure 3.8 View of the West Ridge). Quadrat #43 had the greatest density with 186 stems in the sampled population. The dominant family was Rosaceae (19.1%) largely represented by

Figure 3.8 View of the West Ridge east-facing slope, at the northernmost portion of the Park, depicting a mature oak forest of mixed hardwoods with species of *Acer rubrum*, *Betula lenta*, *Carya cordiformis*, *Fraxinus americana*, *Liriodendron tulipifera*, *Prunus serotina*, *Quercus rubra*, and *Q. velutina*. *Viburnum acerifolium* forms the understory. Note the abundant rock outcroppings of schist in the background. Late Spring, 2002.

Prunus serotina (n=169) and *Rosa multiflora* (n=81), followed by Adoxaceae (15.1%) represented by *Viburnum acerifolium*, *V. dentatum*, and *V. prunifolium*. Stem diameters ranged from 2.0 - 171.20 cm DBH (mean 5.22 cm, SD 10.98) for 18 plots (Figure 3.9).

In the first interval bar within the DBH range of 2.0 - 12 cm (mean 2.7 cm, SD 1.11), small stems (n=1840) were represented by 93.2% of the sampled population. Among shrubs, *Lonicera maackii* (n=227) was dominant, representing 12.3% of the sampled population, and found in 10 out of 18 quadrats. *Lonicera maackii* has the highest rate of invasion on the West Ridge. Next were natives *Viburnum acerifolium* (n=168) (9.1%), *V. dentatum* (n=113) (6.1%), *V. prunifolium* (n=18) (0.9%), and *Lindera benzoin* (n=159) (8.6%). *Cornus* was represented by 3 species, *C. foemina* (n=111) (6.0%), found in quadrat # 39, *C. sericea* (n=21) (1.1%) and *C. amomum* (n=5) (0.2%), both found in quadrat #38 in a small floodplain bounded by the Hudson River.

Other natives included *Hamamelis virginiana* (n=13) (0.7%), *Aronia arbutifolia* (n=6) (0.3%) in quadrat #35, and *Rubus*, represented by native *R. allegheniensis* (n=21) (1.1%), and two non-natives, *R. laciniatus* (n=44) (2.3%) found only in quadrat #31, and *R. occidentalis* (n=38) (2.0%).

Notable, was one species of *Rhododendron periclymenoides* (n=6) (0.3%), found in quadrat #43 in the southwestern portion of the Park which mostly dominated by an invasive tree species, *Robinia pseudoacacia*.

Quadrat #26, at the most southern end of the Park, was almost entirely represented by nonnative, and invasive species of trees, shrubs, and vines with the exception of *Quercus rubra* (n=2), *Celtis occidentalis* (n=3), and *Vitis riparia* (n=9). Just in this one quadrat, shrubs were represented by *Hibiscus syriaca* (n=22), *Ligustrum vulgare* (n=11), *Lonicera* *maackii* (n=19), and *Rosa multiflora* (n=28). Among vines, *Celastrus orbiculatus* (n=23) and *Wisteria sinensis* (n=1); among trees, *Acer platanoides* (n=10), *Ailanthus altissima* (n=28), and *Robinia pseudoacacia* (n=3) were also present.

Among trees in the same interval bar, the dominant was *Prunus serotina* (n=166) (9.0%) followed by *Fraxinus americana* (n=41) (2.2%), *Carya cordiformis* (n=39) (2.1%), *Sassafras albidum* (n=38) (2.0%), *Ailanthus altissima* (n=37) (2.0%), and *Gymnocladus dioica* (n=26) (1.4%), found only in quadrat #25. *Acer* was represented by three species: *A. rubrum* (n=23) (1.2%), *A. saccharum* (n=23) (1.2%), and *A. pseudoplatanus* (n=6) (0.2%), followed by *Betula lenta* (n=19) (1.0%), and *Pinus strobus* (n=15) (0.8%). *Quercus* was represented by three species: *Q. rubra* (n=12) (0.6%), *Q alba* (n=4) (0.2%), and *Q. velutina* (n=4) (0.1%). Others included *Celtis occidentalis* (n=9) (0.4%), *Fagus grandifolia* (n= 8) (.04%), *Robinia pseudoacacia* (n=7) (0.4%), *Aesculus hippocastanum* (n=7) (0.3%), *Liriodendron tulipifera* (n=6) (0.3%), *Cornus florida* (n=4) (0.2%), *Morus alba* (n=3) (0.1%), *Phellodendron amurense* (n=2) (0.1%) found in quadrat #36, *Prunus avium* (n=2) (0.1%), *Pyrus baccata* (n=3) (0.1%), and *P. communis* (n=1) (0.1%) in order of abundance.

Among vines were *Celastrus orbiculatus* (n=106) (5.7%), *Toxicodendron radicans* (n=33) (1.7%), and *Ampelopsis brevipedunculata* (n=26) (1.4%). *Vitis* was represented by *V. riparia* (n=17) (0.9%), *V. aestivalis* (n=5) (0.2%), and *V. labrusca* (n=4) (0.2%), along with *Wisteria sinensis* (n=1) (0.05%) in order of abundance.

The second interval bar (12.0 - 22.0 cm DBH) drops considerably in contrast to the first interval bar, with 24 stems representing 1.2% of the sampled taxa. Representing the tree species were *Robinia pseudoacacia* (n=8), *Celtis occidentalis* (n=3), *Liriodendron tulipifera* (n=2), *Prunus serotina* (n=2), and *Quercus velutina* (n=2) in order of abundance. The remaining stems (n=17) were all singletons: *Carya cordiformis*, *C. tomentosa*, *Gymnocladus dioica*, *Morus alba*, *Phellodendron amurense*, *Quercus alba* and *Q. rubra*.

The third interval bar (22.0 - 32.0 cm DBH) is slightly higher than the second interval, with 41 stems representing 2.1% of the sampled population. Among trees in this interval were *Quercus rubra* (n=15), *Robinia pseudoacacia* (n=10), *Sassafras albidum* (n=4), *Carya cordiformis* (n=2), and *Quercus velutina* (n=2) in order of abundance. The remaining 8 stems were all singletons: *Betula lenta*, *Carya tomentosa*, *Gleditsia triacanthos*, *Gymnocladus dioica*, *Prunus serotina*, *Quercus coccinea*, *Q. prinus*, and *Ulmus americana*.

Within a DBH range of 30 - 171.20 cm bar interval (n=77), the largest taxon was *Fagus sylvatica* (171.2 cm). The next largest taxa were *Quercus alba* (102.7 cm) in quadrat #24, followed by *Q. rubra* (99.8 cm) in quadrat #36, followed by *Aesculus hippocastanum* (93.8 cm) in quadrat #29, *Liriodendron tulipifera* (83.7 cm) in quadrat #38, *Robinia pseudoacacia* (71.5 cm) in quadrat #29, *Fagus grandifolia* (69.8 cm) in quadrat #23, *Quercus velutina* (66.6 cm) in quadrat #31, *Pinus nigra* (62.50 cm) in quadrat #36, *Tsuga canadensis* (57.8 cm) in quadrat #23, and *Quercus prinus* (43.8 cm) in quadrat #34.

Like the other geographic locations, the West Ridge has suffered numerous fires as evidenced by the blackened trunks of larger trees, and gaps in the canopy created by tree-falls. These areas have many young seedlings and saplings of *Prunus serotina* regenerating, especially quadrats #28 (n=18), 31 (n=14), 34 (n=19), 36 (n=25), 38 (n=11), 41 (n=31), and 43 (n=12). *Prunus serotina* was found in 16 out of 18 quadrats of the sampled taxa.

There is a preponderance of *Prunus serotina* (n=21) in quadrat #45 (listed under Ridge Tops (west) Table 3.3) and *Sassafras albidum* (n=3) is establishing itself with many poles under < 2.0 cm DBH. *Quercus rubra* (n=12) and Q. *velutina* (n=2) are the only dominant canopy trees here along with *Carya cordiformis* (n=4) and *C. tomentosa* (n=3). The shrub layer is dominated by *Viburnum acerifolium* (n=64). Loeb (1986) defined this community as the north-facing forest and also noted the abundant reproduction of *Prunus serotina* among others.

At the most northerly end of the West Ridge slopes (north-facing and west-facing sides), native species such as *Kalmia latifolia* are growing and expanding their niche on the west-facing slope just past the shadow of the Henry Hudson Bridge (Figure 2.1 Map). This area has a mature, secondary growth forest with many large oak and tulip trees. Also present are hickory, sweet birch, black cherry, white ash, and red maple trees. In quadrat #34, east-facing slope, just before the bridge, three specimens of *Cornus florida* were found and seem to be thriving.

On the higher slopes there are a number of ferns and mosses such as *Dennstaedtia punctiloba*, *Thelypteris noveboracensis*, *Osmunda cinnamomea*, *Onoclea sensibilis*, and *Polystichum acrosticoides*; one specimen of Ebony-spleenwort (*Asplenium platyneuron*), and the mosses, *Dicranum* spp. (rock cap moss), *Leucobryum* spp. (white pin cushion moss), and *Polystichum* spp. (haircap moss).

Basal Area

The basal area (BA, cm) is the sum of the stem cross-sectional area at DBH (cm) for all taxa. Relative dominance is a taxonomic ranking extrapolated from the basal area of a species, relative to the total basal area of all taxa. The basal area (cm^2) was converted to meters (m^2).

Within the 45 10 X 10 m^2 quadrats, the total basal area for all woody taxa was 60.1 m^2 (600771 cm^2). For the Valley-Clove (11 quadrats), the BA was 17.9 m^2 (179882 cm^2); for the East Ridge (8 quadrats), the BA was 9.11 m^2 (91190.8 cm^2); for the Ridge Tops (east and west), the BA was 10.0 m^2 (100190.0 cm^2); for the West Ridge, the BA was 22.9 m^2 (229568.0 cm^2).

Among all woody species the taxon with the greatest basal area was *Quercus rubra*, BA = 23.09 m^2 (230973.00 cm^2), with a relative dominance of 38% and a 78% representation in the 45 10 X 10 m^2 quadrats. Following is *Liriodendron tulipifera,* BA = 12.97 m^2 (129787.00 cm^2), with a relative dominance of 21.6%. By contrast, *Quercus velutina* had a basal area of 2.71 m^2 (27163.10 cm^2) with a relative dominance of 4.52%, followed by *Quercus prinus* (BA = 2.56 m^2) (25673.50 cm^2) with a relative dominance of 4.27%, less than *Q. rubra, and Q. velutina*, and with just 13% quadrat representation.

Species Importance Values (IV)

Three quantitative parameters were obtained from this study – density, frequency, and basal area. Importance values (with a total value of 300.00) are a summation of relative density (%), relative frequency (%), and relative dominance (%) (Mueller-Dombois and Ellenberg 1974). Importance values were calculated for all 77 woody species and 28 families in the 45 10 X 10 m^2 quadrats (Table 3.6). The species were arranged in a dominance hierarchy from high to low importance. Importance values carry a measureable weight for describing the contribution by individual taxa to the plant community. Basic descriptive statistics, such as number of trees (abundance), percentage of representation in quadrats and basal area are given in Table 3.7. Four subsets of data for the Valley-Clove, East Ridge, Ridge Tops, and West Ridge are discussed later in the Chapter.

A comparison was made between the individual tree species, the ecological rank held by each species, and observations of their frequency, density, basal area (BA), and mean DBH. Shrub stems and also vines, were considered apart from tree species, with comparisons made between ecological dominance, frequency, and density.

Among all woody taxa, *Quercus rubra* (n=121) with a mean DBH of 42.09 cm ranked first as the species with the highest dominance value (IV = 48.70%). *Quercus rubra* was represented in 35 out of 45 sampled quadrats (78%) (Table 3.6). Among trees only, *Quercus rubra* had an IV of 60.13% with a summed basal area of 23.09 m^2 (Table 3.7). At 7.28%, it had the highest relative frequency but was second in relative density (2.97%) to *Prunus serotina.*

Prunus serotina (n=286) ranked fifth in ecological dominance with an IV of 15.1% out of all woody taxa. It had the highest relative density (7.03%) but was second in relative frequency (7.07%) after *Quercus rubra*. Among trees only, *Prunus serotina* ranked second in ecological dominance (IV = 34.7%) with a mean DBH of 3.94 cm and a summed basal area of 6.36 m^2. *Prunus serotina* was represented in 34 out of 45 quadrats (76%). *Fraxinus americana* (n=101) ranked seventh in ecological dominance with an IV of 9.24% out of all woody taxa. At 2.48%, it ranked second in relative density and relative frequency (4.78%) after *Prunus serotina*. Among trees only, *Fraxinus americana* ranked fourth in dominance (IV = 17.4%) with a mean DBH of 5.62 cm and a summed basal area of 1.18 m^2. *Fraxinus americana* was represented in 25 out of 45 quadrats (51%).

Carya cordiformis (n=97) ranked eighth in ecological dominance (IV = 8.50%) out of all woody taxa. At 2.38%, it ranked third in relative density and had about the same relative frequency (4.78%) as *Fraxinus americana*. Among trees only, *Carya cordiformis* ranked fifth in dominance (IV = 16.44%) with mean DBH of 6.04 cm and a summed basal area of 0.80 m^2. *Carya cordiformis* was represented in 24 out of 45 quadrats (51%), the same representation for *Fraxinus americana*.

Next was *Sassafras albidum* (n=101), sharing the same relative density (2.48%) with *Fraxinus americana* but its relative frequency (3.95%) was less than *Carya cordiformis* and *Fraxinus americana. Sassafras albidum* ranked eleventh in ecological dominance (IV = 7.06%) out of all woody taxa. Among trees only, *Sassafras albidum* ranked sixth in dominance (IV = 14.76%) with a mean DBH of 4.04 cm and a summed basal area of 0.38 m^2 and was represented in 20 out of 45 quadrats (42%).

Liriodendron tulipifera (n=34) ranked second in ecological dominance after *Quercus rubra* among all woody taxa with an IV of 25.5%. However, it ranked sixth in relative frequency (3.12%) among just tree species after *Sassafras albidum* (3.95%), and had only a relative density of 0.84%, well below that of *Quercus rubra*, *Prunus serotina*, *Carya cordiformis*, and *Fraxinus americana*. *Liriodendron tulipifera* was represented in 15 out of 45 sampled quadrats (33%), having the greatest number in the Valley-Clove forest. In the trees only category, *Liriodendron tulipifera* ranked third in ecological dominance (IV = 29.5%) with a summed basal area of 12.97 m^2 after *Quercus rubra*, and a mean DBH of 57.1 cm. Interestingly, *Liriodendron tulipifera* is second in ecological dominance only to *Quercus rubra* based on basal area, but density and frequency are well below less dominant tree species mentioned above.

Quercus velutina ranked twelfth in ecological dominance with an IV of 7.06% with a relative density of 0.47% and relative frequency of 2.08%, much lower than *Liriodendron tulipifera* among all woody taxa. Among trees only, *Quercus velutina* ranked ninth in dominance (IV = 9.33%) with a summed basal area of 2.71 m^2 and a mean DBH of 38.16 cm.

In the shrub category, *Lindera benzoin* (n=760) had a mean DBH of 2.65 cm and ranked third in ecological dominance with an IV of 23.7% among all woody taxa. At 18.67%, it had the highest stem density and relative frequency (4.37%). *Lindera benzoin* was represented in 21 out of 45 quadrats (4.7%). The second taxon having the next highest density was *Viburnum acerifolium* (n=618) (15.18%), ranking fourth in ecological dominance (IV = 19.07%) with relative frequency of 3.53%, a little less than *Lindera benzoin*. *Viburnum acerifolium* had a mean DBH of 2.11 cm, slightly less than *Lindera benzoin*. It was represented in 17 out of 45 quadrats (3.8%).

Lonicera maackii ranked sixth in ecological dominance (IV = 9.78%) with a relative density of 6.61% and frequency of 2.91%. *Lonicera maacki* had a mean DBH of 2.72 cm and was represented in 14 out of 45 quadrats (3.1%). *Rosa multiflora* (n=186) ranked tenth in dominance (IV = 7.79%) with a relative density of 4.57% and frequency of 3.12%, higher than the frequency of *Lonicera maackii* but lower in density. *Rosa multiflora* had a mean DBH of 2.08 cm and was represented in 15 out of 45 quadrats

(3.3%).

In the vine category, the non-native, invasive *Celastrus orbiculatus* (n=181) ranked ninth in ecological dominance (IV = 7.87%) out of all woody taxa with a relative density of 4.45% and frequency of 3.33%. It was the only vine within the twelve top taxa category which includes trees and shrub stems. In comparison, the native *Toxicodendron radicans* (n=43) ranked twentieth in dominance (IV = 4.21%) with frequency of 3.12% and density of 1.06%. In frequency, *Toxicodendron radicans* is closer to *Celastrus orbiculatus*, but not in density.

Frequency Distribution of Diameters for the Twelve Top Taxa

The variability in frequency distribution and descriptive statistics of diameters in the 45 m^2 quadrats was also determined for the 12 top taxa. The first 3 taxa, *Quercus rubra*, *Q. velutina*, and *Prunus serotina* are presented in Figure 3.10, followed by *Carya cordiformis*, *Fraxinus americana*, and *Liriodendron tulipifera* (Figure 3.11), *Lindera benzoin, Viburnum acerifolium* and *Sassafras albidum* (Figure 3.12), and lastly, *Celastrus orbiculatus, Lonicera maackii, and Rosa multiflora* (Figure 3.13). Table 3.8 represents the ecological dominance ranking and species importance values (IV) for these twelve top taxa.

Quercus rubra (n=121) had a mean DBH of 42.09 cm and a range of 2.30 - 122.60 cm. Its mean stem density per quadrat was 2.68%. Within a DBH range of 2.0 - 7.0 cm, the first interval bar, *Quercus rubra* (n=13) represents 10.7%. The distribution climbs in the fifth interval bar (22.0 - 27.0 cm DBH range) (n=11) representing 9.09%. In the sixth interval bar (27.0 - 32.0 cm DBH range) (n=23), it reaches its highest peak representing 19.0% of the stems. *Quercus rubra* ranked first in ecological dominance and had an importance value of 48.6 % among all woody taxa. It also had the largest diameter (122.70 cm DBH) of all the oak species. *Quercus rubra* appeared in 6 out of 11 quadrats of the Valley-Clove (n=9); in the East Ridge (n=16), 7 out of 8 quadrats; Ridge Tops (east and west) (n= 30), in 8 out of 8 quadrats; and West Ridge (n=66), in 14 out of 18 quadrats. The Fagaceae is the only family to be represented by 5 species within Inwood Hill Park: *Quercus alba*, *Q. coccinea*, *Q. prinus*, *Q. rubra*, and *Q. velutina*. *Quercus rubra* is thriving and new stem growth is evidenced by the first, fifth, and sixth interval bars showing the frequency and distribution across nearly all quadrats.

In comparison, *Quercus velutina* (n=19) had a mean DBH of 38.16 cm and a range of 2.10 - 72.90 cm. Its mean stem density per quadrat was 0.42%. Within a DBH range of 2.0 - 4.0 cm, the first interval bar, *Quercus velutina* (n=2) represented 10.5% of the stems. It is absent within the range of 4.0 - 17.0 cm. It appears in the distribution again at the 18.0 - 20.0 cm range, the third interval bar (n=1), representing 5.2% of the stems. In the fifth interval bar, 30.0 - 32.0 cm DBH range, *Quercus velutina* (n=2) equals the first interval bar in frequency distribution at 10.5%, and again, in the 42.0 - 44.0 cm DBH (n=2). The largest diameter for Quercus velutina (n=1) was > 72.90 DBH sampled in quadrat #44 in the Ridge Top west forest.

The frequency distribution in Figure 3.10 shows the sparse population of *Quercus velutina* and little regeneration of new stems with most of the interval bars representing singletons and counts no higher than 2 within the DBH cm ranges. *Quercus velutina* is only represented in 10 out of 45 quadrats, and within the four geographic locations: Valley-Clove (n=0), East Ridge (n=2), Ridge Tops (n=4), and West Ridge (n=13).

Quercus velutina ranked twelfth in ecological dominance with an IV of 7.06% out of all woody taxa sampled.

Quercus velutina grows best on moist, rich, well-drained, silty clay to loam soils, and in all aspects and slope positions. Generally, it prefers the middle to lower slopes with northerly and easterly exposure, especially cove forests. It needs a moderate climate with average annual temperatures of 13 C (55 F), precipitation of 1020 to 1270 mm (40-50 in), and a frost-free season of about 180 days. In the area over which *Quercus velutina* grows, mean annual temperature ranges from about 7 C (45 F) in the north to 20 C (68 F) to north-central Florida (Brinkman 1965).

The most widespread soils on which *Quercus velutina* will grow are the Udalfs and Udolls – soils that are derived from glacial materials, sandstones, shales, and limestone (U.S. Department of Agriculture, Soil Conservation Service 1975). New York City, at the time this census was performed, had been in drought conditions for 2 or 3 years (Figure 2.2). Leaf abscission for most of the trees in Inwood started in late August, 2001 as a result of lack of moisture (and also extremes of heat), especially on the slopes of both ridges where *Quercus velutina* was found. The seedlings can survive drought conditions, but growth becomes slow or can cease altogether. However, *Quercus velutina* seedlings are more drought-tolerant than *Quercus rubra* seedlings and about the same as *Quercus alba* seedlings (Seidel 1972).

Quercus velutina is classed as intermediate in tolerance to shade but less tolerant than many of its associates, such as *Quercus alba* and *Q. prinus*, *Carya* spp., *Fagus* spp., *Acer* spp., and *Ulmus* spp. It is more tolerant than *Liriodendron tulipifera* and *Prunus serotina*, and about the same as *Quercus rubra* and *Q. coccinea*, with which it grows in close association (Brinkman 1965; Sander and Clark 1971; Sander 1972).

Prunus serotina (n=286) had a mean DBH of 3.94 cm and a range of 2.0 - 33.0 cm. Its mean stem density per quadrat was 6.35%. Within a DBH range of 2.0 - 4.0 cm, the first interval bar shows the greatest frequency and distribution of *Prunus serotina* (n=211), representing 73.7% of the sampled taxa. In the DBH range of 4.0 - 6.0 cm, the second interval bar drops considerably lower than the first, with *Prunus serotina* (n=51) representing 17.8%. In the third interval bar within a DBH range of 6.0 - 8.0 cm, *Prunus serotina* (n=12) represented 4.19% of the sampled population. The greatest abundance of stems is represented only in the first interval bar indicating a rapid growth rate and frequency distribution. *Prunus serotina* ranked fifth in ecological dominance with an IV of 15.15%, and appeared in 34 out of 45 quadrats of the sampled taxa, and within the four geographic locations: Valley-Clove (n=5), East Ridge (n=31), Ridge Tops (east and west) (n=81), and the West Ridge (n=169).

The next 3 taxa are shown in Figure 3.11 and represent the frequency distribution of *Carya cordiformis*, *Fraxinus americana*, and *Liriodendron tulipifera. Carya cordiformis* (n=97) had a mean DBH of 6.04 cm and a range of 2.0 - 41.30 cm. Its mean stem density per quadrat was 2.15%. Within a range of 2.0 - 4.0 cm DBH, the first interval bar shows the greatest distribution and frequency for *Carya cordiformis* (n=67) representing 69.07% of the sampled population. This species of hickory is more abundant than the other three species in the Park: *Carya glabra*, *C. ovata* and *C. tomentosa.* The largest diameter stem was 41.30 cm DBH sampled in quadrat #30 in the West Ridge (east-facing) forest. In the second interval bar, within a DBH range of 4.0 - 6.0 cm, the population of *Carya cordiformis* (n=14) represented 14.43%, and in the third interval bar (n=4), within 6.0 - 8.0 cm, only 4.12% were represented. The remaining interval bars contain only singletons with small percentages until the eighth interval bar, 24.0 - 26.0 cm DBH, where *Carya cordiformis* (n=3) represented 3.09%. The largest diameter stem for *Carya cordiformis* fell within a DBH range of 40.0 - 42.0 cm as noted above representing 1.03% of the population. *Carya cordiformis* was found in 11 out of 45 quadrats, and within the four geographic locations: Valley-Clove (n=11), East Ridge (n=2), Ridge Tops (n=38), with 11 stems in quadrat #21, and West Ridge (n=46). *Carya cordiformis* ranked eighth in ecological dominance with an IV of 8.50% within the 45 10 X 10 m^2 quadrats.

Carya cordiformis is a medium to large size native species, typically reaching a height of 60 - 80 ft. (18 - 24 m) (Fernald 1950; Godfrey 1988). *Carya cordiformis* is generally classified as intolerant of shade, preferring an open canopy. Top dieback and resprouting may occur frequently, with each successive shoot attaining a larger size and developing a stronger root system than its predecessor. It is by this process that hickory reproduction gradually accumulates and develops under moderate canopies, especially on sites dry enough to restrict reproduction of more tolerant, but more fire, or drought-sensitive species. *Carya cordiformis* saplings are damaged by fire, and older trees are also susceptible to fire damage due to the low insulating capacity of the hard bark (Clements 1936; Clebsch and Busing 1989; Smith 1990). The Ridge Tops have had many fires where Carya *cordiformis* seems most abundant. However, most of the rate of growth is between 2.0 - 6.0 cm DBH, which may be due to vegetative reproduction as a prolific root-and-stump sprouter. Most sprouts from sapling and pole-size trees are root crown sprouts (Rothenberger 1985).

Fraxinus americana (n=101) is far more abundant than *Carya cordiformis*. *Fraxinus americana* had a mean DBH of 5.62 cm and a range of 2.0 - 75.40 cm. Its mean stem density per quadrat was 2.24% Within the DBH range of 2.0 - 7.0 cm, the first interval bar shows the highest peak of relative frequency and distribution for *Fraxinus americana* (n=92) representing 91.09% of the sampled stems. The largest diameter stem was found in quadrat #19 in the Valley-Clove. In the second interval bar within a range of 7.0 -12.0 cm DBH, *Fraxinus americana* (n=2) represented just 1.98%. In the fifth interval bar, 22.0 - 27.0 cm range, there were 3 stems representing 2.97%. For the remaining intervals, all were singletons. *Fraxinus americana* appeared in 25 out of 45 quadrats, and within the four geographic locations: Valley-Clove (n=7), East Ridge (n=6). Ridge Tops (n=47), and West Ridge (n=41). *Fraxinus americana,* a native species, ranked seventh out of the twelve top taxa in ecological dominance with an IV of 9.24%.

Fraxinus americana has suffered from dieback, particularly on the West Ridge at the southern perimeter, and many trees are dead or dying. Most of the logs I encountered as tree falls were *Fraxinus americana*. It is never a dominant species in the forest. Ash dieback is especially prevalent in the northeastern part of its range and occurs from the Great Plains to the Atlantic Coast between 35 and 45 degrees north latitude (Sinclair et al.1988). The disease, ash yellows, caused by mycoplasma-like organisms (MLO) has been found associated with most of the dying trees where ash decline is conspicuous (Matteoni and Sinclair 1985). However, since not all dying trees are infected with MLO, ash decline is thought to result from multiple causes. Drought-weakened trees may be invaded by canker-causing, branch-girdling fungi such as *Fusicoccum* spp. and *Cytophoma pruninosa*. Additional stresses that may be involved in the etiology of ash decline are air pollution, leaf-spotting fungi, and viruses (Hibben and Silverborg 1978).

Fraxinus americana seems to grow best on rich, moist, well-drained soils requiring a high nitrogen content and moderate to high calcium content. The Ridge Tops (west) have the greatest number of stems (n=47) with 15 stems in quadrat #44. The Valley-Clove, which has fairly high nitrogen and calcium levels, supports the largest diameter *Fraxinus americana* (75.40 cm DBH), and is situated directly on the remains of the middens (discarded oyster shells for the most part). Nutrient culture results show that an absence of nitrogen reduces seedling dry weight by 38% compared to seedlings grown in complete nutrient solution, and that calcium is the second most important macroelement followed by sulphur (Erdmann et al.1979). Its pH tolerance varies from 5.0 to 7.5. In the Valley-Clove, soil samples measured a pH of 6.01 where *Fraxinus americana* was found.

Fraxinus americana is a pioneer species that establishes itself usually on abandoned fertile fields. It is also a shade tolerant tree when very young, and seedlings can survive with less than 3 percent of full sunlight, but grow little under these conditions. In Inwood Hill, *Fraxinus americana* is most prevalent in areas that have been burned in the past, such as the Ridge Top west areas and along the perimeters of the Westside Highway, or in areas that are mostly grassy.

The tallest trees are *Liriodendron tulipifera*, some reaching heights of 140-175 feet, especially those found in the Valley-Clove. The Valley-Clove is essentially a cove-type forest where soils are rich, moist, and well-drained. *Liriodendron tulipifera* (n=34), a native species, ranked second among all woody taxa in the 45 10 X 10 m^2 quadrats with an importance value of 25.5%. The largest diameter stem was 121.7 cm DBH found in quadrat #5 in the Valley-Clove.

Liriodendron tulipifera had a mean DBH of 57.13 cm and a range of 4.20 - 121.70 cm. Its mean stem density per quadrat was 0.75%. Within the DBH range of 2.0 - 7.0 cm, the first interval bar, *Liriodendron tulipifera* (n=6) represented 17.6%. These are young seedlings and saplings. In the second interval bar, within a range of 7.0 - 12.0 cm DBH, there were just two saplings (n=2) representing 5.9%, as was the case for the third interval bar (12.0 - 17.0 cm DBH) (n=2) (5.9%) also. In the sixth interval bar within a range of 27.0 - 32.0 cm DBH, *Liriodendron tulipifera* (n=3) represents 8.8% of the population. By the thirteenth interval bar, in a DBH range of 92.0 - 97.0 cm, fully mature trees, *Liriodendron tulipifera* (n=4) represented 11.7%.

Within a DBH range of 42.0 - 62.0 cm, there is an absence of *Liriodendron tulipifera*. This is evidence of very few saplings mixed in with fully mature trees and nearly negligible mid-size trees.

The next 3 native taxa are shown in Figure 3.12, which represents the frequency distribution of *Lindera benzoin* (n=760), *Viburnum acerifolium* (n=618), and *Sassafras albidum* (n=101) within the 45 10 X 10 m^2 quadrats of Inwood Hill. *Lindera benzoin,* and *Viburnum acerifolium,* ranked third and fourth in ecological dominance among all woody taxa with importance values of 23.75% and 19.07% respectively. *Sassafras albidum* ranked eleventh in ecological dominance with an IV of 7.06%.

Lindera benzoin (n=760) was found mostly in the Valley-Clove (11 out of 11 quadrats), although it had a good representation in the West Ridge (7 out of 18 quadrats), East Ridge (3 out of 8 quadrats), but none for the Ridge Tops. *Lindera benzoin* had a mean DBH of 2.65 cm and a range of 2.0 - 4.10 cm. Its mean stem density per quadrat was 16.8%.

In the first interval bar within a DBH range of 2.0 - 2.25 cm, *Lindera benzoin* (n=149) represented 19.6% of the sampled stems, and in the second interval bar, 2.25 - 2.50 cm DBH, it represented 18.6% (n=142). The third interval bar, 2.50 - 2.75 cm DBH, shows the peak of the frequency distribution, representing 24.07% of the sampled stems (n=183). The largest stem diameter for *Lindera benzoin* was measured at 4.10 cm DBH (quadrat #2) in the Valley-Clove.

The next dominant shrub, *Viburnum acerifolium*, was found mostly in the East Ridge (n=368), followed by West Ridge (n=168), Ridge Tops (n=70), and Valley-Clove (n=12). *Viburnum acerifolium* (n=618) had a mean DBH of 2.11 cm and a range of 2.0 - 3.0 cm. Its mean stem density was 13.73%.

In the first interval bar within a DBH range of 2.0 - 2.25 cm, *Viburnum acerifolium* (n=537) shows the peak of the frequency distribution, representing 86.8% of the sampled stems. In the second interval bar, 2.25 - 2.50 cm DBH, the frequency distribution drops considerably, representing 11.8% (n=118). In the 2.50 - 2.75 cm DBH range, the third interval bar, *Viburnum acerifolium* (n=6) represented just 0.97%. The single stem in the DBH range of 2.75 - 3.0 cm, was measured at 3.0 cm. *Viburnum acerifolium* does not achieve diameters much larger than 3.0 cm and mostly represents flushes of new growth. It is a low, sparse shrub starting as a single stem (which may generate from numerous colonizing, suckering roots) that branches from two opposite, appressed buds, and generally reaches 4 to 6 ft. tall and 3 to 4 ft. wide. It is extremely shade tolerant and occurs naturally. The west-facing slope of the East Ridge has the greatest density of stems (4.6%) with many more uncounted that were under the ≤ 2.0 cm

DBH cut-point.

Sassafras albidum (n=101) had a mean DBH of 4.04 cm and a range of 2.0 - 31.20 cm. Its mean stem density per quadrat was 2.24%. Within a DBH range of 2.0 - 4.0 cm, the first interval bar, *Sassafras albidum* (n=88) represented 67.12% of the sampled stems. These are poles for the most part, some 15 to 20 ft. in height. The second interval bar drops considerably lower within the DBH range of 4.0 - 6.0 cm representing 5.9% (n=6). In the 28.0 - 30.0 cm (n=2) and the 30.0 - 32.0 cm (n=1) DBH range, *Sassafras albidum* was represented by only 3 mature stems, 2.5% and 1.1% respectively. This is a pioneer, gap-phase species like *Prunus serotina*. The largest diameter stem was found in quadrat #37, West Ridge, northwest-facing slope.

The final 3 taxa, shown in Figure 3.13, are represented within the 45 10 X 10 m^2 quadrats by *Celastrus orbiculatus* (n=181), a vine, and *Lonicera maackii* (n=269), *and Rosa multiflora* (n=186), both shrubs. *Lonicera maackii*, *Celastrus orbiculatus*, and *Rosa multiflora* ranked sixth, ninth, and tenth with species importance values (IV) of 9.78%, 7.9%, and 7.79% (respectively) in ecological dominance.

Celastrus orbiculatus (n=181) had a mean DBH of 2.10 cm and a range of 2.0 - 2.90 cm. Its mean stem density per quadrat was 4.02%. *Celastrus orbiculatus*, a climbing, twining vine, is a very serious invasive species within all of Inwood Hill Park.

Within a DBH range of 2.0 - 2.25 cm, the first interval bar, *Celastrus orbiculatus* (n=163) represented 90.05% of the sampled stems, indicating much new growth.
The second interval bar, within a DBH range of 2.25 - 2.50 cm, drops much lower than the first representing 9.39% (n=17). One specimen was found within a DBH range of 2.75 - 3.0 cm representing 0.52% in quadrat #37, measuring 2.90 cm DBH. Within the

Valley Clove, *Celastrus orbiculatus* (n=4) was found in quadrat #18, just one out of 11 quadrats; in the East Ridge (n=8), 2 out of 8 quadrats; for the Ridge Tops (n=63), 3 out of 8 quadrats; and in theWest Ridge (n=106), 12 out of 18 quadrats. Quadrat #20 had the greatest density of *Celastrus orbiculatus* (n=33) for the Ridge Top (west) forest, where at least 2 fires were set.

Lonicera maackii (n=269) had a mean DBH of 2.72 cm and a range of 2.0 - 3.90 cm. Its mean stem density per quadrat was 5.97%. It is the top invasive woody species in all of Inwood Hill Park.

In the first interval bar within a DBH range of 2.0 - 2.25 cm, *Lonicera maackii* (n=36) represented 13.38% of the sampled stems. The second interval bar within a DBH range of 2.25 - 2.50 cm (n=43), is slightly higher than the first, representing 15.98%. The third interval bar (2.50 - 2.75 cm DBH) (n=57) rises beyond the first and second bar representing 21.90%, while the fourth interval bar (2.75 - 3.0 cm DBH) (n=53) drops slightly, representing 19.70%. The fifth interval bar (3.0 - 3.25 cm DBH) (n=68), peaks in frequency distribution representing 25.27%.

Lonicera maackii appeared in 14 out of 45 quadrats, and within the four geographic locations: Valley-Clove (n=0), East Ridge (n=9), Ridge Tops (east and west) (n=33), and West Ridge (n=227) with quadrat #36 having the highest number of stems (n=46).

Rosa multiflora (n=186) had a mean DBH of 2.08 cm and a range of 2.0 - 2.30 cm. Its mean stem density per quadrat was 4.13%. It is next most invasive species after *Lonicera maackii* among woody shrubs, and a formidable one to measure.

In the first interval bar within a DBH range of 2.0 - 2.25 cm, *Rosa multiflora* (n=177) represented 95.16% of the sampled taxa. This interval represents the greatest frequency distribution for this shrub. The second interval bar is almost negligible (2.25 - 2.50 cm DBH) (n=9) (4.83%). However, it does show thicker stems with prickles nearly a ½ inch long indicating substantial growth and spread. The largest stem was > 2.30 cm DBH, and at its base, the stems were nearly > 3.60 cm. *Rosa multiflora* appeared in 15 out of 45 quadrats, and within the four geographic locations: Valley-Clove (n=40), East Ridge (n=46), Ridge Tops (n=19), and West Ridge (n=81). The highest stem density (n=41) was found in quadrat #37. The areas surrounding quadrats #36 and 37 are former sites of the Kahlen and Maher residences as evidenced by basement and chimney remains. These sites are near to the Hudson River on the west-facing side of the West Ridge.

Species Importance Values for the Valley-Clove Forest

The next set of importance values (IV) are for the first subset of data: the Valley-Clove forest, and are presented in Table 3.9.

Lindera benzoin (n=572) was first in ecological dominance (IV = 87.77%) with the highest relative density of 72.41% and frequency of 13.58%. It was represented in 11 out of 11 quadrats with quadrat #7 having the greatest number of stems (n=83) (Figure 3.14 View of *Lindera benzoin* in early Spring, 2002). The second ranking taxon was *Liriodendron tulipifera* (n=20) (IV = 72.81%) with the highest relative dominance of 59.17%, density of 2.53%, and frequency of 11.1%. In terms of relative dominance, *Liriodendron tulipifera* ranked first for all of the Valley-Clove with the greatest number of stems (n=6) in quadrat #6. Its density, however, is low, representing fully mature trees that are widely spaced with few saplings in between. Third in ecological dominance was *Quercus rubra* (n=9) (IV = 27.9%), with a relative density of 1.14% and frequency of 7.41%. Relative dominance for *Quercus rubra* weighed in at 19.4% after *Liriodendron tulipifera*.

The nonnative, invasive species, *Rosa multiflora* (n=40) had the second highest density (5.06%) after *Lindera benzoin* with a relative frequency of 4.94% and ranked fifth in ecological dominance (IV = 10.54%). It had the greatest concentration of stems (n=17) in quadrat #17. *Viburnum dentatum* (n=24) had the third highest density (3.04%) after *Rosa multiflora*, with a frequency of 2.47%. *Viburnum dentatum* ranked eleventh in dominance (IV = 5.55%).

Fraxinus americana (n=7), which ranked fourth in ecological dominance (IV = 10.54%), had a density of 0.89% but shared a relative frequency (4.94%) with *Acer*

Figure 3.14 View depicting the density of *Lindera benzoin* on the floor of the Valley-Clove forest in early Spring, 2002. *Liriodendron tulipifera* and *Quercus rubra* form the canopy.

saccharum and *Carya cordiformis. Acer saccharum* (n=9) ranked seventh in ecological dominance (IV = 8.1%) but had a greater density (1.14%) than *Fraxinus americana*. Following *Acer saccharum* was *Celtis occidentalis* (n=12), ranking eighth in dominance (IV = 7.93%). *Celtis occidentalis* had a density of 1.52% and a frequency of 6.17%, higher than *Fraxinus americana*, *Acer saccharum*, and *Carya cordiformis*, but lower in relative dominance (0.24%). *Carya cordiformis* and *Celtis occidentalis* are, for the most part, saplings with smaller DBH's than *Fraxinus americana* and *Acer saccharum* with mean DBHs of > 24.4 cm and > 15.4 cm respectively. Worthy of note is the shrub *Hamamelis virginiana* (n=10) (IV = 3.79%), that has a somewhat small representation in the Valley-Clove and is now being planted by NRG. There was only one *Cornus florida* (n=1) (IV =1.36%) and one *Cercis canadensis* (n=1) (IV = 1.36%), both of which have rather a poor representation as understory trees in the Valley-Clove. To date, NRG has been planting these two species.

Also worthy of note was one rather large specimen of *Ulmus americana* (> 59.0 cm DBH). There are very few specimens of *Ulmus americana* represented in Inwood Hill and one or two specimens of *Ulmus rubra*.

Species Importance Values for the East Ridge

The second subset of data represents importance values (IV) for the East Ridge forest presented in Table 3.10.

Viburnum acerifolium (n=368), like its cohort *Lindera benzoin* in the Valley-Clove, is the ecologically most dominant species (IV = 62.11%). At 52.05%, it ranks first in density and frequency (8.64%) and was represented in 7 out of 8 quadrats. But in relative dominance (1.46%), it ranked much lower than *Lindera benzoin* (6.53%).

The second ecologically dominant taxon was *Quercus rubra* (n=16) (IV = 57.05%). *Quercus rubra* had a density of 2.26% with frequency of 8.64%, the same as *Lindera benzoin*. However, it was first in relative dominance (46.15%) with a mean DBH of > 52.56 cm.

Quercus prinus (n=8), another member of the Fagaceae, ranked third in dominance (IV = 22.6%) with a relative density of 1.13% and frequency of 3.70%. It ranked second in relative dominance (17.7%) with a mean DBH of > 45.32 cm. Following is the third member of the Fagaceae, *Quercus alba* (n=7) which ranked fourth in ecological dominance (IV = 16.64%) with a relative density of 0.99% and frequency of 3.70%, the same as *Quercus prinus*. *Quercus alba* had a mean DBH of > 36.56 cm with a relative dominance of 11.95%.

The next highest taxon in density after *Viburnum acerifolium* was *Acer rubrum* (n=47). At 6.65% density, and frequency of 8.64%, it ranked higher than *Quercus alba* and *Q. prinus* and shared the same frequency with *Q. rubra*. *Acer rubrum* ranked fifth in ecological dominance (16.55%) with a mean DBH of > 4.95 cm. However, its relative dominance (1.27%) was much lower than *Quercus rubra*, *Q. prinus*, and *Q. alba, Acer rubrum* was represented in 7 out of 8 quadrats with the largest specimen (>17.70 cm DBH) in quadrat #9 (west-facing slope). Quadrat #11 (east-facing slope) had the highest number of stems (n=14) for *Acer rubrum*. The East Ridge has the greatest number of stems (n=47) of *Acer rubrum* out of the four geographic locations.

Ranking sixth in ecological dominance was *Prunus serotina* (n=31) (IV = 13.58%) with a relative density of 4.39%, frequency of 8.64% and dominance (0.56%). While *Prunus serotina* has a very high representation (frequency) on par with the three top *Quercus* spp. on the East Ridge, the number of stems (n=31) do not reflect the large numbers of seedlings as most of these are below the cut-point of ≤ 2.0 cm DBH with *Sassafras albidum* being second as mentioned under the descriptions of the twelve top taxa. *Prunus serotina* had a mean DBH of > 3.94 cm and was represented in 7 out of 8 quadrats.

Sassafras albidum (n=17) (IV =11.95%) ranked seventh in ecological dominance after *Prunus serotina* with a density of 2.41% and frequency of 8.64%, the same as *Prunus serotina*. The same circumstances exist for *Sassafras albidum* as for *Prunus serotina*, with many *Sassafras* poles under < 2.0 cm DBH. *Sassafras albidum* was represented in 7 out of 8 quadrats.

The third highest taxon, in terms of density after *Acer rubrum*, was *Rosa multiflora* (n=46). Its density (6.51%) is slightly higher than that recorded for the Valley-Clove forest (5.06%). However, in terms of relative frequency, *Rosa multiflora* had a lower rate of frequency (2.47%) than in the Valley-Clove (4.54%). *Rosa multiflora* ranked ninth in ecological dominance (IV = 9.14%) with representation in 2 out of 8 quadrats and had the greatest stem concentration in quadrat #27 (n=41).

Hamamelis virginiana (n=29) ranked eighth in ecological dominance (IV = .41%). At 4.10% in density, it ranked higher than in the Valley-Clove (1.27%) and seems to favor the west-facing slope of the East Ridge where most of the stems were found. Compared with *Lindera benzoin* (n=29), which ranked tenth in dominance (IV = 7.99%), both had the same percent in density. However, *Hamamelis virginiana* had a higher rate of frequency (4.94%) than *Lindera benzoin* (3.70%). Of note is the non-native *Pinus nigra* (n=1) (IV =7.91%), a singleton, which ranked eleventh in ecological dominance after *Lindera benzoin* (IV = 7.99%) with negligible density and frequency percents. However, in terms of relative dominance (6.53%), it ranked fourth after *Quercus alba*. One tree was found in quadrat #27 with a DBH of > 87.10 cm. surrounded by *Rosa multiflora.* Five species of oak were represented in the East Ridge: *Quercus alba*, *Q. coccinea*, *Q. prinus*, *Q. rubra*, and *Q. velutina.*

Species Importance Values for the Ridge Tops

The third subset of data represents importance values (IV) for the Ridge Tops (east and west) and is presented in Table 3.11. The Ridge Tops (east and west), contain abundant representations of *Celastrus orbiculatus, Cornus foemina, Lindera benzoin*, *Lonicera maackii*, *Prunus serotina*, *Quercus rubra*, *Rosa multiflora, Viburnum acerifolium*, and *V. dentatum.*

Ranking first in ecological dominance was *Quercus rubra* (n=30) with an IV of 72.3% and relative dominance at 59.2%. Its density was 5% with a frequency of 8%. *Quercus rubra* was represented in 8 out of 8 quadrats, comparable with the East Ridge where it appeared in 7 out of 8 quadrats. For the Ridge Top east, it was represented in quadrats #10, 15, 20, and 21 (n=12), and for the Ridge Top west, quadrats #32, 42, 44, and 45 (n=18). The highest number of stems (n=12) was recorded in quadrat #45 (the most northerly portion of the West Ridge), and the largest tree measured >100.2 cm DBH in quadrat #21. The mean DBH for *Quercus rubra* was > 44.3 cm and mean stem density for the 8 quadrats was 3.75%.

Second in ecological dominance was Prunus serotina (n=80) (IV = 24.08%). At 13.6%, it ranked first in density, ahead of *Quercus rubra*, but shared it shared the same rate of frequency (8%) with *Q. rubra*. However, in terms of relative dominance, *Prunus* *serotina* ranked very low (2.4%). For the Ridge Top east, *Prunus serotina* was represented in quadrats #10, 15, 20, and 21 (n=41), and for Ridge Top west, quadrats #32, 42, 44, and 45 (n=39). Altogether, it was represented in 8 out of 8 quadrats. The highest number of stems (n=21) was recorded in quadrat #45 (and also for *Quercus rubra*), and the largest stem diameter for *Prunus serotina* was > 27.7 cm found in quadrat #20. Its mean stem density was 10.0%.

The third ranking taxon was *Fraxinus americana* (n=47) (IV = 16.72%), density (7.9%), and frequency (6.9%) after *Prunus serotina*. *Fraxinus americana* was represented in 7 out of 8 quadrats with the greatest stem concentration (n=15) in quadrat #44 with a mean stem density of 5.88% for the 8 quadrats. The largest diameter tree was found in quadrat #42 with a DBH of > 24.20 cm.

Fourth in ecological dominance was *Liriodendron tulipifera* (n=3) (IV =16.52% nearly that of *Fraxinus americana*. However, in terms of relative dominance (14%), *Liriodendron tulipifera* ranked second after *Quercus rubra* despite its low density (0.5%) and frequency rate (2.30%) while *Fraxinus americana* ranked at only 1.9%. *Liriodendron tulipifera* had a mean DBH of > 67.90 cm and the largest tree was found in quadrat #32 at > 95.60 cm DBH.

Ranking fifth in ecological dominance was *Viburnum acerifolium* (n=70) (IV=14.3%). In density (11.8%), it ranked second to *Prunus serotina*, but the rate of frequency (2.3%) was the same as *Liriodendron tulipifera*. The greatest number of stems (n=64) were represented in qyadrat #45, and mean stem density per 8 quadrats was 8.75%.

Sixth in ecological dominance was *Celastrus orbiculatus* (n=63) (IV = 14.25%).

At 10.6% density, it ranked third after *Viburnum acerifolium* but had a higher rate of frequency (3.4%) than *Viburnum acerifolium*. The greatest concentration of stems (n=33) was found in quadrat #20, an area that has been burned twice in the last 10 years. The canopy here is open with many small diameter stems not higher than 10 > 25 ft. The DBH's of Oriental bittersweet are all in the range of 2.0 - 2.30 cm indicating rapid growth with many lateral roots. Mean stem density per 8 quadrats was 7.88%.

Ranking seventh in dominance was *Carya cordiformis* (n=38 (IV = 12.66). Its density (6.4%) was just under the density of *Sassafras albidum* (6.7%). However, in frequency (5.7%), *Carya cordiformis* had an edge over *Sassafras albidum* (4.6%). *Carya cordiformis* had its greatest representation (n=11) in quadrat #21 and appeared in 6 out of 8 quadrats. The largest tree measured >14.80 cm DBH in quadrat #44. *Carya cordiformis* had a mean DBH of > 3.50 cm, and mean stem density for the 8 quadrats was 4.75%.

Sassafras albidum (n=40) (IV = 11.54%) ranked eighth in dominance, nearly that of *Carya cordiformis*. *Sassafras albidum* was represented in 4 out of 8 quadrats with a mean stem density of 5%.The largest diameter stem was > 4.40 cm DBH in quadrat #42 and mean DBH was > 2.58 cm, indicating all young poles.

The second member of the Fagaceae, *Quercus velutina* (n=4), ranked ninth in dominance (IV =10.32%), with a relative density of 6.7%, frequency of 2.3%, and dominance of 7.4% after *Liriodendron tulipifera.* The largest diameter stem was measured at > 72.90 cm in quadrat #44. *Quercus velutina* had a mean DBH of > 45.80 cm.

Ranking tenth in ecological dominance was *Lonicera maackii* (n=33) (IV = 9.20%). Its density was 5.5% and frequency was 3.4%. Compared with *Viburnum* *dentatum* (n=46) (IV = 8.86%), which ranked eleventh, density and frequency were lower, as *V. dentatum* ranked fourth in density (7.6%) after *Celastrus orbiculatus*.

Worthy of note were two shrub species of *Rhus*, *R. typhina* (n=10) and *R. aromatica* (n=6), and one species of *Amelanchier canadensis* (n=3). The Fagaceae were represented by 5 species of *Quercus*: *Q. alba*, *Q. coccinea*, *Q. prinus*, *Q. rubra*, and *Q. velutina*. Two specimens of *Catalpa bignonioides* (Bignoniaceae), now considered a native-invasive species, were found in quadrat #44.

Several singletons were represented on the Ridge Tops: *Acer rubrum, Cornus florida*, *Juglans cinerea* and *J. nigra*, *Maclura pomifera*, and *Quercus alba.*

Species Importance Values for the West Ridge

The fourth subset of data represents importance values (IV) for the West Ridge and is presented in Table 3.12.

Ranking first in ecological dominance was *Quercus rubra* (n=66) (IV = 50.66%) with a relative density of 3.3%, frequency of 6.1%, and dominance of 41.2%. *Quercus rubra* was represented in 14 out of 18 quadrats. The largest stem was found in quadrat #36 with a DBH of > 99.8 cm. The mean DBH of *Quercus rubra* was > 38.17 cm, and mean stem density per quadrat was 3.67% and greatest number of stems (n=15) were found in quadrat #34.

Ranking second in dominance was *Prunus serotina* (n=169) (IV = 16.6%) with a relative density of 9%, frequency of 7%, and dominance of 1.1%. *Prunus serotina* was represented in 16 out of 18 quadrats with a mean DBH of 3.46 cm, and the largest stem (>25.5 cm DBH) was found in quadrat #23. Mean stem density per quadrat was 9.39%. In terms of relative dominance (1.1%), it ranked very low, mainly because most of the stems were in the small size-class. The greatest number of stems (n=25) were found in quadrat #36.

In third place was *Lonicera maackii* (n=227) (IV = 16.4%), on par with *Prunus serotina*. However, *Lonicera maackii* ranked first in density (11%) but less in frequency (4.4%) than *Prunus serotina*. *Lonicera maackii* was represented in 10 out of 18 quadrats having the greatest number of stems (n=46) in quadrat #36. Mean stem density per quadrat was 12.6%, much higher than *Prunus serotina*.

Fourth was *Robinia pseudoacacia* (n=31) (IV = 12.26%) with relative density of 1.5% and frequency of 3.5%, which was much lower than *Prunus serotina*, but in relative dominance (7.2%), much higher. *Robinia pseudoacacia* was represented in 8 out of 18 quadrats with the largest stem (> 71.5 cm DBH) in quadrat #29. Mean DBH was > 21.3 cm and mean stem density per quadrat was 1.72%.

The fifth ranking taxon was *Lindera benzoin* (n=159) (IV = 11.5%) with density 8% and frequency 3%. This species was represented in 7 out of 18 quadrats with a mean stem density of 8.8%. Average stem size ranged from 2.0 cm - 3.40 cm DBH.

Fagus sylvatica (n=2) (IV = 11%) ranked sixth with very low density of 0.6% and frequency of 1%. However, in relative dominance (10%), it ranked second after *Quercus rubra*. This is the largest tree recorded for all the 45 quadrats with a DBH of > 171.20 cm in quadrat #37. Only one other *Fagus sylvatica* was found that measured > 2.30 cm. This very large specimen is on a former estate that was facing the Hudson River during the latter part of the 1800s. The basal area (BA) of *Fagus sylvatica* increases the dominance ranking by family for the Fagaceae considerably (which is discussed later in the Chapter).

Following *Fagus sylvatica* in dominance was *Quercus velutina* (n=13)

(IV = 10.8%), ranking seventh. Density (0.6%) was negligible and frequency (3%) was the same for *Lindera benzoin*. In relative dominance (8%), it ranked third after *Fagus sylvatica*. *Quercus velutina* had a mean DBH of > 35.71 cm (after *Quercus rubra*), and the largest stem was > 66.60 cm in quadrat #29.

Ranking eighth in ecological dominance was *Viburnum acerifolium* (n=168) (IV = 10.4%). At 8.5% density, it ranked third after *Prunus serotina* (9%) and slightly more than *Lindera benzoin* (8%). In frequency (1.8%) however, it had a lower rate than *Lindera benzoin* (3%). *Viburnum acerifolium* was represented in 4 out of 18 quadrats with the greatest concentration of stems in quadrats #33 (n=83) and #34 (n=70). Stem density per quadrat was 9.3%.

Ninth in ecological dominance was *Celastrus orbiculatus* (n=106) (IV = 9.8%). The density was 5.4% and frequency 4.4% in comparison with another non-native, invasive vine, *Ampelopsis brevipedunculata* (n=26) (IV =3.1%), with a density of 1.3% and frequency of 2%. The native species, *Toxicodendron radicans* (n=33) (IV = 6.9%), while low in density (1.7%) had a higher rate of frequency (5.2%) on par with *Celastrus orbiculatus*.

Tenth in dominance was *Carya cordiformis* (n=46) (IV =9.8%), the same as *Celastrus orbiculatus*. Its density was 2.3% with frequency at 5.2%. *Carya cordiformis* had a mean DBH of 7.03 cm with the largest stem (> 41.30 cm) in quadrat #30.

Ranking eleventh in dominance was *Aesculus hippocastanum* (n=11) (IV = 8.8%). While density (0.6%) and frequency (1.7%) were rather low, its relative dominance (7%) ranked just under *Robinia pseudoacacia* (7.2%). There were only 13 trees recorded for this species out of the 45 quadrats. *Aesculus hippocastanum* had a mean DBH of > 25.10 cm with the largest stem (> 93.80 cm) in quadrat #29.

Twelfth was *Rosa multiflora* (n=81) (IV = 7.2%). *Rosa multiflora* has abundant representation in all the four geographic locations and gives substantial weight to the family dominance ranking for the Rosaceae. On the West Ridge, it had a density of 4.1% and a frequency of 3.1%.

Worthy of note were several other species among shrubs: *Aronia arbutifolia* (n=6), three species of *Cornus*: *C. amomum* (n=5), *C. foemina* (n=111) found only in quadrat #40, and *C. sericea* (n=21). Others were *Hamamelis virginiana* (n=13), and three species of *Rubus*: *R. allegheniensis* (n=21), *R. laciniatus* (n=44), and *R. occidentalis* (n=38). *Rhododendron pericylmenoides* (n=6) was the only member of the Ericaceae, and *Rhus* was represented by *R. typhina* (n=20). *Viburnum* was represented by three species: *V. acerifolium* (n=168), *V. dentatum* (n=113), and *V. prunifolium* (n=18).

Among vines, *Toxicodendron radicans* (n=33) was present, and *Vitis* was represented three species: *V. aestivalis* (n=5), *V. labrusca* (n=4), and *V. riparia* (n=17). *Wisteria sinensis* (n=1) was the only vine member of the Fabaceae.

Worthy of note were *Acer rubrum* (n=24) and *A saccharum* (n=23), *Betula lenta* (n=20), *Cornus florida* (n=4), *Gymnocladus dioica* (n=26), found only in quadrat #25, *Pinus strobus* (n=15), and *Prunus avium* (n=2).

Several singletons (n=1) were also present; among these were *Gleditsia triacanthos*, *Maclura pomifera*, *Pinus nigra*, *Pyrus communis*, *Quercus coccinea*, *Tsuga canadensis*, and *Ulmus americana*.

Family Importance Values (FIV)

In this next set of data, family importance values (FIV) for all woody taxa within Inwood Hill are considered. The use of family importance values (FIV) have been applied to several tree inventories by various workers (Mori et al. 1983; Campbell et al. 1986; Ferreira and Prance 1998). Importance values, number of stems, percent representation in quadrats, and basal area were calculated and presented in the following tables: for all woody taxa (n=4070), Tables 3.13 and 3.14, and for trees only (n=1256), Tables 3.15 and 3.16.

Among all woody taxa, the Fagaceae ranked first as the most dominant and richest arborescent family (Table 3.13). It was represented by seven species and collectively contained 196 individuals: *Fagus grandifolia* (n=13), *F. sylvatica* (n=2), *Quercus alba* (n=16), *Q. coccinea* (n=8), *Q. prinus* (n=17), *Q. rubra* (n=121), and *Q. velutina* (n=19) with a total IV of 71.43% out of a possible 300 %. Relative density was low at 4.8% in comparison to the next dominant family, the Lauraceae. However, its relative frequency (10.2%) was the highest overall. The Fagaceae had a relative dominance of 56.4% and a combined basal area (BA) of 33.9 m^2 (338685.00 cm^2) (Table 3.14). The Fagaceae were found in 39 out of 45 sampled quadrats (87.0%)

The second dominant family was the Lauraceae. It was represented by two species and collectively contained 861 individual stems: primarily the non-arborescent *Lindera benzoin* (n=760), and secondarily, arborescent *Sassafras albidum* (n=101) with a total IV of 31.43%. In terms of relative density, the Lauraceae had the highest rate of 21.2%, exceeding all the other families, and relative frequency (9.0%) was just 1% under the next dominant family, the Adoxaceae. The Lauraceae had a relative dominance of only 1.4% and a combined basal area (BA) of 0.81 m^2 (8128.40 cm^2), indicating many small stems. The Lauraceae were found in 33 out of 45 sampled quadrats (76.0%).

The third ecologically dominant family was Adoxaceae, containing only non-arborescent species. It was represented by four species of *Viburnum* and collectively contained 843 individual stems: *V. acerifolium* (n=618), *V. dentatum* (n=190), *V. opulus* (n=7), and *V. prunifolium* (n=28) with a total IV of 27.78%. Relative density (20.7%) was second to the Lauraceae, but relative frequency (7.0%) was lower than the next dominant family, the Rosaceae. The Adoxaceae had a minimum relative dominance of 0.01% with a combined basal area (BA) of 0.30 m^2 (3025.10 cm^2), a much smaller basal area than the Lauraceae which contained both tree and shrub species. The Adoxaceae were found in 25 out of 45 sampled quadrats (56.0%).

The fourth ranking family was the Rosaceae containing both arborescent and non-arborescent species. It was represented by eight species collectively containing 621 individual stems: *Amelanchier canadensis* (n=3), *Aronia arbutifolia* (n=6), *Crataegus* spp. (n=1), *Prunus avium* (n=2), *P. serotina* (n=286), *Pyrus baccata* (n=5), *P. communis* (n=1), *P. malus* (n=2), *Rhodotypos scandens* (n=14), *Rosa multiflora* (n=186), *Rubus allegheniensis* (n=24), *R. laciniatus* (n=44), and *R. occidentalis* (n=47) with a total IV of 26.52%. At 15.3% density, it ranked third after Adoxaceae, but relative frequency (10.0%) was second only to the Fagaceae, indicating a wide dispersal of stems within the study area. The Rosaceae had a relative dominance of 1.3%, lower than the Lauraceae, with a combined basal area (BA) 0.77 m^2 (7718.90 cm^2). The Rosaceae were found in 38 out of the 45 sampled quadrats (87.0%), the same dispersion rate as the Fagaceae.

The Magnoliaceae ranked fifth in ecological dominance and contained only arborescent stems. It was represented by only one species, *Liriodendron tulipifera* (n=34) with a total IV of 26.38%. Relative density was very low (1.0%), indicating a sparse number of stems, and frequency (3.9%) was well below that of the Fagaceae and Rosaceae. However, in terms of relative dominance (21.6%), it was second only to the Fagaceae with a combined basal area (BA) of 12.9 m^2 (129787.00 cm^2). Although the number of stems recorded were very few, the basal area of *Liriodendron tulipifera* for nearly all the stems was on par with the Fagaceae, indicating the dominance of this species.

The next three families, Oleaceae, Juglandaceae, and Aceraceae, ranked sixth through eighth respectively, and had similar rates of relative density, frequency and dominance.

The Oleaceae was represented by four species collectively containing 147 individual stems: *Forsythia suspensa x viridissima* (n=33), *Fraxinus americana* (n=101), and *Ligustrum vulgare* (n=13) with a total IV of 11.93%. Relative density (3.6%), relative frequency (6.3%), and relative dominance (2.0%) were close to that of Juglandaceae and Aceraceae. Oleaceae had a combined basal area (BA) of 1.2 m^2 (12156.20 cm^2) and was represented in 24 out of 45 sampled quadrats (53.0%).

The Juglandaceae contained all arborescent stems. It was represented by five species collectively containing 115 individuals: *Carya cordiformis* (n=97), *C. ovata* (n=3), *C. tomentosa* (n=13), *Juglans cinerea* (n=1), and *J. nigra* (n=1) with a total IV of 11.24%. Its relative density (2.3%), frequency (6.6%), and dominance (1.9%) gave it a combined basal area of 1.1 m^2 (11147.60 cm^2). It was represented in 23 out of 45 sampled quadrats (56.0%).

The Aceraceae contained all arborescent stems. It was represented by four species and collectively contained 149 individuals mainly in the genus *Acer*: *A. platanoides* (n=6), *A. pseudoplatanus* (n=6), *A. rubrum* (n=85), and *A. saccharum* (n=52) for a total IV of 11.20%. Relative density (3.7%) was nearly the same as the Oleaceae, and relative frequency (5.5%) was slightly less than Oleaceae and Juglandaceae. Relative dominance (2.0%) was the same as the Oleaceae. Aceraceae had a combined basal (BA) area of 1.2 m^2 (12192.10 cm^2) and was represented in 22 out of 45 sampled quadrats (47%).

The Caprifoliaceae and Celastraceae ranked ninth and tenth respectively, and both contained non-arborescent stems.

The Caprifoliaceae was represented by one species, *Lonicera maackii* (n=269), for a total IV of 10.54%. In relative density (6.6%) however, Caprifoliaceae ranked fourth after the Rosaceae. Its frequency rate of 3.7%, and negligible dominance (0.01%) gave it a combined basal area (BA) of 0.15 m^2 (1588.60 cm^2). It was represented in 14 out of 45 sampled quadrats.

The Celastraceae was represented by two species: *Celastrus orbiculatus* (n=181) and *Euonymus alatus* (n=5), collectively containing 186 individuals for a total IV of 9.14%. In relative density (4.6%) however, it ranked fifth after Caprifoliaceae, and ahead of the Oleaceae, Juglandaceae, and Aceraceae. Celastraceae had a frequency rate of 4.5%, close to that of next dominant family, the Anacardiaceae. Its combined basal area (BA) of 0.06 m^2 (650.40 cm^2) however, gave it a low dominance ranking (0.001%) as no stem exceeded ≥2.80 cm DBH. It was found in 17 out of 45 sampled quadrats (38%).

Eleventh in ecological dominance was the Anacardiaceae represented by three species collectively containing 79 stems: *Rhus aromatica* (n=6), *R. typhina* (n=30), and *Toxicodendron radicans* (n=46) for a total IV of 6.74%. Relative density (1.9%) was low, but relative frequency (4.7%) was on par with Celastraceae, with relative dominance being negligible. Anacardiaceae had a combined basal area (BA) of 0.05 m^2 (465.10 cm^2) and was found in 18 out of 45 sampled quadrats (40%).

Family Importance Values for Trees Only

The next set of data represents importance values, basal areas, percent quadrat representation, and number of stems for arborescent tree families only (n=1256) and is presented in Tables 3.15 and 3.16.

The Fagaceae is the top ecologically dominant family among all arborescent species collectively containing 196 individuals as noted in Table 3.13. Among tree families only, its importance value of 88.36% reflects a higher percentage than among all woody taxa within the 45 10 X 10 m^2 quadrats. Relative density (15.6%), relative frequency (15.1%), and relative dominance (57.6%) gave it a combined basal area (BA) of 33.8 m^2 (338685.00 cm^2) with 87% quadrat representation (Tables 3.15, 3.16).

The Rosaceae is the second dominant family representing five arborescent species and collectively containing 297 individuals: *Crataegus* spp. (n=1), *Prunus avium* (n=2), *P. serotina* (n=281), *Pyrus baccata* (n=5), *P. communis* (n=1), and *P. malus* (n=2). Among tree families only, its importance value of 37.94% was less than that of the Fagaceae. At a relative density of 23.6% however, it ranked first overall, but its relative frequency (13.2%) was 2% less than the Fagaceae. Its relative dominance (1%) however, reflects a much lower IV rank. Rosaceae had a combined basal area (BA) of 0.65 m^2 (6577.00 cm^2) with 76% quadrat representation.

Third in rank was the Magnoliaceae, represented by one species, *Liriodendron tulipifera* (n=34). Relative density (2.7%) was low, and relative frequency (5.8%) was just slightly higher than the Ulmaceae (5.4%). In relative dominance (22.1%) however, it ranked second to the Fagaceae with an IV of 30.61%, giving it a combined basal area (BA) of 12.9 m^2 (129787.00 cm^2) and 33% quadrat representation.

The next three families, Aceraceae, Juglandaceae, and Oleaceae, ranked fourth, fifth, and sixth (respectively) in ecological dominance, and all had similar relative dominance.

Aceraceae was represented by four arborescent species in the genus *Acer*, collectively containing 149 individuals as noted in Table 3.13. At a relative density of 11.9%, it ranked third after the Rosaceae, and in relative frequency (8.1%), it ranked fifth after the Oleaceae. Its relative dominance (2.1%) was higher than Rosaceae by less than 1% for a total IV of 22.08%, giving it a combined basal area (BA) of 1.21 m^2 (12192.10 cm^2) with 47% quadrat representation.

Juglandaceae was represented by five arborescent species collectively containing 114 individuals. At 9.2% relative density, it ranked fourth after Aceraceae, but with a frequency of 9.7%, it ranked second to that of Rosaceae. In relative dominance (1.9%), it ranked lower than that of Aceraceae and Oleaceae for a total IV of 20.74% with a combined basal area (BA) of 1.11 m^2 (11147.60 cm^2) and 56% quadrat representation.

Oleaceae was represented by just one arborescent species, *Fraxinus americana*, collectively containing 101 individuals. At 8.0% relative density, it ranked fifth after the Juglandaceae, but its frequency of 8.9% was higher than Aceraceae by nearly 1% for a total IV of 18.98%. This gave the Oleaceae a relative dominance of 2.0% with a combined basal area (BA) of 1.18 m^2 (11875.20 cm^2) and 51% quadrat representation.

The next three families were the Lauraceae, Betulaceae, and Ulmaceae, ranking seventh, eighth, and ninth (respectively) in ecological dominance.

The Lauraceae had one arborescent species represented by *Sassafras albidum* collectively containing 101 individuals. Its relative density (8.0%) was the same as the Oleaceae, but relative frequency (7.4%) was lower than both Oleaceae and Aceraceae. Its relative dominance was 0.7%, the same as that of Betulaceae for a total IV of 16.06% with a combined basal area (BA) of 0.38 m^2 (3826.60 cm^2) and 42% quadrat representation.

Betulaceae, like Magnoliaceae, had no other family member and was represented by one species, *Betula lenta* (n=44). Its relative density of 3.5% was slightly higher than the Magnoliaceae, as well as its frequency (6.2%). Its relative dominance (0.7%) gave it a total IV of 10.43% with a combined basal area (BA) of 0.42 m^2 (4247.50 cm^2) and 36% quadrat representation.

Ulmaceae had two arborescent species represented by *Celtis occidentalis* (n=29) and *Ulmus americana* (n=2) and collectively contained 31 individuals. Relative density (2.5%) was on par with Magnoliaceae as well as relative frequency (5.4%). Its low relative dominance (1.0%) gave it a total IV of 8.88% with a combined basal area of 0.57 m^2 (5790.30 cm^2) and 31% quadrat representation.

Tenth in rank was the Fabaceae with one arborescent species, *Robinia pseudoacacia* (n=31). Relative density was low (2.5%) as was relative frequency (3.1%). In terms of relative dominance (2.8%), it was on par with Hippocastanaceae, which ranked twelfth, giving it a total IV of 8.38%, the same weighting as Ulmaceae. The

Fabaceae had a combined basal area (BA) of 1.65 m^2 (16530.00 cm^2) and 18% quadrat representation.

Family Importance Values for the Valley-Clove Forest

In this first subset of data, family importance values (FIV) were calculated for the Valley-Clove forest (n=790) and are presented in Tables 3.17, 3.18. The first five top ranking families are considered here.

Ranking first in ecological dominance for the Valley-Clove were the Lauraceae represented by two species: non-arborescent *Lindera benzoin* (n=572) and arborescent *Sassafras albidum* (n=2) collectively containing 574 stems for a total IV of 90.18% out of a possible 300.0%. It ranked first overall with a relative density of 73% and a relative frequency of 16%. However, its relative dominance of 2.0% was 50% less than the next dominant family, the Magnoliaceae. In terms of basal area, nearly all the stems would be considered in the small-size class, hence the low relative dominance rank. Lauraceae had a combined basal area (BA) of only 0.32 m^2 (3256.20 cm^2) but with an astonishing 100% quadrat representation.

Second in ecological dominance was Magnoliaceae represented by one arborescent species: *Liriodendron tulipifera* (n=20) for a total IV of 74.56%. Its relative density of 3.0% was low but relative frequency of 13.0% was second to the Lauraceae. However, its relative dominance of 59.0% was the highest for all the families with a combined basal area (BA) of 10.6 m^2 (106405.00 cm^2) and 82% quadrat representation.

In third place was the Fagaceae represented by two species of *Quercus*: *Q. alba* (n=1), and *Q. rubra* (n=10) collectively containing 11 individuals for a total IV of 30.34%. Relative density (1.0%) was very low and relative frequency (9.0%) ranked the same as Adoxaceae and Ulmaceae, which ranked fourth and sixth in dominance (respectively). In terms of relative dominance (20.0%), it was nearly 40% below that of Magnoliaceae with a combined basal area (BA) of 3.66 m^2 (36637.20 cm^2) and 55% quadrat representation.

Adoxaceae ranked fourth in ecological dominance, represented by four non-arborescent species of *Viburnum*: *V. acerifolium* (n=12), *V. dentatum* (n=24), *V. opulus* (n=7), and *V. prunifolium* (n=10) collectively containing 53 individual stems for a total IV of 15.41%. The Adoxaceae had a relative density of 7.0%, ranking second after Lauraceae with a relative frequency of 9.0%, the same as the arborescent families, Fagaceae and Ulmaceae. In terms of relative dominance, however, its 0.01% was entirely negligible. The Adoxaceae had a combined basal area of 0.023 m^2 (237.90 cm^2) with 55% quadrat representation.

Rosaceae ranked fifth in ecological dominance and was represented by three species: arborescent *Crataegus* spp. (n=1) and *Prunus serotina* (n=5), and non-arborescent *Rosa multiflora* (n=40) collectively containing 46 individual stems for a total IV of 13.56%. In relative density (7.0%), Rosaceae ranked third after Adoxaceae and had a relative frequency of (7.0%), two percentage points below that of Adoxaceae. In relative dominance (0.06%), it was similar to Adoxaceae. Its combined basal area (BA) of 0.10 m^2 (1076.60 cm^2) was slightly higher than Adoxaceae with 45% quadrat representation.

Family Importance Values for the East Ridge Forest

In the second subset of data, family importance values (FIV) were calculated for the East Ridge forest (n=707) and are presented in Tables 3.19, 3.20. The top five families are considered here.

The first ecologically dominant and richest family was the Fagaceae represented by six arborescent species: *Fagus grandifolia* (n=4), *Quercus alba* (n=7), *Q. coccinea* (n=1), *Q. prinus* (n=8), *Q. rubra* (n=16), and *Q. velutina* (n=2) collectively containing 38 individuals for a total IV of 98.04%. The Fagaceae had a low relative density of 5.4% compared with the Adoxaceae, which ranked first in density (53.2%), and consisted mainly of many small, non-arborescent stems with a very low basal area (BA). In relative frequency (12.9%) however, the Fagaceae ranks first overall as well as in relative dominance (79.8%) indicating a combined and substantial basal area (BA) of 7.27 m^2 (72738.00 cm^2) with 100% quadrat representation for the East Ridge forest.

Second in ecological dominance was the non-arborescent family, Adoxaceae, which was represented by two species of *Viburnum*: *V. acerifolium* (n=368) and *V. dentatum* (n=8) collectively containing 376 individual stems for a total IV of 65.92%. As mentioned above, the Adoxaceae had the highest density (53.2%) and the second highest relative frequency (11.3%) after Fagaceae. In relative dominance, however, its very low 1.5% gave it a combined basal area (BA) of only 0.13 m^2 (1322.40 cm^2) with 88% quadrat representation. The East Ridge has a greater concentration of *Viburnum acerifolium* than that of the other three geographic locations.

The third ranking family was the Aceraceae represented by three arborescent species in the genus *Acer*: *A. platanoides* (n=2), *A. rubrum* (n=47), and *A. saccharum* (n=10), collectively containing 59 individuals for a total IV of 25.37%. In terms of relative density (8.3%), Aceraceae ranked third after Rosaceae (11.3%). In relative frequency (11.3%), it shared the same rate as Adoxaceae, Rosaceae, and Lauraceae.

In relative dominance (5.7%) it ranked third after Pinaceae (6.5%), an unusual situation as the Pinaceae, represented only by *Pinus nigra* (n=1), had a larger basal area (BA) of 0.59 m^2 (5958.40 cm^2) while Aceraceae had a combined basal area (BA) of 0.52 m^2 (5226.90 cm^2). Aceraceae had the greatest number of stems in the East Ridge forest with an 88% quadrat representation.

Ranking fourth in ecological dominance was the Rosaceae represented by three species: arborescent *Prunus serotina* (n=31), and non-arborescent *Rosa multiflora* (n=46) and *Rubus allegheniensis* (n=3), collectively containing 80 individual stems for a total IV of 23.34%. Relative density (11.3%) ranked second to the Adoxaceae (53.2%) but relative frequency (11.3%) was the same as Adoxaceae. In terms of relative dominance, Rosaceae ranked very low (0.71%) indicating many small stems which gave it a combined basal area of 0.06 m^2 (670.20 cm^2) and 88% quadrat representation.

Ranking fifth in ecological dominance were the Lauraceae represented by two species: non-arborescent *Lindera benzoin* (n=29) and arborescent *Sassafras albidum* (n=17) collectively containing 46 individual stems for a total IV of 88.88%. At a relative density of 6.5%, it ranked fourth after Aceraceae, and its frequency of 11.3% was the same as Aceraceae, Adoxaceae, and Rosaceae. Relative dominance was 1.1%, slightly lower than that of Adoxaceae giving it a combined basal (BA) of 0.09 m^2 (994.50 cm^2) and 88% quadrat representation.

Family Importance Values for the Ridge Tops Forest

In the third subset of data, family importance values (FIV) were calculated for the Ridge Tops (east and west) forest (n=595) and are presented in Tables 3.21, 3.22. The top five families are considered here.

The first ecologically dominant family was the Fagaceae represented by five arborescent species in the genus *Quercus*: *Q. alba* (n=1), *Q. coccinea* (n=6), *Q. prinus* (n=3), *Q. rubra* (n=30), and *Q. velutina* (n=4), collectively containing 44 individuals for a total IV of 92.29%. Relative density (7.4%) ranked fourth after Oleaceae (7.9%), but in relative frequency (10.6%) it ranked together with the Rosaceae, the next dominant family. Its relative dominance of 74.3% ranked first overall giving it a combined basal area (BA) of 7.44 m^2 (74430.80 cm^2) and 100% quadrat representation.

Second in ecological dominance were the Rosaceae represented by five species collectively containing 115 individual stems: non-arborescent *Amelanchier canadensis* (n=3), *Rosa multiflora* (n=19), and *Rubus occidentalis* (n=9), and arborescent *Prunus serotina* (n=80), *Pyrus baccata* (n=2), and *P. malus* (n=2) for a total IV of 32.72%. In relative density (19.5%), the Rosaceae ranked first, and in relative frequency (10.6%), it shared the top spot with Fagaceae. However, in relative dominance (2.6%) it ranked very low, indicating many small stems for a combined basal area (BA) of 0.26 m^2 (2626.20 cm^2) with 100% quadrat representation, the same as Fagaceae.

Third in ecological dominance were the Adoxaceae represented by two non-arborescent species in the genus *Viburnum*: *V. acerifolium* (n=70) and *V. dentatum* (n=46) collectively containing 116 individual stems for a total IV of 24.27%. In relative density (19.5%), the Adoxaceae shared the top spot with Rosaceae, also at a frequency of 19.5%. Its relative frequency (4.5%) however, was much lower, on par with the Caprifoliaceae, which ranked tenth in ecological dominance. Its relative dominance was a negligible 0.4% giving it a combined basal area of just 0.03 m^2 (395.10 cm^2) and 43% quadrat representation.

In fourth place ranking was the Oleaceae represented by one arborescent species, *Fraxinus americana* (n=47), for a total IV of 18.92%. *Fraxinus americana* had a relative density of 7.9%, ranking fourth after Celastraceae, and in relative frequency (9.1%), it ranked third after the Rosaceae. In relative dominance (1.9%), it ranked very low which gave it a combined basal area of 0.19 m^2 (1934.10 cm^2) with 86% quadrat representation, a fairly good showing. However, the low dominance rank indicates that many of the stems are in a range of 2.0 cm - 10.0 cm DBH, a small size-class.

Fifth in ecological dominance was the Celastraceae represented by two species, non-arborescent *Euonymus alatus* (n=5) and *Celastrus orbiculatus* (n=63), collectively containing 68 individual stems for a total IV of 17.72%. At 11.4% density, it ranked third to the Adoxaceae and Rosaceae, and in relative frequency (6.1%), it ranked fourth after Oleaceae. However, its relative dominance was a mere 0.2% giving it a combined basal area of 0.023 m^2 (230.10 cm^2) with 57% quadrat representation. *Celastrus orbiculatus*, a non-native invasive vine species had its second highest representation on the Ridge Tops with the West Ridge being first. Stems can be anywhere from 2.0 cm - 4.0 cm DBH, and it has a growth habit that invades the crowns of young saplings effectively blocking photosynthesis and strangulating their vascular systems.

Family Importance Values for the West Ridge

In this fourth subset of data, family importance values (FIV) were calculated for the West Ridge (n=1978) and are presented in Tables 3.23, 3.24. The top five families are considered here.

The Fagaceae, as was noted for the East Ridge and Ridge Tops, was again the first ecologically dominant family represented by seven arborescent species collectively containing 103 individuals: *Fagus grandifolia* (n=9), *F. sylvatica* (n=2), *Quercus alba* (n=6), *Q. coccinea* (n=1), *Q. prinus* (n=6), *Q. rubra* (n=66), and *Q. velutina* (n=13) for a total IV of 82.17%. Despite having a relative dominance of 67.5%, density was low at 5.2%, but a relative frequency of 9.5% was second only to the Rosaceae, the next dominant family. The Fagaceae had a combined basal area (BA) of 15.4 m^2 (154878.00 cm^2) indicating many large size individuals with 94% quadrat representation.

The Rosaceae was the second ecologically dominant family represented by ten species collectively containing 379 individual stems: arborescent *Prunus avium* (n=2), *P. serotina* (n=169), *Pyrus baccata* (n=3), and *P. communis* (n=1); non-arborescent *Aronia arbutifolia* (n=6), *Rhodotypos scandens* (n=14), *Rosa multiflora* (n=81), *Rubus allegheniensis* (n=21), *R. laciniatus* (n=44), and *R. occidentalis* (n=38) for a total IV of 30.67%. Rosaceae ranked first in both relative density (19.2%) and frequency (10.1%), but in relative dominance (1.5%), it ranked very low for a combined basal area (BA) of 0.33m^2 (3345.90 cm^2) and 100% quadrat representation. Most of these stems were non-arborescent species with small DBH's which accounts for the low dominance rank and basal area.

Third in ecological dominance was the Adoxaceae represented by three non-arborescent species in the genus *Viburnum*: *V. acerifolium* (n=168), *V. dentatum* (n=113), and *V. prunifolium* (n=18), collectively containing 299 individual stems for a total IV of 20.61%. Adoxaceae ranked second to Rosaceae in density (15.1%) with a relative frequency (5.0%) which ranked lower than the Caprifoliaceae (5.6%). However, in relative dominance (0.5%) it ranked nearly the same percentage as Caprifoliaceae (0.6%), giving it a combined basal area (BA) of 0.10 m^2 (1069.60 cm^2) and 50% quadrat representation. All stems in the Adoxaceae measured between 2.0 - 2.30 cm DBH, indicating innumerable small size-class stems as was the case with Caprifoliaceae.

The Lauraceae ranked fourth in ecological dominance represented by two species, non-arborescent *Lindera benzoin* (n=159) and arborescent *Sassafras albidum* (n=42), collectively containing 201 individual stems for a total IV of 18.34%. Lauraceae ranked fourth in relative density (10.2%) after Caprifoliaceae, but in relative frequency (6.7%) Lauraceae shared third place with Anacardiaceae and Juglandaceae. In relative dominance (1.6%) it ranked very low, on par with Rosaceae, for a combined basal area (BA) of 0.36 m^2 (3657.50 cm^2) with 67% quadrat representation.

Ranking fifth in ecological dominance was the Caprifoliaceae represented by one non-arborescent species, *Lonicera maackii* (n=227), for a total IV of 17.64%. At 11.5% relative density, the Caprifoliaceae ranked third after Adoxaceae, and in relative frequency (5.6%) it shared the same rate with Celastraceae. In relative dominance (0.6%) however, the low rank gave Caprifoliaceae a combined basal area (BA) of 0.13 m^2 (1335.40 cm^2) with 56% quadrat representation.

Plant Community Structure, Diversity, and Composition of Inwood Hill Park

In this section, the diversity of Inwood Hill Park's arborescent and non-arborescent community is explored in the four geographic locations by revealing the structure and the distribution of species relative to the material presented earlier in the Chapter.

Tree, shrub, and vine diameters (size classes), obtained from the four subsets of data (extrapolated from the main data set), are explored for dominance hierarchy and frequency distributions (Figures 3.15, 3.16, 3.17, 3.18, 3.19). Frequency distributions for all woody taxa families in the 45 10 X 10 m^2 quadrats are presented in Figure 3.20, for tree families only, Figure 3.21, and for the four geographic locations, Figures 3.22, 3.23, 3.24, and 3.25 respectively.

Secondly, herbaceous taxa within the 45 2 X 2 m^2 quadrats are discussed and described in the four geographic locations and presented in Tables 3.25,3.26, 3.27, 3.28, 3.29, and 3.30 respectively.

The additional 5 2 X 4 m^2 quadrats containing all taxa in the salt marsh community of plants is also described and presented in Tables 3.31 and 3.32.

Frequency Distributions for Woody Taxa of Different Diameter Size Classes: Small, Mid, and Large

Small, mid, and large diameter size stems were divided among the four geographic locations: Valley-Clove, East Ridge, Ridge Tops (east and west), West Ridge, and for the whole of Inwood Hill Park (Figures 3.15, 3.16, 3.17, 3.18, 3.19 respectively). The diameter size-classes were small size class diameter (2.0 - 9.70 cm DBH) (n= 3765) comprising 93%, mid size-class diameter (10.20 - 29.90 cm DBH) (n=127) comprising 3%, and large size-class diameter (30.20 - 171.20 cm DBH) (n=178) comprising 4% of the sampled population for the 45 m^2 quadrats (Figure 3.15a, b, and c). This approach is in contrast to several authors who utilized other methods (largely non-statistical) for determining size class. Brewer (2001) created two arbitrary diameter size-classes: small size-class (10.0 - 19.99 cm) and large size-class (20.0 -113.0 cm DBH); Auclair and Cottam (1971) treated arborescent data as: saplings- 1.0-4.0 inch (2.54 - 10.16 cm), sub-canopy trees- 4.0-8.0 inch (10.16 - 20.32 cm), and canopy trees, 8.0 inches (20.32 cm). For Inwood Park a “sapling” class was not applied although the small size-class trees can be considered saplings. In a largely statistical analysis, Glaeser (2004) used three diameter size classes: small-size 2.0 - 2.8 cm DBH, mid-size 2.8 - 7.48 cm DBH, and large-size 7.48 cm - 116.7 cm DBH, for a study of the arborescent vegetation of Forest Park, Queens. For this approach to diameter size-classes in Inwood Park, Loeb's (1986) methods (described in Chapter 2) were used. A detailed analysis of the three diameter size classes is presented here.

For all of the 45 10 X 20 m^2 quadrats distributed within the Valley-Clove, East Ridge, Ridge Tops (east and west), and the West Ridge forests, species richness within the small diameter (DBH cm) trees, shrubs, and vines was represented by 69 species in 28 families. Stem density was 3765 stems in 45 m^2 quadrats with a basal area (BA) of 0.977 m^2 (9770.40 cm^2). Mean stem density per quadrat was 83.6% (Figure 3.15a).

Of the overall small-size stems, the most frequent taxa encountered were *Lindera benzoin* (n=760), with a relative frequency of 20.20%, followed by *Viburnum acerifolium* (n=618) (16.40%), *Prunus serotina* (n=276) (7.30%), *Lonicera maackii* (n=269) (7.10%), *Viburnum dentatum* (n=190) (5.00%), *Rosa multiflora* (n=186) (4.94%), *Celastrus orbiculatus* (n=181) (4.80%) in order of abundance. Encounters in lesser numbers included *Cornus foemina* (n=111) (2.90%), which was found in only one quadrat, and *Sassafras albidum* (n=96) (2.55%), *Fraxinus americana* (n=93) (2.47%), *Carya cordiformis* (n=86) (2.28%), and *Acer rubrum* (n=81) (2.20%) in order of abundance. Among shrubs, *Lindera benzoin* displayed the greatest relative density (18.67%) followed by *Viburnum acerifolium* (15.18%), and *Lonicera maackii* (6.61%). *Lindera benzoin* had the highest relative dominance (0.72%) as an extrapolation of the basal area (BA), followed by *Viburnum acerifolium* (0.36%), and *Lonicera maackii* (0.26%).

In the small-size hierarchy, these high values gave *Lindera benzoin* an importance value (IV) of 23.75%, making it the ecologically dominant taxon. Following the hierarchy in decreasing order of importance were *Viburnum acerifolium* (19.07%) and *Lonicera maackii* (9.78%) (Table 3.6)

The small diameter size represented 93% (n=3765) of the sampled population within a diameter range of 2.0 - 9.70 cm DBH (mean DBH of 2.71 cm, SD 1.03). This narrow distribution range is in strong contrast to the broad diameter range of large size trees (n=178) with a DBH range of 30.20 - 171.20 cm. The narrow spread of the frequency distribution within the small-size class was taken at 2.00 - 3.00 cm histogram intervals and the first two intervals were analyzed (Figure 3.15a).

On close inspection, the 2.0 - 3.0 cm DBH interval bar was largely represented by shrubs and vines. *Viburnum acerifolium* (n=617), with a relative frequency of 21.6% was the dominant species in this interval range. Following, in order of decreasing abundance were *Lindera benzoin* (n=572) (20.02%), *Viburnum dentatum* (n=189) (6.61%), *Lonicera maackii* (n=189) (6.61%), *Rosa multiflora* (n=186) (6.51%), *Celastrus orbiculatus* (n=181) (6.33%), *Cornus foemina* (n=99) (3.47%), *Rubus occidentalis* (n=47) (1.64%), *R. laciniatus* (n=44) (1.51%), *Toxicodendron radicans* (n=40) (1.40%), *Ampelopsis brevipedunculata* (n=36) (1.26%), *Rubus allegheniensis* (n=24) (0.84%), *Viburnum prunifolium* (n=23) (0.80%), *Forsythia suspensa* (n=22) (0.77%), and *Cornus sericea* (n=21) (0.73%). In lesser numbers were *Hibiscus syriacus* (n=14) (0.49%), *Rhodotypos scandens* (n=14) (0.49%), *Rhus typhina* (n=14) (0.49%, *Hamamelis virginiana* (n=11) (0.38%), *Philadelphus coronarius* (n=9) (0.31%), *Ligustrum vulgare* (n=8) (0.26%), *Aronia arbutifolia* (n=6) (0.21%), *Rhododendron periclymenoides* (n=6)

(0.21%), *Viburnum opulus* (n=6) (0.21%), *Euonymus alatus* (n=5) (0.17%), and *Vaccinium corymbosum* (n=4) (0.14%). The genus *Vitis* was represented by 3 species: *V. aestivalis* (n=5) (0.18%), *V. labrusca* (n=10) (0.35%), and *V. riparia* (n=15) (0.53%), followed by *Wisteria sinensis* (n=2) (0.07%).

Among trees in the same interval bar, *Prunus serotina* (n=142), with a relative frequency of 4.97%, was the most abundant tree species encountered followed by *Sassafras albidum* (n=72) (2.52%), *Fraxinus americana* (n=56) (1.96%), and *Carya cordiformis* (n=47) (1.64%). In lesser numbers were *Acer rubrum* (n=23) (0.80%), *Ailanthus altissima* (n=21) (0.73%), *Betula lenta* (n=12) (0.42%), *Gymnocladus dioica* (n=12) (0.42%), *Acer saccharum* (n=10) (0.35%), *Quercus rubra* (n=8) (0.28%), *Celtis occidentalis* (n=4) (0.14%), *Fagus grandifolia* (n=3) (0.10%), and *Quercus velutina* (n=2) (0.70%). A number of singletons (n=1) (0.35%) were also represented: *Catalpa bignonioides*, *Fagus sylvatica*, *Pyrus baccata*, *Quercus prinus*, *Robinia pseudoacacia*, and *Tilia americana.*

There were 2856 stems just in this 2.0 - 3.0 cm DBH size interval representing 76.8% of the sampled population. This interval bar is significant because it represents 54 species out of the entire 77 species recorded for all 45 quadrats. Had the cut-points for DBH's been higher than 3.00 cm, many of the species represented in this 2.0 - 3.0 cm range would not have shown the abundant diversity that exists within Inwood Park.

In the 3.00 - 4.00 cm DBH interval bar, the species most frequently encountered was *Lindera benzoin* (n=185) with a relative frequency of 30.27% in this interval range. Following were *Lonicera maackii* (n=80) (13.09%), *Prunus serotina* (n=69) (11.29%), *Hamamelis virginiana* (n=29) (4.74%), *Fraxinus americana* (n=26) (4.25%), *Acer* *saccharum* (n=21) (2.45%), *Carya cordiformis* (n=20) (3.27%), *Ailanthus altissima* (n=17) (2.78%), *Rhus typhina* (n=16) (2.61%), *Sassafras albidum* (n=16) (2.61%), *Acer rubrum* (n=15) (2.34%), *Cornus foemina* (n=12) (1.96%), found only in one quadrat, *Forsythia suspensa* (n=11) (1.80%), *Betula lenta* (n=8) (1.30%), *Hibiscus syriacus* (n=8) (1.30%), *Gymnocladus dioica* (n=7) (1.14%), *Celtis occidentalis* (n=6) (0.98%), *Ligustrum vulgare* (n=5) (0.81%), *Viburnum prunifolium* (n=5) (0.81%), *Carya tomentosa* (n=4) (0.65%), *Fagus grandifolia* (n=4) (0.65%), *Vitis labrusca* (n=4) (0.65%), *Acer pseudoplatanus* (n=3) (0.49%), *Catalpa bignonioides* (n=3) (0.49%), *Rhus aromatica* (n=3) (0.49%), *Toxicodendron radicans* (n=3) (0.49%), *Wisteria sinensis* (n=3) (0.49%), *Acer platanoides* (n=2) (0.32%), *Aesculus hippocastanum* (n=2) (0.32%), *Carya ovata* (n=2) (0.32%), *Morus alba* (n=2) (0.32%), *Phellodendron amurense* (n=2) (0.32%), *Quercus rubra* (n=2) (0.32%), *Robinia pseudoacacia* (n=2) (0.32%), and *Vitis riparia* (n=2) (0.32%) in order of decreasing abundance. A number of singletons (n=1) (0.16%) were represented by *Amelanchier canadensis*, *Cercis canadensis*, *Cornus florida*, *Pinus strobus*, *Pyrus baccata*, *P. communis*, *P. malus*, *Quercus alba*, *Tilia americana*, *Viburnum acerifolium*, *V. dentatum*, and *V. opulus*. There were 611 stems in this interval bar with 47 species in 24 families representing 16.78% of the sampled taxa.

In the next size class, mid-size diameter stems (n=127) comprised just 3% of the sampled population. Species richness was represented by 31 species in 19 families. Frequency distribution ranged within a DBH of 10.20 - 29.90 cm (mean 21.02 cm, SD 5.98). Mean stem density per quadrat was 2.82 with a combined basal area (BA) of 0.261 m^2 (2608.10 cm^2) (Figure 3.15b).

Within a range of 10.20 - 29.90 cm DBH, the species most frequently encountered was *Quercus rubra* (n=25), the dominant taxon, with a relative frequency of 19.68% in this size class. Following were *Robinia pseudoacacia* (n=19) (14.96), *Prunus serotina* (n=9) (7.08%), *Ailanthus altissima* (n=6) (4.72%), *Carya cordiformis* (n=6) (4.72%), *Celtis occidentalis* (n=5) (3.93%), *Fraxinus americana* (n=5) (3.93%), *Quercus alba* (n=5) (3.93%), *Q. coccinea* (n=5) (3.93%), *Liriodendron tulipifera* (n=4) (3.15%), *Pinus strobus* (n=4) (3.15%) and *Sassafras albidum* (n=4) (3.15%) in order of abundance. Less frequent encounters were *Acer rubrum* (n=3) (2.36%), *Carya tomentosa* (n=3) (2.36%), *Quercus velutina* (n=3) (2.36%), *Betula lenta* (n=2) (1.57%), *Cornus florida* (n=2) (1.57%), *Maclura pomifera* (n=2) (1.57%), *Morus alba* (n=2) (1.57%), and *Quercus prinus* (n=2) (1.57%). There were 11 singletons (n=1) (0.78%) in this interval range represented by *Acer platanoides*, *A. saccharum*, *Aesculus hippocastanum*, *Gleditsia triacanthos*, *Gymnocladus dioica*, *Juglans cinerea*, *J. nigra*, *Paulownia tomentosa*, *Phellodendron amurense*, *Tilia americana*, and *Ulmus americana*.

In the first 5 interval bars (10.20 - 19.70 cm DBH range), the most abundant species was *Robinia pseudoacacia* (n=8), with a relative frequency of 13.11% within this range. Following, in order of decreasing abundance were, *Prunus serotina* (n=7) (11.47%), *Ailanthus altissima* (n=6) (9.83%), *Celtis occidentalis* (n=5) (8.19%), *Liriodendron tulipifera* (n=4) (6.55%), *Pinus strobus* (n=4) (6.55%), *Acer rubrum* (n=3) (4.91%), *Carya cordiformis* (n=3) (4.91%), *Quercus alba* (n=3) (4.91%), *Quercus rubra* (n=3) (4.91%), *Carya tomentosa* (n=2) (3.27%), *Cornus florida* (n=2) (3.27%), and *Fraxinus americana* (n=2) (3.27%). There were 9 singletons (n=1) (1.63%) within the first 5 intervals: *Acer saccharum*, *Betula lenta*, *Gymnocladus dioica*, *Maclura pomifera*, *Morus alba*, *Phellodendron amurense*, *Quercus prinus*, *Q. velutina*, and *Tilia americana.*

There were 61 species in 17 families within this range.

In the next 5 interval bars (21.20 - 29.90 cm DBH range), the most abundant species encountered was *Quercus rubra* (n=22), with a relative frequency of 33.33% within this interval range. Following were *Robinia pseudoacacia* (n=11) (16.66%), *Quercus coccinea* (n=5) (7.57%), *Sassafras albidum* (n=4) (6.06%), *Carya cordiformis* (n=3) (4.54%), *Fraxinus americana* (n=3) (4.54%), *Prunus serotina* (n=2) (3.03%), *Quercus alba* (n=2) (3.03%), and *Q. velutina* (n=2) (3.03%) in order of decreasing abundance There were 12 singletons (n=1) (1.51%) within this range: *Acer platanoides*, *Aesculus hippocastanum*, *Betula lenta*, *Carya tomentosa*, *Gleditsia triacanthos*, *Juglans cinerea* and *J. nigra*, *Maclura pomifera*, *Morus alba*, *Paulownia tomentosa*, *Quercus prinus*, and *Ulmus americana*. There were 66 species in 13 families within this range. The largest tree in this mid-size class was *Sassafras albidum* (29.90 cm DBH), followed by *Quercus rubra* (29.50 cm DBH), *Q. coccinea* (29.40 cm DBH), *Robinia pseudoacacia* and *Ulmus americana*, both at 28.90 cm DBH.

In the next size class, large diameter stems (n=178) comprised 4% of the sampled population. Species richness was represented by 25 species in 15 families. Frequency distribution ranged within a DBH of 30.20 - 171.20 cm (mean 56.26 cm, SD 24.84). Mean stem density per quadrat was 3.95 with a combined basal area (BA) of 10.14 m^2 (10014.80 cm^2) (Figure 3.15c).

Within a range of 30.20 - 171.20 cm DBH, the taxon most encountered was *Quercus rubra* (n=82), with a relative frequency of 46.06% within this range. Following were *Liriodendron tulipifera* (n=23) (12.92%), *Quercus velutina* (n=14) (7.86%), *Q. prinus* (n=13) (7.30%), *Q. alba* (n=6) (3.3%), *Aesculus hippocastanum* (n=5) (2.80%), *Carya cordiformis* (n=5) (2.80%), *Robinia pseudoacacia* (n=4) (2.24%), *Acer saccharum* (n=3) (1.68%), *Fraxinus americana* (n=3) (1.68%), *Quercus coccinea* (n=3) (1.68%), *Paulownia tomentosa* (n=2) (1.12%), *Pinus nigra* (n=2) (1.12%), and *Tilia americana* (n=2) (1.12%) in order of decreasing abundance. There were 11 singletons (n=1) (0.56%) represented by *Acer rubrum*, *Betula lenta*, *Carya ovata*, *Celtis occidentalis*, *Fagus grandifolia*, *F. sylvatica*, *Gymnocladus dioica*, *Prunus serotina*, *Sassafras albidum*, *Tsuga canadensis*, and *Ulmus americana*. The largest tree was *Fagus sylvatica* (171.20 cm DBH), and the smallest, *Carya cordiformis* (30.20 cm DBH), within this range.

Within a DBH range of 30.20 - 40.80 cm, the species most encountered were *Quercus rubra* (n=33), with a relative frequency of 48.52% within this DBH range. Following were *Quercus velutina* (n=6) (8.82%), *Quercus prinus* (n=5) (7.35%), *Carya cordiformis* (n=4) (5.88%), *Liriodendron tulipifera* (n=3) (4.41%), *Quercus coccinea* (n=3) (4.41%), *Aesculus hippocastanum* (n=2) (2.94%), *Quercus alba* (n=2) (2.94%), and *Robinia pseudoacacia* (n=2) (2.94%) in order of decreasing abundance. There were 68 species in 11 families represented within this DBH range.

Frequency Distribution for Woody Taxa of Different Diameter Size Classes for the Valley-Clove Forest: Small and Large

In the Valley-Clove forest, species richness within the small diameter (DBH) trees, shrubs, and vines, was represented by 25 woody species in 17 families. Frequency distribution ranged within a DBH of 2.00 - 9.50 cm (mean 2.74 cm, SD 0.78). Stem density was 742 stems in 11 10 X 10 m^2 quadrats with a combined basal area (BA) of 2.67 m^2 (26755.70 cm^2) (Figure 3.16a). Mean stem density per quadrat was 41.2%.

Within a DBH range of 2.00 - 9.50 cm, small-size stems (n=742) represented

93.92% of the sampled population out of the entire 790 stems for the Valley-Clove. Out of the overall small stem category (n=3765), the Valley-Clove represented 19.70% of the sampled taxa.

Within this range, the species most frequently encountered was *Lindera benzoin* (n=572) with a relative frequency of 77.08%. Following were *Rosa multiflora* (n=40) (5.39%), *Viburnum dentatum* (n=24) (3.23%), *Acer rubrum* (n=13) (1.75%), *Viburnum acerifolium* (n=12) (1.61%), *Celtis occidentalis* (n=11) (1.48%), *Hamamelis virginiana* (n=10) (1.34%), *Viburnum prunifolium* (n=10) (1.34%), *Carya cordiformis* (n=8) (1.07%), *Viburnum opulus* (n=7) (0.94%), *Acer saccharum* (n=6) (0.80%), *Celastrus orbiculatus* (n=4) (0.53%), *Fraxinus americana* (n=4) (0.53%), *Prunus serotina* (n=4) (0.53%), and *Tilia americana* (n=3) (0.40%) in order of decreasing abundance. In less frequent encounters were *Carya ovata* (n=2) (0.27%), *Morus alba* (n=2) (0.27%), *Sassafras albidum* (n=2) (0.27%), (0.27%), and *Vitis labrusca* (n=2) (0.27%). The rest of the species were all singletons (n=1) (0.13%) represented by *Ailanthus altissima*, *Cercis canadensis*, *Cornus florida*, *Crataegus* spp., *Liriodendron tulipifera*, and *Quercus rubra*.

Among shrubs, *Lindera benzoin* had the greatest relative density of 72.4% followed by *Rosa multiflora* (5.17%), and *Viburnum dentatum* (3.0%). *Lindera benzoin* had the highest relative dominance (0.18%) in this size class as an extrapolation of the basal area followed by *Rosa multiflora* (0.08%) and *Viburnum dentatum* (0.05%). In the small size hierarchy, the high values gave *Lindera benzoin* an importance value (IV) of 87.77% making it the ecologically dominant taxon (Table 3.9).

On close inspection, within a DBH range of 2.00 - 3.00 cm, the species most frequently encountered was *Lindera benzoin* (n=434) with a relative frequency of 80.90%

within this interval range. Following, in order of decreasing abundance were, *Rosa multiflora* (n=40) (7.46%), *Viburnum dentatum* (n=23) (4.29%), *V. acerifolium* (n=12) (2.23%), *V. prunifolium* (n=7) (1.30%), *V. opulus* (n=6) (1.11%), and *Acer rubrum* (n=5) (0.93%). The frequency distribution peaks at 536 stems within this interval bar representing 72.2% of the sampled population. There were 13 species in 9 families just within this range which displayed a substantial number of small size stems.

Within a DBH range of 3.00 - 4.00 cm, the interval bar drops considerably. The species most frequently encountered was *Lindera benzoin* (n=135), with a relative frequency of 78.03% within this DBH range. Following, in order of decreasing abundance were, *Hamamelis virginiana* (n=8) (4.62%), *Acer rubrum* (n=4) (2.31%), *Carya cordiformis* (n=4) (2.31%), *Fraxinus americana* (n=4) (2.31%), *Celtis occidentalis* (n=3) (1.73%), *Acer saccharum* (n=2) (1.15%), and *Carya ovata* (n=2) (1.5%). There were 173 stems in the sampled population (23.3%) represented by 17 species in 13 families within this interval bar.

In the next diameter (DBH) size-class, species richness was represented by 12 woody taxa in 10 families representing 5.06% of the sampled population. Large size stems ranged within a DBH of 30.20 - 122.60 cm (mean 68.36 cm, SD 29.15). Stem density was 40 stems within the 18 10 X 10 m^2 quadrats with a combined basal area of 0.279 m^2 (2,796.90 cm^2). Mean stem density per quadrat was 2.2%.

The species within this DBH range were largely represented by *Liriodendron tulipifera* (n=19), with a relative frequency of 47.50% making it the ecologically dominant taxon. Following, in order of decreasing abundance were, *Quercus rubra* (n=7) (17.50%), *Acer saccharum* (n=2) (5.00%), *Carya cordiformis* (n=2) (5.00%), *Fraxinus* *americana* (n=2) (5.00%), and *Tilia americana* (n=2) (5.00%). There were 6 singletons (n=1) (2.5%) represented by *Betula lenta*, *Carya ovata*, *Paulownia tomentosa*, *Prunus serotina*, *Quercus alba*, and *Ulmus americana* (Figure 3.16b). The largest tree was *Quercus rubra* (122.60 cm DBH) followed by *Liriodendron tulipifera* (121.70 cm DBH).

Among trees, *Liriodendron tulipifera* had the greatest relative density of 2.53%, followed by *Quercus rubra* (1.14%). *Liriodendron tulipifera* had the highest relative dominance (59.17%) as an extrapolation of the basal area followed by *Quercus rubra* (19.45%). In the large-size hierarchy, the high values gave *Liriodendron tulipifera* an importance value (IV) of 72.81%, making it the ecologically dominant taxon, followed by *Quercus rubra,* the second dominant, with an IV of 27.99% (Table 3.9).

The Valley Clove forest has a high preponderance of small stems, largely in the shrub category, scattered among lesser numbers of mature canopy trees, nearly all of which are in the large size category as mentioned above. There were very few mid-size trees (n=8) (0.062%) that were sampled out of the 11 quadrats that would have constituted a mid-size diameter category. These few individuals fell within the DBH range of 12.00 - 30.00 cm as follows: *Acer saccharum* (n=1), *Fraxinus americana* (n=1), *Carya cordiformis* (n=1), *C. ovata* (n=1), *Celtis occidentalis* (n=1) *Morus alba* (n=1), *Q. rubra* (n=1), and *Tilia americana* (n=1).

Frequency Distribution for Woody Taxa of Different Diameter Size Classes for the East Ridge Forest: Small, Mid, and Large

In the East Ridge forest, species richness within the small diameter (DBH) size class of trees, shrubs, and vines, was represented by 29 woody species in 18 families. The small diameter size represented 82.2% of the population sampled within a diameter

(DBH) range of 2.0 - 9.50 cm (mean 2.69 cm, SD 1.19). Stem density was 658 stems in 8 10 X 10 m^2 quadrats with a combined basal area of 0.74 m^2 (1743.20 cm^2) (Figure 3.17a).

Within a DBH range of 2.00 - 9.50 cm, small size stems (n=658) represented 93.06% of the sampled population out of the entire 707 stems for the East Ridge. Out of the overall small stem category (n=3765), the East Ridge represented 17.47% of the sampled taxa. The most frequently encountered species was *Viburnum acerifolium* (n=368) with a relative frequency of 55.92% within this interval range. Following, in order of decreasing abundance, were *Acer rubrum* (n=46) (6.99%), *Rosa multiflora* (n=46) (6.99%), *Prunus serotina* (n=30) (4.55%), *Hamamelis virginiana* (n=29) (4.40%), *Lindera benzoin* (n=29) (4.40%), *Sassafras albidum* (n=16) (2.43%), *Acer saccharum* (n=9) (1.36%), *Betula lenta* (n=9) (1.36%), *Lonicera maackii* (n=9) (1.36%), *Celastrus orbiculatus* (n=8) (1.21%), *Viburnum dentatum* (n=8) (1.21%), *Vitis labrusca* (n=8) (1.21%), *Ampelopsis brevipedunculata* (n=6) (0.91%), *Fraxinus americana* (n=5) (0.76%), *Morus alba* (n=5) (0.76%), *Fagus grandifolia* (n=4) (0.60%), *Vaccinium corymbosum* (n=4) (0.60%), *Ailanthus altissima* (n=3) (0.45%), *Cornus florida* (n=3) (0.45%), *Rubus allegheniensis* (n=3) (0.45%), *Carya cordiformis* (n=2) (0.30%), and *Catalpa bignonioides* (n=2) (0.30%). There were 6 singletons (n=1) (0.15%) represented by *Acer platanoides*, *Carya tomentosa*, *Celtis occidentalis*, *Quercus alba*, *Q. prinus*, and *Q. rubra*.

Among shrubs, *Viburnum acerifolium* had the highest relative density of 52.05% followed by *Rosa multiflora* (6.51%) and *Hamamelis virginiana* (4.10%). *Viburnum acerifolium* had the highest relative dominance (1.42%) in this size class as an extrapolation of the basal area followed by *Hamamelis virginiana* (0.38%) and *Rosa* *multiflora* (0.17%). In the small-size hierarchy, the high values gave *Viburnum acerifolium* an importance value (IV) of 62.11%, making it the ecologically dominant taxon, followed by *Hamamelis virginiana* (IV = 9.41%) and *Rosa multiflora* (IV = 9.14%) (Table 3.10).

On close inspection, within the DBH range of 2.00 - 3.00 cm, the small size stems (n=515) represented 78.3% of the sampled population. Among the most frequently encountered species was *Viburnum acerifolium* (n=367) with a relative frequency of 71.26% within this interval range. Following, in order of decreasing abundance, were *Rosa multiflora* (n=46) (8.93%), *Lindera benzoin* (n=21) (4.07%), *Sassafras albidum* (n=12) (2.33%), *Acer rubrum* (n=10) (1.94%), *Celastrus orbiculatus* (n=8) (1.55%), *Lonicera maackii* (n=8) (1.55%), *Viburnum dentatum* (n=8) (1.55%), *Ampelopsis brevipedunculata* (n=6) (1.16%), *Vitis labrusca* (n=6) (1.16%), *Prunus serotina* (n=5) (0.97%), *Vaccinium corymbosum* (n=4) (0.77%), *Acer saccharum* (n=3) (0.58%), *Betula lenta* (n=3) (0.58%), *Rubus allegheniensis* (n=3) (0.58%), and *Hamamelis virginiana* (n=2) (0.38%). There were 3 singletons (n=1) (0.19%) represented by *Acer platanoides*, *Catalpa bignonioides*, and *Quercus prinus*. In this interval bar, the frequency distribution peaks, as the taxa were mostly shrubs and vines along with a few small-size trees, representing 19 species in 12 families.

In the next diameter (DBH) size-class, species richness among trees was 11 species within 9 families representing 2.83% of the sampled taxa out of the 707 stems in the East Ridge forest. Out of the overall mid-size stem category (n=127), the East Ridge represented 15.7% of the sampled population. Mid-size stems ranged within a DBH of 11.20 - 29.90 cm (mean 18.37 cm, SD 5.57). Stem density was 20 stems within the 8

10 X 10 m^2 quadrats with a combined basal area of $0.38m^2$ ($3.85.40\ cm^2$) (Figure 3.17b). Mean stem density per quadrat was 2.5%.

Within the DBH range of 11.90 - 29.90, mid-size stems most frequently encountered was *Ailanthus altissima* (n=6) with a relative frequency of 30.00% within this interval range. Following were *Quercus alba* (n=3) (15.00%), *Cornus florida* (n=2) (10.00%), and *Quercus rubra* (n=2) (10.00%). There were 7 singletons (n=1) (5.00%) represented by *Acer platanoides* and *A. rubrum*, *Carya tomentosa*, *Celtis occidentalis*, *Liriodendron tulipifera*, *Prunus serotina*, and *Sassafras albidum*. The largest diameter stem was *Sassafras albidum* (29.90 cm DBH) followed by *Quercus rubra* (27.80 cm DBH).

In the next diameter (DBH) size class, species richness was 8 woody taxa within 4 families representing 4.1% of the sampled taxa out of the 707 stems in the East Ridge forest. Out of the overall large-size stem category (n=178), the East Ridge represented 15.7% of the sampled taxa. Large size stems ranged within a DBH of 31.50 - 87.70 cm (mean 56.38 cm, SD 19.73). Stem density was 29 stems within the 8 10 X 10 m^2 quadrats with a combined basal area of $0.163m^2$ ($1,635.00\ cm^2$) (Figure 3.17c). Mean stem density per quadrat was 3.62%.

Among the trees most frequently encountered was *Quercus rubra* (n=13) with a relative frequency of 44.82% within this DBH range. Following, in order of decreasing abundance, were *Quercus prinus* (n=7) (24.13%), *Q. alba* (n=3) (10.34%), and *Q. velutina* (n=2) (6.89%). There were 4 singletons (n=1) (3.44%) represented by *Acer saccharum*, *Fraxinus americana*, *Pinus nigra*, and *Quercus coccinea*. The three largest diameter stems were represented by *Quercus rubra*, 87.70 cm and 87.20 cm respectively, followed by *Pinus nigra* (86.10 cm). The Fagaceae, with five species in the genus *Quercus*, are well represented on the East Ridge. However, there is an absence of the Magnoliaceae within the large size-class. Soils here may be a factor as well as the many fires that have plagued this geographic location. *Quercus* spp. seem to survive the frequent fires as does *Prunus serotina*.

Among trees, *Quercus rubra* had the highest relative density of 2.26% followed by *Q. prinus* (1.13%) and *Q. alba* (0.99%). *Quercus rubra* had the greatest relative dominance of 4.61% in this size class as an extrapolation of the basal area followed by *Q. prinus* (1.77%), and *Q. alba* (1.19%). In the large-size hierarchy, the high values gave *Quercus rubra* an importance value (IV) of 57.05%, making it the top ecologically dominant taxon followed by *Q. prinus* (IV = 22.60%), and *Q. alba* (IV = 16.64%) (Table 3.10).

Frequency Distribution for Woody Taxa of Different Diameter Size Classes for the Ridge Tops (east and west) Forest: Small, Mid, and Large

For the Ridge Tops (east and west) forest, species richness within the small diameter (DBH) size class of trees, shrubs, and vines, was represented by 30 woody species in 19 families. The small diameter (DBH) size represented 89.2% of the population sampled out of entire 595 stems for the Ridge Tops. Out of the overall small-size stem category (n=3765), the Ridge Tops represented 14.10% of the sampled taxa. Small size stems ranged within a diameter (DBH) of 2.0 - 9.70 cm (mean 2.77 cm, SD 1.13). Stem density was 531 stems in 8 10 X 10 m^2 quadrats with a combined basal area of 0.146 m^2 (1468.40 cm^2) (Figure 3.18a). Mean stem density per quadrat was 66.3%.

Within a DBH range of 2.0 - 9.70 cm, the small size stems most frequently encountered was *Prunus serotina* (n=75) with a relative frequency of 14.12% within this interval range. Following, in order of decreasing abundance, were *Viburnum acerifolium* (n=70) (13.18%), *Celastrus orbiculatus* (n=63) (11.86%), *Viburnum dentatum* (n=46) (8.66%), *Fraxinus americana* (n=43) (8.09%), *Sassafras albidum* (n=40) (7.53%), *Carya cordiformis* (n=37) (6.96%), *Lonicera maackii* (n=33) (6.21%), *Rosa multiflora* (n=19) (3.57%), *Betula lenta* (n=13) (2.44%), *Acer saccharum* (n=10) (1.88%), *Rhus typhina* (n=10) (1.88%), *Toxicodendron radicans* (n=10) (1.88%), *Philadelphus coronarius* (n=9) (1.69%), *Rubus occidentalis* (n=9) (1.69%), *Rhus aromatica* (n=6) (1.13%), *Euonymus alatus* (n=5) (0.94%), *Ailanthus altissima* (n=4) (0.75%), *Ampelopsis brevipedunculata* (n=4) (0.75%), *Carya tomentosa* (n=4) (0.75%), *Wisteria sinensis* (n=4) (0.75%), *Amelanchier canadensis* (n=3) (0.56%), *Morus alba* (n=3) (.056%), *Catalpa bignonioides* (n=2) (0.37%), *Celtis occidentalis* (n=2) (0.37%), *Pyrus baccata* (n=2) (0.37%), and *P. malus* (n=2) (0.37%). There were 3 singletons (n=1) (0.18%) represented by *Acer rubrum*, *Cornus florida*, and *Quercus prinus*.

Among shrubs and vines, *Viburnum acerifolium* had the highest relative density of 11.77% followed by *Celastrus orbiculatus* (10.59%), and *Lonicera maackii* (5.55%). *Viburnum acerifolium* had the highest relative dominance (0.24%) as an extrapolation of the basal area followed by *Celastrus orbiculatus* (0.22%) and *Lonicera maackii* (0.21%). The high values gave *Viburnum acerifolium* an importance value (IV) of 14.30% as the dominant taxon among shrubs, and *Celastrus orbiculatus* (IV = 14.25%), was the dominant taxon among vines within this same interval range (Table 3.11).

On close inspection, within a DBH range of 2.0 - 3.0 cm, the small size stems (n=394) represented 74.2% out of the 531 stems sampled. The species most frequently encountered was *Viburnum acerifolium* (n=70) with a relative frequency of 17.76% within this interval range. Following, in order of decreasing abundance, were *Celastrus orbiculatus* (n=63) (15.99%), *Viburnum dentatum* (n=46) (11.67%), *Prunus serotina* (n=42) (10.66%), *Sassafras albidum* (n=31) (7.86%), *Fraxinus americana* (n=28) (7.10%), *Carya cordiformis* (n=24) (6.09%), *Lonicera maackii* (n=20 (5.06%), *Rosa multiflora* (n=19) (4.82%), *Toxicodendron radicans* (n=10) (2.53%), *Philadelphus coronarius* (n=9) (2.28%), *Rubus occidentalis* (n=9) (2.28%), *Euonymus alatus* (n=5) (1.26%), *Ampelopsis brevipedunculata* (n=4) (1.01%), *Rhus typhina* (n=4) (1.01%), *Rhus aromatica* (n=3) (0.76%), *Acer saccharum* (n=2) (0.50%), and *Wisteria sinensis* (n=2) (0.50%). There were 3 singletons (n=1) (0.25%) represented by *Betula lenta*, *Celtis occidentalis*, and *Pyrus baccata*. Species richness within this interval bar was 21 species in 14 families consisting mainly of shrubs and vines, with *Prunus serotina*, *Sassafras albidum*, *Fraxinus americana*, and *Carya cordiformis* accounting for the small-size trees.

In the next diameter (DBH) size class, species richness was 13 woody taxa in 9 families representing 5.37% of the sampled population out of the entire 595 stems for the Ridge Tops. Out of the overall mid-size stem category (n=127), the Ridge Tops represented 25.2% of the sampled taxa. Mid-size stems ranged within a DBH of 10.40 - 29.40 cm (mean 22.88 cm, SD 5.06). Stem density was 32 stems in 8 10 X 10 m^2 quadrats with a combined basal area of 0.071 m^2 (712.50 cm^2) (Figure 3.18b). Mean stem density per quadrat was 4%.

Within a DBH range of 10.40 - 29.40 cm, mid-size stems most frequently encountered were *Quercus rubra* (n=10) with a relative frequency of 31.25% within this interval range. Following, in decreasing abundance, were *Prunus serotina* (n=5)

(15.62%), *Fraxinus americana* (n=4) (12.50%), and *Quercus coccinea* (n=4) (12.50%). There were 9 singletons (n=1) (3.12%) within this interval range represented by *Aesculus hippocastanum*, *Betula lenta*, *Carya cordiformis*, *Juglans cinerea* and *J. nigra*, *Liriodendron tulipifera*, *Maclura pomifera*, *Paulownia tomentosa*, and *Quercus prinus*. The largest diameter stem was *Quercus coccinea* (29.40 cm DBH) (Ridge Top east) followed by *Quercus rubra* (28.60 cm DBH) (Ridge Top west). In contrast to the small size stem category, mid-size stems were few as is the case for the next diameter size-class, large size. The Ridge Tops have many small stems with canopy gaps where fires have occurred. *Prunus serotina* and *Sassafras albidum* are prolific sprouters in these gaps as noted by their abundance.

In the next diameter (DBH) size-class, species richness was 32 woody taxa in 4 families representing 5.37% of the sampled population out of the entire 595 stems for the Ridge Tops. Out of the overall large-size stem category (n=178), the Ridge Tops represented 17.98% of the sampled taxa. Stem density was 32 stems in 8 10 X 10 m^2 quadrats. Large-size stems ranged within a DBH of 30.50 - 100.20 cm (mean 52.67 cm, SD 23.07) with a combined basal area of 0.159 m^2 (1590.20 cm^2) (Figure 3.18c). Mean stem density per quadrat was 4%.

Within a DBH range of 30.50 - 100.20 cm, the species most encountered was *Quercus rubra* (n=20) with a relative frequency of 62.50% within this interval range. Following were *Quercus velutina* (n=4) (12.50%), *Liriodendron tulipifera* (n=2) (3.12%), and *Quercus coccinea* (n=2) (3.12%) in order of decreasing abundance. *Quercus rubra* had the highest relative dominance (59.21%) as an extrapolation of the basal area for the Ridge Tops. The high value marked it as the ecologically dominant taxon with an importance value of 72.30% (Table 3.11).

Within a DBH range of 30.5 - 49.60 cm, the first five interval bars, the frequency distribution displays a marked contrast to the remaining intervals. Within this range there were 6 species in 3 families represented by *Quercus rubra* (n=12) (60%), *Q. velutina* (n=3) (15%), *Q. coccinea* (n=2) (10%), and 3 singletons (n=1) (5%), *Aesculus hippocastanum*, *Paulownia tomentosa*, and *Quercus alba*. The Fagaceae is the dominant family on the Ridge Tops (east and west). However, there are relatively few individuals as was displayed for the mid-size class of trees compared to the number of small-size stems mentioned above. *Aesculus hippocastanum* is spreading in certain areas on the West Ridge, and there are a good number of mature specimens. *Paulownia tomentosa* does not appear to be seeding in, as no seedling-sapling size trees were encountered during the census.

Frequency Distribution for Woody Taxa of Different Diameter Size Classes in the West Ridge Forest: Small, Mid, and Large

For the West Ridge forest, species richness within the small diameter size class of trees, shrubs, and vines was represented by 55 woody taxa in 25 families. The small diameter size represented 92.72% of the sampled population out of the entire 1978 stems for the West Ridge. Out of the overall small-size stem category (n=3765), the West Ridge represented 48.71% of the sampled taxa. Small-size stems ranged within a DBH of 2.00 - 9.70 cm (mean 2.69 cm, SD 1.00) (Figure 3.19a). Stem density was 1834 stems in 18 10 X 10 m^2 quadrats with a combined basal area of 0.495 m^2 (4953.30 cm^2). Mean stem density per quadrat was 101.8%.

Within the small diameter (DBH) (2.00 - 9.70 cm) size class, the species most encountered was *Lonicera maackii* (n=227) with a relative frequency of 12.37% within this interval range. Following were *Viburnum acerifolium* (n=168) (9.16%), *Prunus serotina* (n=166) (9.05%), *Lindera benzoin* (n=159) (8.67%), *Viburnum dentatum* (n=113) (6.16%), *Cornus foemina* (n=111) (6.05%), *Celastrus orbiculatus* (n=106) (5.78%), *Rosa multiflora* (n=81) (4.41%), *Rubus laciniatus* (n=44) (2.39%), *Fraxinus americana* (n=41) (2.23%), *Carya cordiformis* (n=39) (2.12%), *Ailanthus altissima* (n=38) (2.107%), *Rubus occidentalis* (n=38) (2.07%), *Sassafras albidum* (n=38) (2.07%), *Forsythia suspensa* (n=33) (1.79%), *Toxicodendron radicans* (n=33) (1.79%), *Ampelopsis brevipedunculata* (n=26) (1.41%), *Gymnocladus dioica* (n=26) (1.41%), *Acer saccharum* (n=23) (1.25%), *Hibiscus syriacus* (n=22) (1.20%), *Acer rubrum* (n=21) (1.14%), *Cornus sericea* (n=21) (1.14%), *Rubus allegheniensis* (n=21) (1.14%), *Rhus typhina* (n=20) (1.09%), *Betula lenta* (n=19) (1.03%), *Viburnum prunifolium* (n=18) (0.98%), *Vitis riparia* (n=17) (0.92%), *Rhodotypos scandens* (n=14) (0.76%), *Hamamelis virginiana* (n=13) (0.70%), *Ligustrum vulgare* (n=13) (0.70%), *Quercus rubra* (n=12) (0.65%), and *Pinus strobus* (n=11) (0.60%) in order of decreasing abundance. In fewer numbers were *Celtis occidentalis* (n=9) (0.49%), *Fagus grandifolia* (n=8) (0.43%), *Robinia pseudoacacia* (n=8) (0.43%), *Aesculus hippocastanum* (n=7) (0.38%), *Acer pseudoplatanus* (n=6) (0.32%), *Aronia arbutifolia* (n=6) (0.32%), *Liriodendron tulipifera* (n=6) (0.32%), *Rhododendron periclymenoides* (n=6) (0.32%), *Carya tomentosa* (n=5) (0.27%), *Cornus amomum* (n=5) (0.27%), *Vitis aestivalis* (n=5) (0.27%), *Acer platanoides* (n=4) (0.21%), *Cornus florida* (n=4) (0.21%), *Quercus alba* (n=0.21%), *Vitis labrusca* (n=4) (0.21%), *Morus alba* (n=3) (0.16%), *Pyrus baccata* (n=3) (0.16%), *Phellodendron amurense* (n=2) (0.10%), *Quercus velutina* (n=2) (0.10%), and *Prunus* *avium* (n=2) (0.10%) in order of decreasing abundance. There were 3 singletons (n=1) (0.50%) represented by *Fagus sylvatica*, *Pyrus communis*, and *Wisteria sinensis*.

Among shrubs in the West Ridge forest, *Lonicera maackii* (n=227) had the greatest relative density of 11.48% followed by *Viburnum acerifolium* (n=168) (8.44%), *Lindera benzoin* (n=159) (8.04%), *Viburnum dentatum* (n=113) (5.71%), and *Cornus foemina* (n=111) (5.61%).

Lonicera maackii had the highest relative dominance of 0.58% followed by *Lindera benzoin* (0.40%) and *Viburnum acerifolium* (0.25%) as an extrapolation of the basal area. These high values gave *Lonicera maackii* an importance value (IV) of 16.42%, making it the ecologically dominant shrub, followed by *Lindera benzoin* (IV = 11.50%) and *Viburnum acerifolium* (IV = 10.49%) (Table 3.12).

Among vines in the West Ridge forest, *Celastrus orbiculatus* (n=106) had the greatest relative density of 5.36% with a relative frequency of 4.37%. In terms of relative dominance, *Celastrus orbiculatus* ranked low at 0.25%. However, combined with relative density and frequency among vines, it garnered an importance value (IV) of 9.89%, making it the ecologically dominant vine (Table 3.12).

On close inspection, within a DBH range of 2.0 - 3.0 cm, small size stems (n=1412) represented 71.38% out of the small-size category of stems (n=1834) sampled (Figure 3.19a). The species most encountered within this interval range were *Viburnum acerifolium* (n=168) with a relative frequency of 11.89%. Following were *Lonicera maackii* (n=161) (11.40%), *Lindera benzoin* (n=118) (8.35%), *Viburnum dentatum* (n=118) (8.00%), *Celastrus orbiculatus* (n=106) (7.50%), *Cornus foemina* (n=99) (7.01%), *Prunus serotina* (n=94) (6.65%), *Rosa multiflora* (n=81) (5.73%), *Rubus* *laciniatus* (n=44) (3.11%), *Rubus occidentalis* (n=38) (2.69%), *Toxicodendron radicans* (n=30) (2.12%), *Fraxinus americana* (n=28) (1.98%), *Sassafras albidum* (n=28) (1.98%), *Ampelopsis brevipedunculata* (n=26) (1.84%), *Carya cordiformis* (n=22) (1.55%), *Forsythia suspensa* (n=22) (1.55%), *Ailanthus altissima* (n=21) (1.48%), *Cornus sericea* (n=21) (1.48%), *Rubus allegheniensis* (n=21) (1.48%), *Viburnum prunifolium* (n=16) (1.13%), *Vitis riparia* (n=15) (1.06%), *Hibiscus syriacus* (n=14) (0.99%), and *Rhodotypos scandens* (n=14) (0.99%) in order of decreasing abundance. Species less frequently encountered were *Gymnocladus dioica* (n=12) (1.98%), *Rhus typhina* (n=10) (0.70%), *Hamamelis virginiana* (n=9) (0.63%), *Acer rubrum* (n=8) (0.56%), *Betula lenta* (n=8) (0.56%), *Ligustrum vulgare* (n=8) (0.56%), *Quercus rubra* (n=8) (0.56%), *Aronia arbutifolia* (n=6) (0.42%), *Rhododendron pericylmenoides* (n=6) (0.42%), *Acer saccharum* (n=5) (0.35%), *Aesculus hippocastanum* (n=5) (0.35%), *Cornus amomum* (n=5) (0.35%), *Vitis aestivalis* (n=5) (0.35%), *Acer pseudoplatanus* (n=3) (0.21%), *Fagus grandifolia* (n=3) (0.21%), *Vitis labrusca* (n=3) (0.21%), *Acer platanoides* (n=2) (0.14%), *Celtis occidentalis* (n=2) (0.14%), and *Quercus velutina* (n=2) (0.14%). There were 2 singletons (n=1) (0.07%) represented by *Fagus sylvatica* and *Robinia pseudoacacia*. Just within this interval bar, there were 44 woody species out of the entire 55 species recorded for the West Ridge representing 21 families. Almost all of the stems counted were in the shrub and vine category along with very few tree saplings, mainly *Prunus serotina* (n=94), which had the greatest abundance.

Within the DBH range of 3.0 - 4.0 cm, small-size stems (n=298) represented 15.06% out of the small-size category of stems (n=1834) sampled. The species most encountered within this interval range was *Lonicera maackii* (n=66) with a relative frequency of 22.14% followed by *Prunus serotina* (n=44) (14.76%), *Lindera benzoin* (n=41) (13.75%), *Ailanthus altissima* (n=15) (5.03%), *Cornus foemina* (n=12) (4.02%), *Forsythia suspensa* (n=11) (3.69%), *Fraxinus americana* (n=11) (3.69%), *Rhus typhina* (n=10) (3.35%), *Carya cordiformis* (n=9) (3.02%), *Acer saccharum* (n=8) (2.68%), *Hibiscus syriacus* (n=8) (2.68%), *Gymnocladus dioica* (n=7) (2.34%), *Sassafras albidum* (n=7) (2.34%), *Ligustrum vulgare* (n=5) (1.67%), *Betula lenta* (n=4) (1.34%), *Fagus grandifolia* (n=4) (1.34%), and *Hamamelis virginiana* (n=4) (1.34%). In fewer numbers were *Acer pseudoplatanus* (n=3) (1.00%), *Toxicodendron radicans* (n=3) (1.00%), *Acer platanoides* (n=2) (0.67%), *Acer rubrum* (n=2) (0.67%), *Aesculus hippocastanum* (n=2) (0.67%), *Carya tomentosa* (n=2) (0.67%), *Celtis occidentalis* (n=2) (0.67%), *Phellodendron amurense* (n=2) (0.67%), *Quercus rubra* (n=2) (0.67%), *Robinia pseudoacacia* (n=2) (0.67%), *Viburnum prunifolium* (n=2) (0.67%), and *Vitis riparia* (n=2) (0.67%). There were 6 singletons (n=1) (0.33%) represented by *Morus alba*, *Pinus strobus*, *Pyrus baccata*, *P. communis*, *Vitis labrusca*, and *Wisteria sinensis*. Within this interval range, there were 35 species in 22 families.

In the next diameter (DBH) size class, species richness was 21 woody taxa in 13 families representing 3.38% of the sampled population out of the entire 1978 stems for the West Ridge forest. Out of the overall mid-size stem category (n=127), the West Ridge represented 52.8% of the sampled taxa. Mid-size stems ranged within a DBH of 10.20 - 29.60 cm (mean 21.27 cm, SD 6.37). Stem density was 67 stems in 18 10 X 10 m^2 quadrats with a combined basal area of 0.123m^2 (1236.00 cm^2) (Figure 3.19b). Mean stem density per quadrat was 3.72%.

Within a DBH range of 10.20 - 29.60 cm, mid-size stems most frequently encountered was *Robinia pseudoacacia* (n=19) with a relative frequency of 28.35% within this interval range. Following were *Quercus rubra* (n=12) (17.91%), *Carya cordiformis* (n=4) (5.97%), *Pinus strobus* (n=4) (5.97%), *Celtis occidentalis* (n=3) (4.47%), *Prunus serotina* (n=3) (4.47%), *Quercus velutina* (n=3) (4.47%), *Sassafras albidum* (n=3) (4.47%), *Acer rubrum* (n=2) (2.98%), *Carya tomentosa* (n=2) (2.98%), and *Liriodendron tulipifera* (n=2) (2.98%) in order of decreasing abundance. There were 10 singletons (n=1) (1.49%) represented by *Betula lenta*, *Gleditsia triacanthos*, *Gymnocladus dioica*, *Maclura pomifera*, *Morus alba*, *Phellodendron amurense*, *Quercus alba*, *Q. coccinea*, *Q. prinus*, and *Ulmus americana*.

Within a DBH range of 10.20 - 19.70 cm, the first 10 interval bars, mid-size stems (n=30) were represented by *Robinia pseudoacacia* (n=8) with a relative frequency of 26.66% followed by *Pinus strobus* (n=4) (13.33%), *Celtis occidentalis* (n=3) (10.00%), *Acer rubrum* (n=2) (6.66%), *Liriodendron tulipifera* (n=2) (6.66%), and *Prunus serotina* (n=2) (6.66%). The rest of the species were all singletons (n=1) (3.33%) represented by *Carya cordiformis*, *C. tomentosa*, *Gymnocladus dioica*, *Maclura pomifera*, *Morus alba*, *Phellodendron amurense*, *Quercus alba*, *Q. rubra*, and *Q. velutina*. *Carya tomentosa*, *Morus alba*, and *Prunus serotina* were the largest stems within this range, each measuring 19.70 cm DBH, while the smallest was *Pinus strobus* (10.20 cm DBH).

Within a DBH range of 21.20 - 29.60 cm, the next seven interval bars, mid-size stems (n=37) were largely represented by *Quercus rubra* (n=11) with a relative frequency of 29.73% followed by *Robinia pseudoacacia* (n=11) (29.73%), *Carya cordiformis* (n=3) (8.10%), *Sassafras albidum* (n=3) (8.10%), and *Quercus velutina* (n=2) (5.40%) in order of decreasing abundance. There were 7 singletons (n=1) (2.70%) represented by *Betula* *lenta*, *Carya tomentosa*, *Gleditsia triacanthos*, *Prunus serotina*, *Quercus coccinea*, *Q. prinus*, and *Ulmus americana*. The largest mid-size stem was *Sassafras albidum* (29.60 cm DBH), and the smallest, *Quercus velutina* (21.20 cm DBH), within this interval range.

In the next diameter (DBH) size class, species richness was 16 woody species in 10 families representing 3.89% of the sampled population out of the entire 1978 stems for the West Ridge forest. Out of the overall large-size stem category (n=178), the West Ridge represented 43.25% of the sampled taxa. Large size stems ranged within a diameter (DBH) of 30.40 - 171.20 cm (mean 51.42 cm, SD 23.10). Stem density was 77 stems in 18 10 X 10 m^2 quadrats with a combined basal area of 0.393 m^2 (3931.30 cm^2) (Figure 3.19c). Mean stem density per quadrat was 4.27%.

Within a DBH range of 30.40 - 171.20 cm, among the large-size stems most frequently encountered was *Quercus rubra* (n=42) with a relative frequency of 54.54% within this interval range. Following were *Quercus velutina* (n=8) (10.39%), *Q. prinus* (n=5) (6.49%), *Aesculus hippocastanum* (n=4) (5.19%), *Robinia pseudoacacia* (n=4) (5.19%), *Carya cordiformis* (n=3) (3.89%), and *Liriodendron tulipifera* (n=2) (2.59%) in order of decreasing abundance. There were 9 singletons (n=1) (1.29%) represented by *Acer rubrum*, *Celtis occidentalis*, *Fagus grandifolia*, *F. sylvatica*, *Gymnocladus dioica*, *Pinus nigra*, *Quercus alba*, *Sassafras albidum*, and *Tsuga canadensis*. There were 16 woody species in 10 families within this interval range in contrast to the small size category (n=1834) which had a much narrower interval range, but with 55 species in 25 families. However, many of the small size diameter (DBH) stems consisted of shrubs and vines and fewer trees.

Among trees in the West Ridge forest, *Prunus serotina* (n=169) had the greatest relative density of 8.54% and relative frequency of 6.99%. However, *Quercus rubra* (n=66) with a relative density of 3.34% and relative frequency of 6.11%, had a greater relative dominance of 41.21% in contrast to *Prunus serotina* (1.09%) as an extrapolation of the basal area, which gave it an importance value (IV) of 50.66%. *Prunus serotina*, in contrast, as an extrapolation of the basal area based on relative dominance, had an importance value (IV) of 16.62%, considerably less than *Quercus rubra*, which is the top ecologically dominant tree in the large-size class hierarchy (Table 3.13). *Prunus serotina* had a greater abundance in the small size stem category (n=166) as opposed to *Quercus rubra* (n=12), indicating perhaps the composition of the future forest of Inwood as there are many canopy gaps on the West Ridge where *Prunus serotina* is very abundant.

Within a DBH range of 30.40 - 58.60 cm, the first five interval bars, large-size stems (n=54) most frequently encountered were *Quercus rubra* (n=31) with a relative frequency of 57.40% within this interval range. Following were *Quercus velutina* (n=6) (11.11%), *Q. prinus* (n=5) (9.25%), *Carya cordiformis* (n=3) (5.55%), *Aesculus hippocastanum* (n=2) (3.70%), and *Robinia pseudoacacia* (n=2) (3.70%) in order of decreasing abundance. There were 5 singletons (n=1) (1.85%) represented by *Acer rubrum*, *Celtis occidentalis*, *Gymnocladus dioica*, *Sassafras albidum*, and *Tsuga canadensis*. The largest stem within this interval range was *Quercus rubra* (58.60 cm DBH), and the smallest, *Q. velutina* (30.40 cm DBH). There were 11 woody species in 9 families within this range.

Within a DBH range of 62.40 - 171.20 cm, the next nine interval bars, among large-size stems (n=23) most frequently encountered was Quercus rubra (n=11) with a relative frequency of 47.82% within this range. Following were *Aesculus hippocastanum* (n=2) (8.69%), *Liriodendron tulipifera* (n=2) (8.69%), *Quercus velutina* (n=2) (8.69%), and *Robinia pseudoacacia* (n=2) (8.69%) in order of decreasing abundance.There were 4 singletons (n=1) (4.34%) represented by *Fagus grandifolia*, *F. sylvatica*, *Pinus nigra*, and *Quercus alba*. The largest stem was *Fagus sylvatica* (171.20 cm DBH), a cultivar of the European beech, and the smallest, *Quercus velutina* (62.40 cm DBH), within this interval range representing 9 woody species in 5 families.

Frequency Distribution of all Woody Taxa Families

In this next section, the frequency distributions were considered for all woody taxa families in 45 10 X 10 m^2 quadrats in Inwood Hill Park (n=4070) (Figure 3.20) (Table 3.13, 3,14).

Of the top six families considered here, the Lauraceae (n=861) had the highest relative frequency of 21.15%, as displayed in the seventeenth interval bar. The Lauraceae was represented by two species: *Lindera benzoin* (n=760) and *Sassafras albidum* (n=101) with a family importance value (FIV) of 31.43%. *Lindera benzoin* was found mainly in the Valley-Clove forest. Following was the Adoxaceae (n=843), with the second highest relative frequency of 20.71% displayed in the second interval bar. The frequency distribution was represented by four species in the genus *Viburnum*: *V. acerifolium* (n=618), *V. dentatum* (n=190), *V. opulus* (n=7), and *V. prunifolium* (n=28) with a family importance value (FIV) of 27.77%. The third most frequent family was the Rosaceae (n=621), displayed in the twenty-third bar interval, with a relative frequency of 15.25%. The frequency distribution was represented by *Amelanchier canadensis* (n=3), *Aronia arbutifolia* (n=6), *Crataegus* spp. (n=1), *Hibiscus syriacus* (n=22), *Prunus avium* (n=2), *P. serotina* (n=286), *Pyrus baccata* (n=5), *P. communis* (n=1), *P. malus* (n=2), *Rhodotypos scandens* (n=14), *Rosa multiflora* (n=186), *Rubus allegheniensis* (n=24), *R. laciniatus* (n=44), and *R. occidentalis* (n=47) with a family importance value (FIV) of 26.52%. While there are six tree species that are arboreal, *Prunus serotina* represents the greatest abundance of stems over the remaining arboreal taxa, which boosts the percent of frequency followed by non-arboreal *Rosa multiflora*.

Less frequent was Caprifoliaceae (n=269), with a relative frequency of 6.60% as displayed in the seventh interval bar, and representing one shrub, *Lonicera maackii*, with a family importance value (FIV) of 10.54%. Following was the Fagaceae (n=196), with a relative frequency distribution of 4.81% displayed in the twelfth interval bar, and represented by seven arboreal species: *Fagus grandifolia* (n=13), *F. sylvatica* (n=2), *Quercus alba* (n=16), *Q. coccinea* (n=8), *Q. prinus* (n=17), *Q. rubra* (n=121), and *Q. velutina* (n=19) with a family importance value (FIV) of 71.43%.

The Celastraceae (n=186) had a frequency distribution of 4.57% displayed in the eighth interval bar, and was represented by two non-arboreal species, *Celastrus orbiculatus* (n=181) and *Euonymus alatus* (n=5), with a family importance value (FIV) of 9.14%. *Celastrus orbiculatus* has a wide dispersion throughout Inwood Hill Park, except for the Valley-Clove forest as mentioned earlier in the Chapter. It was the only vine that was included among the twelve top taxa (Table 3.8).

Frequency Distribution for All Tree Families

For the tree families (n=1256) within the 45 10 X 10 m2 quadrats, frequency distributions for the top six families are considered here (Figure 3.21) (Tables 3.15, 3.16).

The family with the greatest frequency distribution among trees was Rosaceae (n=297), with a relative frequency distribution of 23.64% as displayed in the fifteenth interval bar. In terms of ecological dominance, the Rosaceae had a family importance value (FIV) of 37.94%. The top arboreal species was *Prunus serotina* (n=286), which accounted for the large distribution, and the fact that the largest diameter stem for *Prunus serotina* was only 33.0 cm DBH with a mean of 3.93 cm, indicating many small stems.

Following the Rosaceae was the Fagaceae with a relative frequency distribution of 15.60% as displayed in the seventh interval bar.While the Fagaceae was the dominant family (FIV = 88.36%) based on relative dominance and basal area, the distribution for this family was 8% lower than that of the Rosaceae. This discrepancy between distribution and FIVs indicates that many stems of the Fagaceae are in the large diameter size-class in contrast to the Rosaceae, which had many more stems in the small diameter size-class as mentioned above.

The third family was the Aceraceae (n=149), with a relative frequency distribution of 11.86% as displayed in the first interval bar. In terms of relative dominance, the Aceraceae ranked fourth with a family importance value (FIV) of 22.07% among trees only. However, among all woody taxa (n=4070), it ranked eighth with an FIV of 11.20%. The top arboreal species within this family is *Acer rubrum* (n=85) followed by *A. saccharum* (n=52), *A. platanoides* (n=6), and *A. pseudoplatanus* (n=6).

The fourth family was the Juglandaceae (n=115) with a relative frequency distribution of 9.15% as displayed in the ninth interval bar. The top arboreal species was *Carya cordiformis* (n=97) followed by *C. tomentosa* (n=13), *C. ovata* (n=3), *Juglans cinerea* (n=1) and *J. nigra* (n=1). In terms of relative dominance, the Juglandaceae placed fifth among trees only with a family importance value (FIV) of 20.74% after the

Aceraceae, but among all woody taxa, it placed seventh (FIV = 11.24%). The largest stem diameter for *Carya cordiformis* was 41.30 cm and the mean was 6.03 cm, indicating that most stem diameters were in the small to mid-size class.

In fifth place were two families, the Lauraceae and the Oleaceae, both having the same number of stems (n=101) with the same relative frequency distribution of 8.04% as displayed in the tenth and thirteenth interval bar. The only arboreal species within the Lauraceae was represented by *Sassafras albidum* (n=101). In terms of relative dominance, the Lauraceae placed seventh among all trees with a family importance value (FIV) of 16.05% in contrast to the Oleaceae which ranked sixth (FIV = 18.97%). *Sassafras albidum* had many small poles with a wide dispersal, the largest stem diameter being 29.90 cm with a mean of 4.04 cm DBH. However, in a DBH range of 2.0 - 4.92 cm, *Sassafras albidum* (n=91) represented a relative frequency distribution of 90.09% of the stems, with just 5 stems in the DBH range of 4.92 - 7.84 cm (4.95%), an indicator of the small diameter size-class. This gave the family less relative dominance (0.65%) as an extrapolation of the basal area and a lower family importance value.

Like the Lauraceae, the Oleaceae had one arboreal species represented by *Fraxinus americana* (n=101). The three largest stem diameters for *Fraxinus americana* were 75.40 cm, 70.40 cm, and 37.20 cm in comparison to *Sassafras albidum*, while the smallest stem was 2.0 cm DBH. *Fraxinus americana* had its greatest number of stems (n=93) in the 2.0 - 9.0 cm DBH range representing a frequency distribution of 92.07% in the small diameter size-class. However, it had three stems in the large diameter size-class, and five stems in the mid-size class, which added considerable weight to the basal area, thus giving the family a higher family importance value.

Frequency Distribution for Families in the Valley-Clove Forest

For the families of all woody taxa (n=790) within the 11 10 X 10 m^2 quadrats of the Valley-Clove forest, frequency distribution rates for the top three families are considered here (Figure 3.22) (Table 3.18, 3.19).

The Lauraceae (n=574) placed first in distribution with a relative frequency of 72.65% as displayed in the seventh interval bar, and was represented by two species, primarily non-arborescent *Lindera benzoin* (n=572), and arborescent *Sassafras albidum* (n=2). In terms of relative dominance, as an extrapolation of the basal area, the Lauraceae ranked first with a family importance value (FIV) of 90.18% and 100% quadrat representation among all woody taxa of the Valley-Clove forest. The Valley-Clove forest is unique in contrast to the other three geographic locations in having a microecosystem represented by *Lindera benzoin*. All *Lindera benzoin* and *Sassafras albidum* stems in the Lauraceae were in a DBH range of 2.0 - 4.0 cm, the small diameter size-class.

Placing second was Adoxaceae (n=53), with a frequency distribution of 6.70% as displayed in the second interval bar, represented four shrub species in the genus *Viburnum*: *V. acerifolium* (n=12), *V. dentatum* (n=24), *V. opulus* (n=7), and *V. prunifolium* (n=10). In terms of relative dominance, as an extrapolation of the basal area, the Adoxaceae ranked fourth with a family importance value (FIV) of 15.41% and 55% quadrat representation among all woody taxa in the Valley-Clove forest. Like *Lindera benzoin,* and *Sassafras albidum*, all *Viburnum* stems, which ranged within a DBH of 2.0 - 4.0 cm, fell into the small diameter size class.

In third place was Rosaceae (n=46), with a frequency distribution of 5.82% as displayed in the eleventh interval bar, represented by three species, primarily non-arborescent *Rosa multiflora* (n=40), arborescent *Crataegus* spp.(n=1), and *Prunus serotina* (n=5). *Rosa multiflora* stems were all within a DBH range of 2.0 - 3.0 cm, as well as *Crataegus*, while 4 stems of *Prunus serotina* fell within a range of 3.0 - 6.0 cm, the small diameter size class. Only 1 stem for *Prunus serotina* (33.0 cm DBH) fell into the large size class. The Rosaceae ranked fifth in ecological dominance with a family importance value (FIV) of 13.56 and 45% quadrat representation in the Valley-Clove forest.

Frequency Distribution for Families in the East Ridge Forest

For the families of all woody taxa (n=707) within the 8 10 X 10 m^2 quadrats in the East Ridge forest, the top three families are considered here (Figure 3.23) (Tables 3.19, 3.20).

Placing first was Adoxaceae (n=376), with a frequency distribution of 53.18% displayed by the second interval bar. It was represented by two shrub species in the genus *Viburnum*: *V. acerifolium* (n=368) and *V. dentatum* (n=8), both of which ranged within a DBH of 2.0 - 3.0 cm. While the Valley-Clove is dominated by *Lindera benzoin*, the East Ridge is dominated primarily by *Viburnum acerifolium*, in the small diameter size class. In terms of relative dominance, as an extrapolation of the basal area, the Adoxaceae ranked second in family importance values (FIV = 65.92%) among all woody taxa in the East Ridge forest with 88% quadrat representation.

Placing second was Rosaceae (n=80), with a frequency distribution of 11.31% as displayed by the seventeenth interval bar, represented three species, primarily arborescent *Prunus serotina* (n=31), non-arborescent *Rosa multiflora* (n=46), and *Rubus allegheniensis* (n=3). Both *Rosa multiflora* and *Rubus allegeheniensis* stems fell into the small diameter size-class ranging within a DBH of 2.0 - 3.0 cm. *Prunus serotina* had 30 stems within a DBH range of 2.50 - 6.60 cm, also the small diameter size-class, with 1 stem (11.40 cm DBH) falling into the mid-size class. In terms of relative dominance, as an extrapolation of the basal area, the Rosaceae ranked fourth with a family importance value (FIV) of 23.34% among all woody taxa in the East Ridge forest and 88% quadrat representation.

Placing third was Aceraceae (n=59), with a frequency distribution of 8.34% as displayed by the first interval bar, represented by three species in the genus *Acer*: *A. platanoides* (n=2), *A. rubrum* (n=47), and *A. saccharum* (n=10). *Acer rubrum* had the greatest abundance of stems with 46 stems falling within a DBH range of 2.10 - 9.50 cm representing 97.87% of the stems sampled for the small diameter size class. Only 1 stem for *Acer rubrum* (17.70 cm DBH) was represented in the mid-size category. For *Acer platanoides*, 1 stem was only 2.30 cm DBH, and the other was 21.80 cm, putting it in the mid-size stem category. *Acer saccharum* stems all fell within a DBH range of 2.30 - 4.60 cm, again, the small diameter size-class. In terms of relative dominance as an extrapolation of the basal area, the Aceraceae had a family importance value (FIV) of 25.37% among all woody taxa in the East Ridge forest with 88% quadrat representation.

**Frequency Distribution for the Families
on the Ridge Tops (east and west) Forest**

For the families of all woody taxa (n=595) within the 8 10 X 10 m^2 quadrats for the Ridge Tops (east and west) forest, six families are considered here (Figure 3.24) (Tables 3.21, 3.22).

Placing first was Adoxaceae (n=116) with a frequency distribution of 19.49% as displayed in the second interval bar. It was represented by two shrub species in the genus *Viburnum*, *V. acerifolium* (n=70) and *V. dentatum* (n=46). Both species were in a DBH range of 2.0 - 3.0 cm, placing them in the small diameter size-class. In terms of relative dominance as an extrapolation of the basal area, the Adoxaceae ranked third in family importance values (FIV = 24.26%) among all woody taxa on the Ridge Tops forest with 43% quadrat representation.

Placing second was Rosaceae (n=115), with a frequency distribution of 19.32% as displayed in the eighteenth interval bar, just a fraction less than the Adoxaceae with nearly the same abundance. The Rosaceae was represented by six species, non-arborescent *Amelanchier canadensis* (n=3), *Rosa multiflora* (n=19), and *Rubus occidentalis* (n=9), along with arborescent *Prunus serotina* (n=80), *Pyrus baccata* (n=2), and *P. malus* (n=2). *Amelanchier canadensis*, *Rosa multiflora*, and *Rubus occidentalis* fell within a DBH range of 2.00 - 9.0 cm as well as *Pyrus baccata* and *P. malus*, placing them in the small diameter size-class. For *Prunus serotina*, 75 stems were also in the small diameter size-class. The remaining 5 stems fell within a DBH range of 10.0 - 30.0 cm, placing them in the mid-size category. In terms of relative dominance as an extrapolation of the basal area, the Rosaceae garnered a family importance value (FIV) of 32.72% among all woody taxa on the Ridge Tops (east and west) forest with 100% quadrat representation, second only to the most dominant family on the Ridge Tops, the Fagaceae.

Placing third was Celastraceae (n=68) with a frequency distribution of 11.42% as displayed in the seventh interval bar. The Celastraceae was represented by two species, non-arborescent shrub, *Euonymus alatus* (n=5), and *Celastrus orbiculatus* (n=63), a vine.

Both species were in a DBH range of 2.00 - 4.00 cm, placing them in the small diameter size-class. In terms of relative dominance, as an extrapolation of the basal area, the Celastraceae ranked fifth in dominance with a family importance value (FIV) of 17.73% among all woody taxa for the Ridge Tops and 57% quadrat representation.

Placing fourth was Oleaceae (n=47) with a frequency distribution of 7.89% displayed in the seventeenth interval bar. Oleaceae was represented by one species, arborescent *Fraxinus americana*. For *Fraxinus americana*, 43 stems fell within a DBH range of 2.0 - 9.0 cm, placing them in the small diameter size-class. The remaining 4 stems fell within a DBH range of 10.0 - 30.0 cm, the mid-size category. The Oleaceae ranked fourth in relative dominance with a family importance value (FIV) of 18.92% as an extrapolation of the basal area, with 86% quadrat representation among all woody taxa for the Ridge Tops (east and west) forest.

Placing fifth was Juglandaceae (n=44) with a frequency distribution of 7.39%, just a fraction of a percent below that of the Oleaceae. Juglandaceae was represented by four arborescent species, *Carya cordiformis* (n=38), *C. tomentosa* (n=4), *Juglans cinerea* (n=1), and *J. nigra* (n=1). For *Carya cordiformis* (n=37) and *C. tomentosa* (n=4), all stems ranged within a DBH of 2.10 - 9.70 cm, which placed them both in the small diameter size-class. For *Carya cordiformis*, 1 stem fell into the mid-size category as well as *Juglans cinerea* and *J. nigra*. The Juglandaceae ranked seventh in ecological dominance, which garnered a family importance value (FIV) of 16.80% as an extrapolation of the basal area, and 71% quadrat representation among all woody taxa for the Ridge Tops (east and west) forest.

Sharing fifth place was Fagaceae (n=44), with the same frequency distribution as the Juglandaceae (7.39%), and the same number of stems. The Fagaceae was represented by five species in the genus *Quercus*, *Q. alba* (n=1), *Q. coccinea* (n=6), *Q. prinus* (n=3), *Q. rubra* (n=30), and *Q. velutina* (n=4). For *Quercus prinus*, 1 stem fell into the small diameter size-class (2.0 - 10.0 cm DBH); for *Quercus coccinea* (n=4), *Q. prinus* (n=1), and *Q. rubra* (n=10), all were in the mid-size stem category (10.0 - 30.0 cm DBH); for *Quercus alba* (n=1), *Q. coccinea* (n=2), *Q. rubra* (n=20), and *Q. velutina* (n=4), all were in the large diameter size-class (30.0 - 100.20 cm DBH). The Fagaceae ranked first in ecological dominance as an extrapolation of the basal area, which garnered the family a family importance value (FIV) of 92.29% with 100% quadrat representation. While the Fagaceae did not have a high frequency distribution rate in comparison with the Adoxaceae and Rosaceae, the family had the advantage of substantial weighting in the basal area, which the Adoxaceae and Rosaceae did not have, despite having an abundance of small stems. The relative dominance percentage gave the Fagaceae a very high family importance value over the Adoxaceae and Rosaceae.

Frequency Distribution for Families in the West Ridge Forest

For the families of all woody taxa (n=1978) within the 18 10 X 10 m^2 quadrats in the West Ridge forest, the top six families are considered here (Figure 3.25) (Tables 3.23, 3.24).

Placing first was Rosaceae (n=379) with a frequency distribution of 19.16% as displayed in the twenty-first interval bar. Rosaceae was represented by eleven species, non-arboreal *Aronia arbutifolia* (n=6), *Hibiscus syriacus* (n=22), *Rhodotypos scandens* (n=14), *Rosa multiflora* (n=81), *Rubus allegheniensis* (n=21), *R. laciniatus* (n=44), and

R. occidentalis; arborescent *Prunus avium* (n=2), *P. serotina* (n=169), *Pyrus baccata* (n=3), and *P. communis* (n=1). *Aronia arbutifolia*, *Hibiscus syriacus*, *Rhodotypos scandens*, *Rosa multiflora*, *Rubus allegheniensis*, *R. laciniatus*, *R. occidentalis*, *Prunus avium*, *Pyrus baccata*, and *P. communis* were all in the small diameter size-class (2.0 - 9.70 cm DBH). *Prunus serotina* had 166 stems in the small diameter size-class alone, 3 stems in the mid diameter size-class (10.20 - 29.60 cm DBH), and none in the large diameter size-class. The Rosaceae ranked second in dominance, as an extrapolation of the basal area, which gave it a family importance value (FIV) of 30.67% with 100% quadrat representation among all woody taxa in the West Ridge forest.

Placing second was Adoxaceae (n=299) with a frequency distribution of 15.11% as displayed in the second interval bar. As in the East Ridge and Ridge Top forests, the Adoxaceae dominate the shrub category in the West Ridge, with the exception of the Valley-Clove forest. Representing the Adoxaceae were three species of *Viburnum*, *V. acerifolium* (n=168), *V. dentatum* (113), and *V. prunifolium* (n=18). All three species were in the small diameter size-class (2.0 - 10.0 cm DBH). In terms of relative dominance as an extrapolation of the basal area, the Adoxaceae garnered a family importance value (FIV) of 20.61% with 50% quadrat representation among all woody taxa in the West Ridge forest.

Placing third was Caprifoliaceae (n=227) with a frequency distribution of 11.47% as displayed in the sixth interval bar. The family was represented by only one species, non-arborescent *Lonicera maackii,* and all stems were in the small diameter size-class (2.0 - 10.0 cm DBH). The Caprifoliaceae had a family importance value (FIV) of 17.64% with 56% quadrat representation among all woody taxa in the West Ridge forest.

Placing fourth was Lauraceae (n=201) with a frequency distribution of 10.16% as displayed in the fifteenth interval bar. The family was represented by two species, non-arborescent *Lindera benzoin* (n=159), and arborescent *Sassafras albidum* (n=42). All stems for *Lindera benzoin* fell within the small diameter size-class (2.0 - 10.0 cm DBH), while *Sassafras albidum* had 38 stems in the small-size class, 3 stems in the mid-size class, the largest stem being 29.60 cm DBH, and none in the large size-class. The Lauraceae ranked fourth in dominance as an extrapolation of the basal area, with a family importance value (FIV) of 18.46% and 67% quadrat representation. In comparison with the Caprifoliaceae, which had a wider frequency dispersal than Lauraceae, the Caprifoliaceae had a lower relative dominance percentage than did the Lauraceae

Placing fifth was Cornaceae (n=141) with a frequency distribution of 7.12% as displayed in the eighth interval bar. Cornaceae was represented by four species in the genus *Cornus*, non-arborescent *C. amomum* (n=5), *C. foemina* (n=111), *C. sericea* (n=21), and arborescent *C. florida* (n=4). All stems for all the species fell within the small diameter size-class (2.0 -10.0 cm DBH). The Cornaceae ranked tenth in dominance as an extrapolation of the basal area, with a family importance value (FIV) of 9.69% among all woody taxa in the West Ridge. Interestingly, *Cornus foemina* was found only in one quadrat (#39), and both *C. amomum* and *C. sericea* were found in the same quadrat (#38) near the Hudson River. The Cornaceae do not have high representation for all of Inwood Hill Park, but efforts to restore some of the species mentioned here have been underway since NRG began its restoration project and planting program.

Placing sixth was Celastraceae (n=106) with a frequency distribution of 5.35% as displayed in the seventh interval bar. The family was represented by *Celastrus* *orbiculatus* in the vine category. All stems for *Celastrus orbiculatus* ranged within a DBH of 2.0 - 3.0 cm, placing them in the small diameter size-class. In terms of relative dominance as an extrapolation of the basal area, the family ranked eighth (FIV = 11.11%) with 56% quadrat representation among all woody taxa in the West Ridge forest. Worthy of note was Fagaceae, which had a frequency distribution of 5.20% as displayed in the eleventh interval bar, and very close to that of the Celastraceae. While the Fagaceae did not have high frequency distributions in comparison to the first three families, the percentage difference between frequency distribution and relative dominance based on basal area is quite large. The first three families had an abundance of non-arborescent shrub stems, all considered in the small diameter size-class, while the Fagaceae are mainly arborescent stems, found mostly in the mid to large diameter size-class. These size classes, with respect to basal area among the families, account for the percentage differences.

Herbaceous Taxa within Inwood Hill Park

In this next section, census results of all herbaceous taxa in 45 2 X 2 m^2 quadrats was recorded noting number of species and abundance, months of blooming, and whether native, non-native, or invasive. The census was taken after the 45 10 X 10 m^2 quadrats had been selected and set up. The smaller herb plots are nested within the larger quadrats with compass points recorded at the site of the permanently tagged stake of each of the larger quadrats.

For all the 45 herb quadrats, 76 genera and 96 species in 41 families were recorded (Table 3.25). Amongst all herbaceous taxa (n=2842), *Aster divaricatus* (n=407) was the top native species representing 14.32% of the sampled population, with a mean stem density per quadrat of 9.04%. Following, in order of abundance, were *Alliaria petiolata* (n=341), a nonnative, invasive plant, representing 12% of the sampled taxa with a mean stem density per quadrat of 7.57%. In fewer numbers were *Parthenocissus quinquefolia* (n=189), a native species representing 6.65% of the population, native *Impatiens capensis* (n=125), representing 4.39%, native *Circaea lutetiana* (n=119), representing 4.18%, *Lonicera japonica* (n=112), a nonnative-invasive species representing 3.94%, native *Polygonum virginianum* (n=99), representing 3.48%, native *Smilacina racemosa* (n=94), representing 3.30%, native *Maianthemum canadense* (n=59), representing 2.07%, *Vinca minor* (n=59), a nonnative representing 2.07%, native *Solidago caesia* (n=58) (2.04%), native *Eupatorium rugosum* (n=57) (2.0%), nonnative, invasive *Artemisia vulgaris* (n=56) (1.97%), native *Galium aparine* (n=53) (1.86%), and native *Solidago juncea* (n=50) (1.75%). A complete breakdown of native (n=65), nonnative (n=19), and invasive (n=13) species is presented in Table 3.30.

Herbaceous Taxa in the Valley-Clove Forest

For the Valley-Clove forest, 701 herbaceous plant stems were recorded in 11 2 X 2 m^2 quadrats (Table 3.26). The top species was nonnative, invasive *Alliaria petiolata* (n=133) (18.97%), represented in 9 quadrats with quadrat #13 having the greatest abundance (n=36). Mean stem density per quadrat was 12.09%. Following were native *Impatiens capensis* (n=108) (15.4%), represented in 10 quadrats with a mean stem density per quadrat of 9.81%. Next were native *Circaea lutetiana* (n=68) (9.70%), represented in 8 quadrats, native *Polygonum virginianum* (n=68) (9.70%), represented in 10 quadrats, native *Aster divaricatus* (n=44) (6.27%), represented in 4 quadrats, and native *Smilacina racemosa* (n=40) (5.70%), represented in 6 quadrats. Two native species of *Viola* were also present: *V. sororia* (n=30) (4.28%), represented in 4 quadrats, and *V. rotundifolia* (n=6), represented in 2 quadrats. Nonnative, invasive *Aegopodium podagraria* (n=29) (4.13%), was found only in quadrat #2. Native *Arisaema triphyllum* (n=4), found in quadrats #3 and 5, made a rare appearance in the Spring of 2003. *Trillium cernuum* (n=3) was also found in quadrat #3.

Worthy of note are some of the rarer species only found in the Valley-Clove forest such as native *Dicentra cucullaria* (n=38) (5.42%), represented in quadrats #1, 3, and 19. Quadrats #3 and 19 lie on a small hill underlain by Inwood marble and the calcareous remains of oyster shells. *Dicentra cucullaria* thrives on limestone soils of which the Valley-Clove is noted for. Another native species found only in the Valley-Clove is *Sanguinaria canadensis* (n=9) (1.28%), represented in quadrat #14 along with nonnative *Pachysandra terminalis* (n=9) (1.28%), native *Podophyllum peltatum* (n=6) (0.85%), and native *Claytonia virginica* (n=6) (0.85%). Quadrat #19 had the greatest abundance of stems (n=91) of the entire 11 quadrats.

Herbaceous Taxa in the East Ridge Forest

For the East Ridge forest, 398 herbaceous plant stems were recorded within 8 2 X 2 m^2 quadrats (Table 3.27). The top native species was *Aster divaricatus* (n=88), found in 8 out 8 quadrats, which represented 22.11% of the sampled population. *Aster divaricatus* had a mean stem density of 11% and a 100% frequency distribution. Next was native *Maianthemum canadense* (n=59) (14.82%), represented in 4 quadrats, followed by native *Monotropa uniflora* (n=29) (7.28%), a saprophytic species found in quadrats #12 and #22. *Juncus tenuis* (n=23) (5.77%), found in 2 quadrats, is rather abundant throughout Inwood Park although *Luzula multiflora* (n=8) (2.01%), found in quadrats #11 and #16, is not nearly as abundant.

Nonnative, invasive *Alliaria petiolata* (n=22) (5.52%) was found only in quadrat #27, along with two other nonnative, invasive species found in the same quadrat, *Lonicera japonica* (n=6) and *Rubus phoenicolasius* (n=3), both species being very abundant throughout the larger quadrat.

In fewer numbers were natives *Rubus flagellaris* (n=18) (4.52%), *Polygonatum biflorum* (n=18) (4.52%), *Eupatorium rugosum* (n=16) (4.02%), *Parthenocissus quinquefolia* (n=15) (3.76%), *Solidago juncea* (n=11) (2.76%), *Chimaphila maculata* (n=11) (2.76%), found only in quadrat #12, *Solidago caesia* (n=8) (2.01%), and *Smilax rotundifolia* (n=3) (0.75%).

Three species of grasses were also noted (counted as clumps rather than individuals): *Dactylis glomerata* (n=7), *Danthonia spicata* (n=8), and *Poa annua* (n=3), and two species of *Carex*: *C. laxifolia* (n=2) and *C. vulpinoidea* (n=1).

An interesting find was *Uvularia perfoliata* (n=2) in quadrat #12, along with *Chimaphila maculata* (n=11), considered here as an herb rather than a sub-shrub, and *Orobanche uniflora* (n=1), a parasitic species found in quadrat #4. Quadrat #11 had the greatest abundance of stems (n=78) of the entire 8 quadrats.

Herbaceous Taxa for the Ridge Tops (east and west) Forest

For the Ridge Tops (east and west) forest, 498 herbaceous plant stems were recorded in 8 2 X 2 m^2 quadrats (Table 3.28). The top species was native *Aster divaricatus* (n=80) representing 16.06% of the sampled population, with a mean stem density per quadrat of 10% and appearing in 6 out of 8 quadrats. The Asteraceae was the top family on the Ridge Tops forest representing 17 species. Next was native *Danthonia* *spicata* (n=40) (8.03%) in quadrats #10 and 15, both quadrats being in an open meadow-type environment on the Ridge Top east. Following, in order of abundance, were native *Parthenocissus quinquefolia* (n=38) (7.63%), nonnative, invasive *Alliaria petiolata* (n=32) (6.42%), native *Solidago juncea* (n=29), nonnative, invasive *Lonicera japonica* (n=26) (5.22%), native *Smilacina racemosa* (n=21) (4.21%), nonnative *Convallaria majalis* (n=19) (3.81%), native *Aster cordifolius* (n=15) (3.01%), nonnative, invasive *Ambrosia artemisifolia* (n=14) (2.81%), native *Polygonum virginianum* (n=12) (2.40%), native *Eupatorium rugosum* (n=11) (2.20%), native *Schizachyrium scoparium* (n=11) (2.20%), and *Solidago bicolor* (n=10) (2.0%).

In fewer numbers were native *Circaea lutetiana* (n=9) (1.80%), nonnative *Dactylis glomerata* (n=8) (1.60%), nonnative, invasive *Artemisia vulgaris* (n=8), (1.60%), nonnative *Hemerocallus fulva* (n=7) (1.40%), native *Polygonatum biflorum* (n=7) (1.40%), nonnative *Poa pratensis* (n=7) (1.40%), native *Panicum virgatum* (n=7) (1.40%), native *Solidago caesia* (n=6) (1.20%), nonnative, invasive *Silene vulgaris* (n=6) (1.20%), native *Desmodium paniculatum* (n=6) (1.20%), nonnative *Polygonum cespitosum* (n=6) (1.20%), native *Helianthus divaricatus* (n=6) (1.20%), native *Luzula multiflora* (n=5) (1.0%), native *Solidago canadensis* (n=5) (1.0%), and nonnative *Commelina communis* (n=5) (1.0%) in order of abundance. Quadrat #21 had the greatest abundance of stems (n=87) of the entire 8 quadrats.

Herbaceous Taxa in the West Ridge Forest

For the West Ridge forest, 1245 herbaceous plant stems were recorded in 18 2 X 2 m^2 quadrats (Table 3.29). The top species was native *Aster divaricatus* (n=195), representing 15.66% of the sampled taxa. *Aster divaricatus* was found in 11 out of 18 quadrats with a mean stem density of 10.83% per quadrat. Next was nonnative, invasive *Alliaria petiolata* (n=154), representing 12.36% of the sampled taxa. This species was found in 14 out of 18 quadrats with a mean stem density per quadrat of 8.55%. Following, in order of the greatest abundance, were native *Parthenocissus quinquefolia* (n=119) (9.55%), nonnative, invasive *Lonicera japonica* (n=65) (5.22%), nonnative, invasive *Vinca minor* (n=59) (4.73%), native *Galium aparine* (n=53) (4.25%), nonnative, invasive *Artemisia vulgaris* (n=48) (3.85%), native *Circaea lutetiana* (n=38) (3.05%), nonnative, invasive *Hemerocallus fulva* (n=36) (2.89%), native *Solidago caesia* (n=35) (2.81%), non-native, invasive *Leonurus cardiaca* (n=26) (2.08%), native *Smilacina racemosa* (n=23) (1.84%), nonnative *Commelina communis* (n=22) (1.76%), native *Polygonatum biflorum* (n=19) (1.52%), native *Impatiens capensis* (n=17) (1.36%), native *Polygonum virginianum* (n=17) (1.36%), native *Solidago juncea* (n=16) (1.28%), native *Viola sororia* (n=15) (1.20%), native *Rubus flagellaris* (n=15) (1.20%), native *Solidago bicolor* (n=14) (1.12%), and nonnative, invasive *Rubus phoenicolasius* (n=14) (1.12%).

In lesser numbers were native *Desmodium paniculatum* (n=11), native *Rubus hispidus* (n=11), nonnative *Hesperis matronalis* (n=10), native *Phytolacca americana* (n=10), nonnative, invasive *Hedera helix* (n=9), nonnative *Geranium robertianum* (n=8), native *Helianthus divaricatus* (n=8), and native *Eupatorium purpureum* (n=8). A native, parasitic annual, *Cuscuta gronovii* (n=4), was found in quadrat #31, and the only member of the Orchidaceae was represented by nonnative *Epipactis helleborine* (n=2), found in quadrats #31 and 34.

The Cyperaceae had three species of *Carex*: *C. laxifolia* (n=9), *C. pensylvanica* (n=3), and *C. vulpinoidea* (n=4). Among grasses, Poaceae was represented by *Deschampsia flexuosa* (n=3) and *Poa pratensis* (n=3).

The Salt Marsh Community of Plants

Inwood Hill Park has one of the last remaining salt marshes in Manhattan. The salt marsh is in the intertidal zone and is flushed twice a day by tides from both the Harlem and Hudson Rivers. However, sediments in the marsh have been accumulating since the old Spuyten Duyvil Creek was filled in. As a result, the water table has risen so that it now overflows the nearby meadow area when the tides are above normal. Within a small transition zone in the flooded area of the meadow, halyphytic herbaceous plants, such as *Distichlis spicata*, have established a foothold. A heavy buildup of an anoxic mud substrate now exists around the perimeter of the salt marsh, and extensive stands of *Spartina cynosuroides* compete with *Phragmites communis* for space and nutrients.

The crescent-shaped salt marsh has a unique community of plants which rings the base of the northern part of Inwood Hill. In addition to the 45 10 X 10 m^2 quadrats in the forested portion of Inwood Hill, five 2 m X 4 m quadrats were set up and a floristic inventory was taken of all taxa, noting bloom times and number of species in this 2 ha salt marsh. A total of 58 genera and 64 species in 37 families were recorded representing 497 stems within the five quadrats (Table 3.31). Table 3.32 depicts quadrats #46 - 50, number of species, number of stems, bloom times, and whether native, nonnative, and invasive for each of the quadrats.

Among herbaceous plants, native *Solidago sempervirens* (n=33), found in all five quadrats, was the most abundant species representing 6.63% of the sampled taxa. Following, in order of decreasing abundance, were nonnative *Trifolium pratense* (n=32)

(6.43%), nonnative, invasive *Taraxacum officinale* (n=25) (5.03%), nonnative *Rumex crispus* (n=23) (4.62%), *Trifolium repens* (n=20) (4.02%), nonnative *Atriplex patula* (n=19) (3.82%), nonnative *Plantago major* (n=19) (3.82%), nonnative, invasive *Artemisia vulgaris* (n=13) (2.61%), nonnative *Stellaria media* (n=13) (2.61%), native *Matricaria matricarioides* (n=12) (2.41%), nonnative, invasive *Silene vulgaris* (n=12) (2.41%), nonnative, invasive *Alliaria petiolata* (n=8) (1.60%), nonnative *Capsella bursa-pastoris* (n=7) (1.40%), nonnative *Galinsoga ciliata* (n=7) (1.40%), native *Amaranthus retroflexus* (n=6) (1.20%), nonnative, invasive *Chenopodium album* (n=6) (1.20%), nonnative *Plantago lanceolata* (n=6) (1.20%), native *Acnida cannabina* (n=5) (1.00%), nonnative, *Commmelina communis* (n=4) (0.80%), nonnative *Lamium purpureum* (n=4) (0.80%), nonnative *Melliotus alba* (n=4) (0.80%), nonnative, invasive *Saponaria officinalis* (n=4) (0.80%), and nonnative *Sedum ternatum* (n=4) (0.80%). In numbers of three or less were native *Galium aparine* (n=3) (0.60%), nonnative, invasive *Malva neglecta* (n=3) (0.60%), nonnative *Rumex obtusifolius* (n=3) (0.60%), nonnative *Senecio vulgaris* (n=3) (0.60%), *native Asclepias syriaca* (n=2) (0.40%), nonnative, invasive *Centaurea maculosa* (n=2) (0.40), nonnative *Cichorium intybus* (n=2) (0.40%), native *Oenothera biennis* (n=2) (0.40%), nonnative *Oxalis stricta* (n=2) (0.40%), nonnative *Solanum dulcamara* (n=2) (0.40%), and nonnative *Sonchus oleraceous* (n=2) (0.40%). There were six singletons (n=1) represented by nonnative *Arctium minus*, native *Aster tenuifolius*, native *Erigeron annuus*, nonnative *Melliotus officinale*, native *Rumex pallidus*, and native *Viola sororia*.

The Cyperaceae had one native species represented by the genus *Carex*, *C. vulpinoidea* (n=7) (1.40%), one native species represented by the genus *Cyperus*, *C.*

strigosus (n=4), and one native species in the genus *Scirpus*, *S. robustus* (n=3) (0.60%).

The most abundant species among grasses, (counted as clumps rather than individuals), was nonnative *Dactylis glomerata* (n=31), found in all five quadrats and representing 6.23% of the sampled taxa. Following, in decreasing abundance, were native cordgrass, *Spartina cynosuroides* (n=18) (3.62%), native *Poa annua* (n=16 (3.21%), nonnative *Eleusine indica* (n=5) (1.0%), nonnative *Lolium perenne* (n=2) (0.28), nonnative *Setaria glauca* (n=2) (0.28%), and two nonnative singletons, *Elymus virginicus* (n=1), and *Digitaria sanguinalis* (n=1).

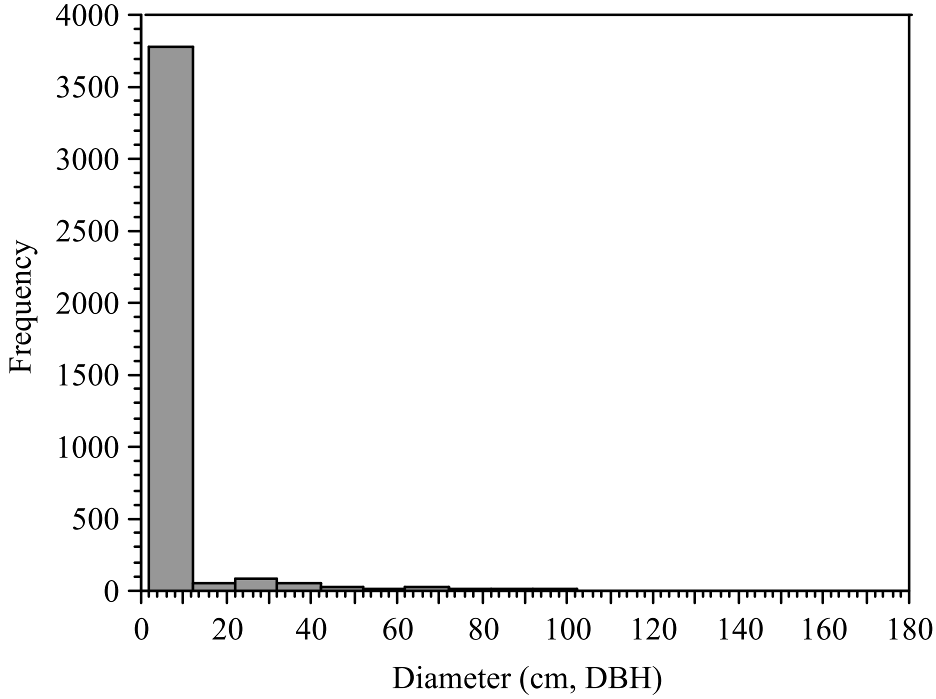
Among shrubs, the most abundant species encountered native *Iva frutescens* (n=19), representing 3.82% of the sampled taxa, found in all five quadrats. Following, in order of decreasing abundance, were nonnative *Amorpha fruticosa* (n=5) (1.00%), native *Baccharis halimifolia* (n=4) (0.80%), native *Hibiscus moscheutos* (n=3) (0.80%), and nonnative, invasive *Rosa multiflora* (n=3) (0.60%).

Among vines, the most abundant species encountered was nonnative, invasive *Celastrus orbiculatus* (n=14) (2.81%), followed by native *Parthenocissus quinquefolia* (n=12) (2.41%). In fewer numbers were native-invasive *Calystegia sepium* (n=8) (1.60%), native *Clematis virginiana* (n=6) (1.20%), and natives *Vitis labrusca* (n=1) (0.20%) and *V. riparia* (n=1) (0.20%).

There was just one tree, *Acer negundo*, found in quadrat #50, as most of the trees have been removed by the Parks Department. However, a few species still ring the perimeter of the marsh, mainly 3 small specimens of *Ulmus alatus*, 2 small specimens of *Crataegus* spp., several mid-size specimens of *Robinia pseudoacacia*, and 2 very large specimens of *Salix* spp. These trees were not counted as they did not fall within the five quadrats.

Of all the plants recorded, the most noteworthy were *Asclepias syriaca*, *Aster tenuifolius*, *Baccharis halimifolia*, *Carex vulpinoidea*, *Clematis virginiana*, *Cyperus strigosus, Erigeron annuus*, *Hibiscus moscheutos*, *Iva frutescens*, *Oenothera biennis*, *Parthenocissus quinquefolia*, *Scirpus robustus*, *Solidago sempervirens*, *Spartina cynosuroides*, *Vitis labrusca* and *V. riparia*, all native species. There were 24 native species, 28 nonnative, 11 nonnative-invasive, and 1 native-invasive among all the taxa sampled in the five quadrats.

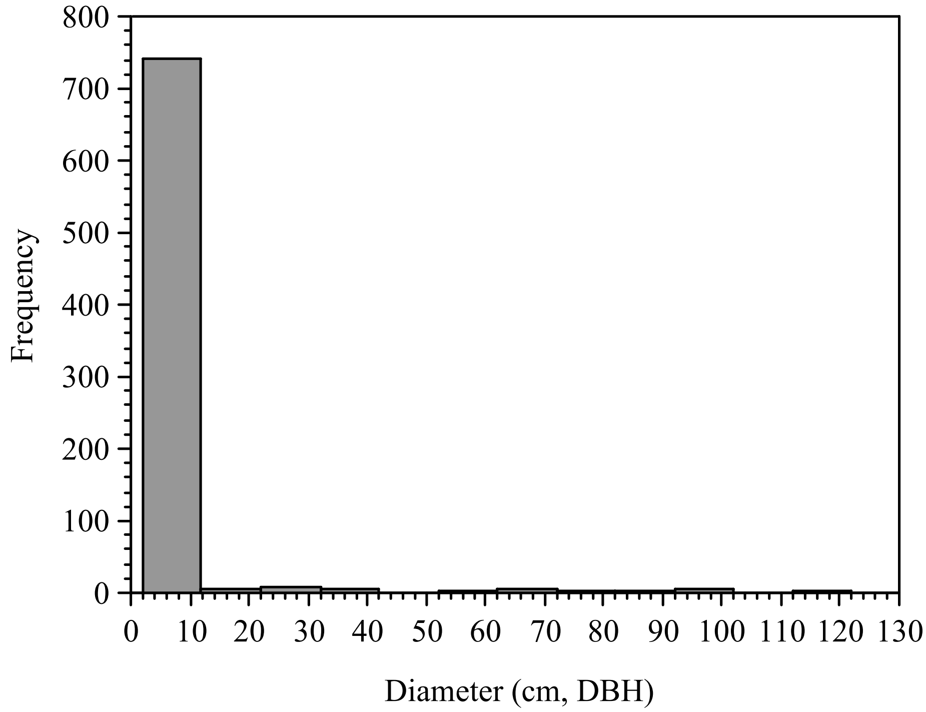
Celastrus orbiculatus is evident throughout most of the salt marsh, with some stems measuring 3.4 cm DBH. The lateral roots have twined around the rocks that ring the perimeter of the marsh and sent up many stems. Some of these stems have strangled a few small trees so that their crowns are now covered entirely with *C. orbiculatus*. This author has spent many hours cutting as many of the lateral roots as possible. However, the roots of *C. orbiculatus* are well established beneath the rocks and unreachable. The brackish water of the salt marsh, even at high tide, seems to have little effect on their growth.



Descriptive Statistics

	DBH (cm)
Mean	5.62
Std. Dev.	12.50
Std. Error	.196
Count	4070
Minimum	2.00
Maximum	171.20

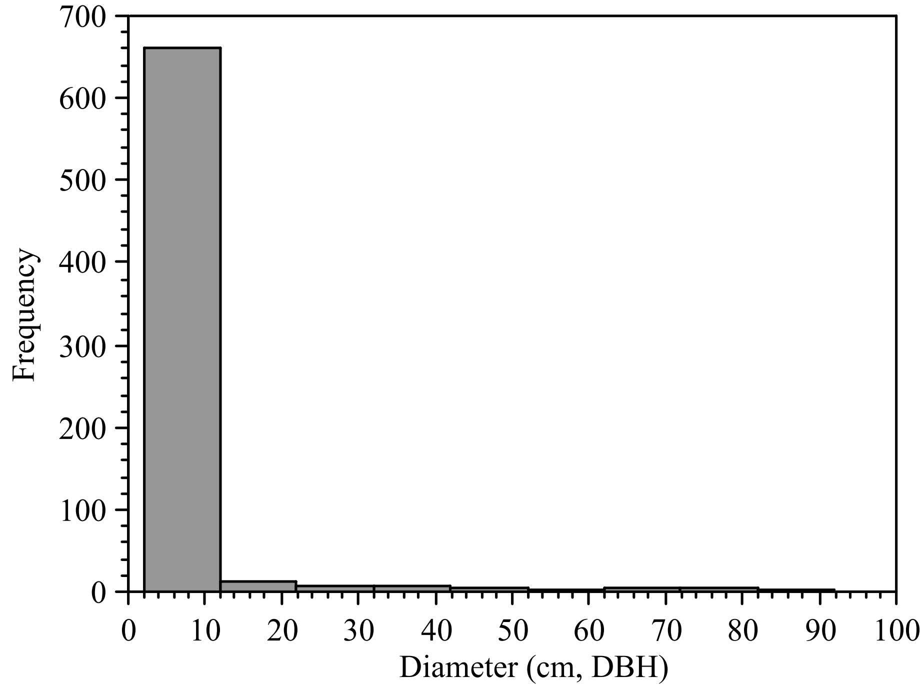
Figure 3.1 Frequency distribution and descriptive statistics of all tree, shrub, and vine stems in 45 10 X 10 m^2 quadrats in Inwood Hill Park (n=4070). Stem diameters ranged from 2.00 - 171.20 cm DBH.



Descriptive Statistics

	DBH (cm)
Mean	6.22
Std. Dev.	15.86
Std. Error	0.56
Count	790
Minimum	2.00
Maximum	122.60

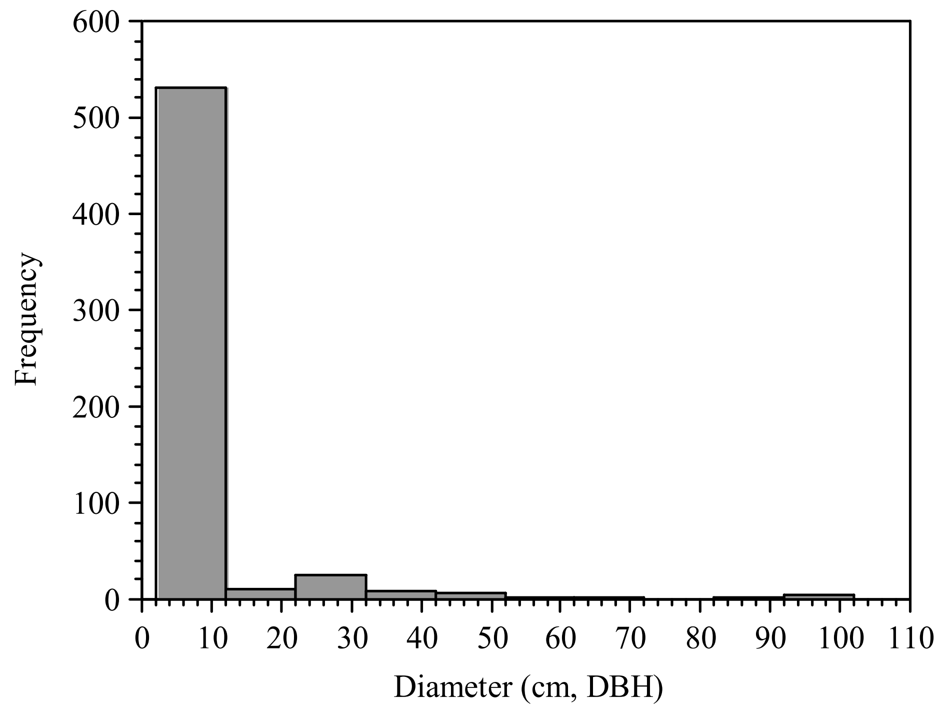
Figure 3.3 Frequency distribution and descriptive statistics of all tree, shrub, and vine stems in the Valley-Clove forest (n=790). Stem diameters ranged from 2.00 - 122.60 cm DBH.



Descriptive Statistics

	DBH (cm)
Mean	5.33
Std. Dev.	11.66
Std. Error	0.44
Count	707
Minimum	2.00
Maximum	87.70

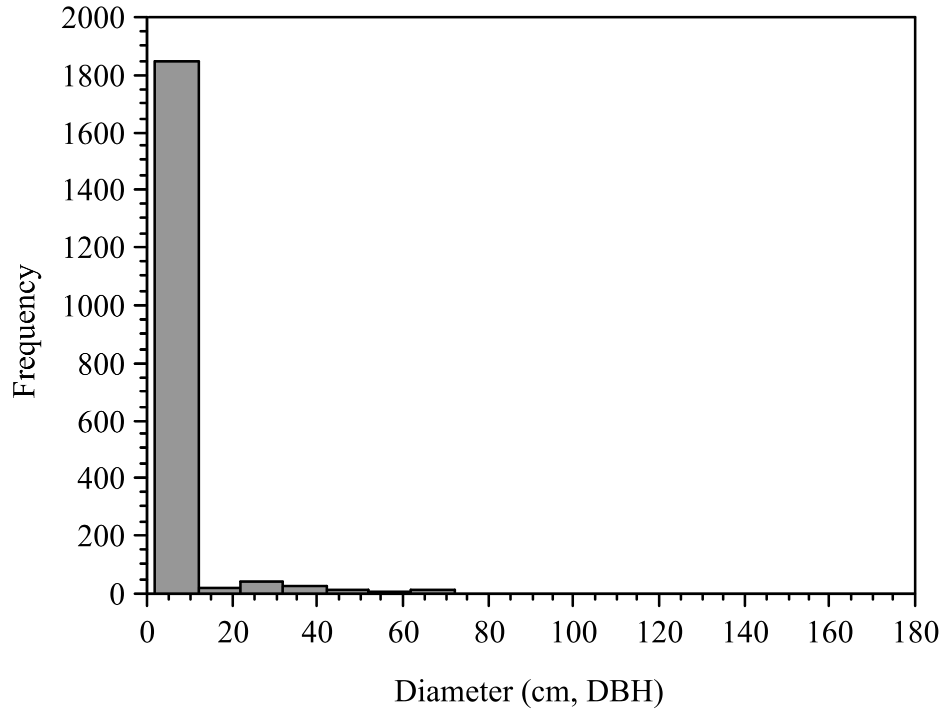
Figure 3.5 Frequency distribution and descriptive statistics of all tree, shrub, and vine stems in the East Ridge and slopes forest (n=707). Stem diameters ranged from 2.00 - 87.70 cm DBH.



Descriptive Statistics

	DBH (cm)
Mean	6.53
Std. Dev.	13.12
Std. Error	0.54
Count	595
Minimum	2.00
Maximum	100.20

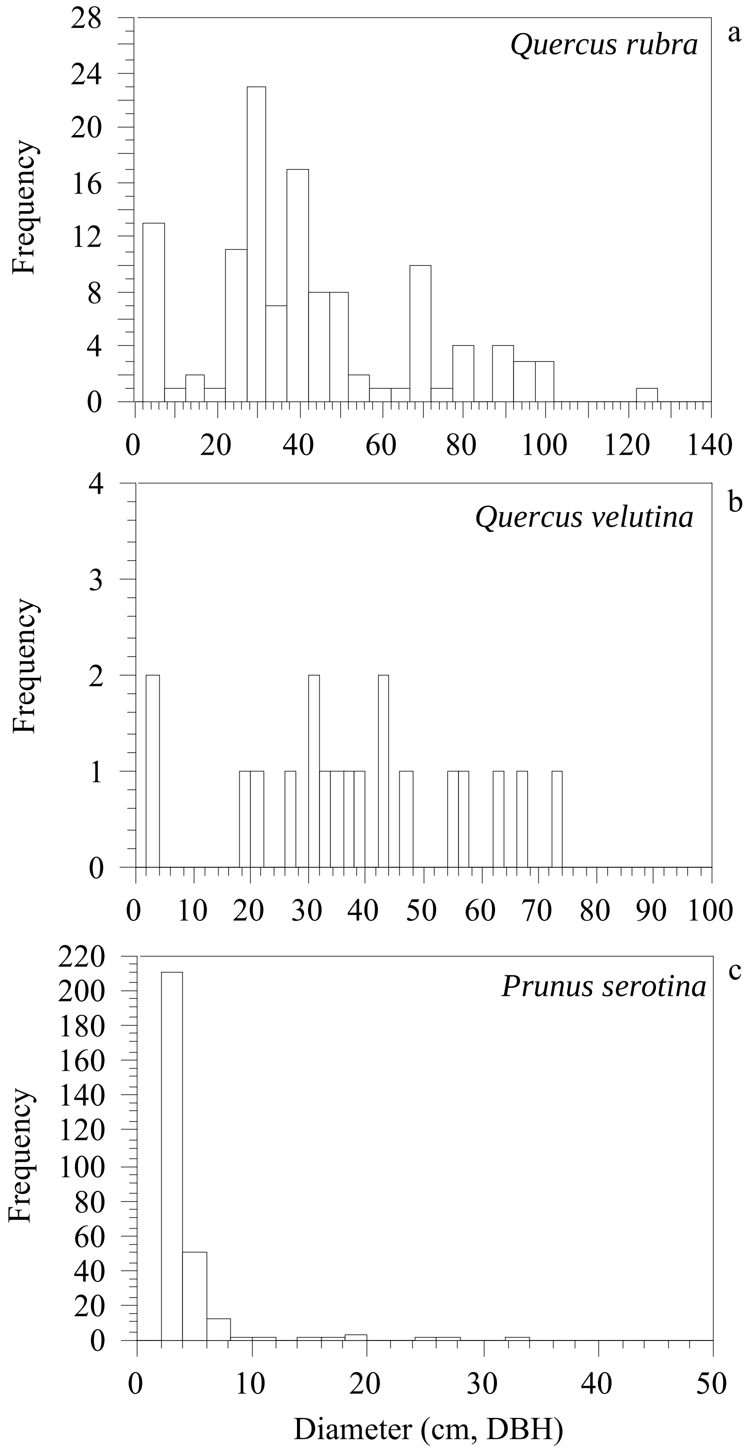
Figure 3.7 Frequency distribution and descriptive statistics of all tree, shrub, and vine stems in the Ridge Tops (east and west) forest (n=595). Stem diameters ranged from 2.00 - 100.20 cm DBH.



Descriptive Statistics

	DBH (cm)
Mean	5.22
Std. Dev.	10.98
Std. Error	0.25
Count	1978
Minimum	2.00
Maximum	171.20

Figure 3.9 Frequency distribution and descriptive statistics of all tree, shrub, and vine stems in the West Ridge and slopes forest (n=1978). Stem diameters ranged from 2.00 - 171.20 cm DBH.



a) Descriptive Statistics

	DBH (cm)
Mean	42.09
Std. Dev.	25.77
Std. Error	2.34
Count	121
Minimum	2.30
Maximum	122.60

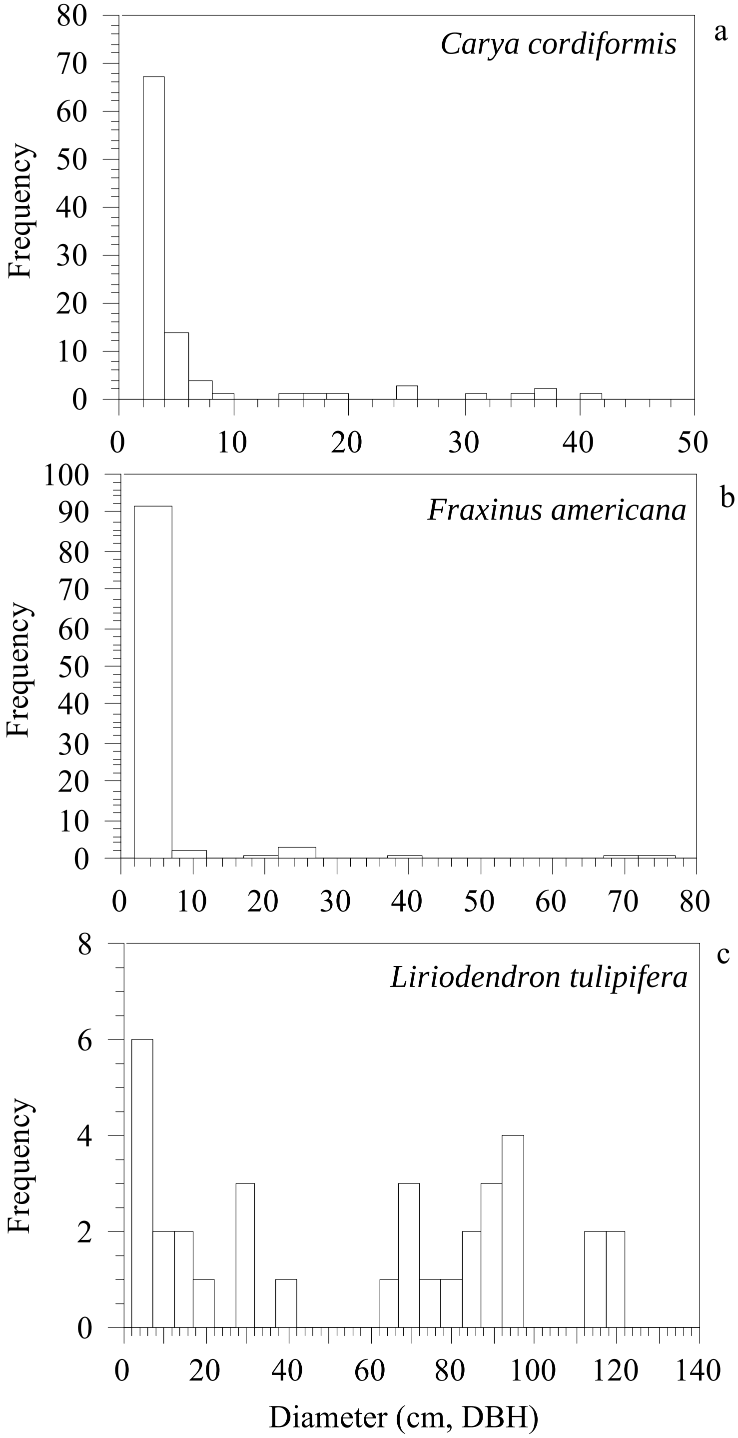
b) Descriptive Statistics

	DBH (cm)
Mean	38.16
Std. Dev.	19.60
Std. Error	4.50
Count	19
Minimum	2.10
Maximum	72.90

c) Descriptive Statistics

	DBH (cm)
Mean	3.94
Std. Dev.	3.59
Std. Error	0.21
Count	286
Minimum	2.00
Maximum	33.00

Figure 3.10 Frequency distribution of diameters for a) *Quercus rubra* (n=121), b) *Quercus velutina* (n=19) and, c) *Prunus serotina* (n=286) within the 45 m^2 quadrats in Inwood Hill Park.



a) Descriptive Statistics

	DBH (cm)
Mean	6.04
Std. Dev.	8.37
Std. Error	0.85
Count	97
Minimum	2.00
Maximum	41.30

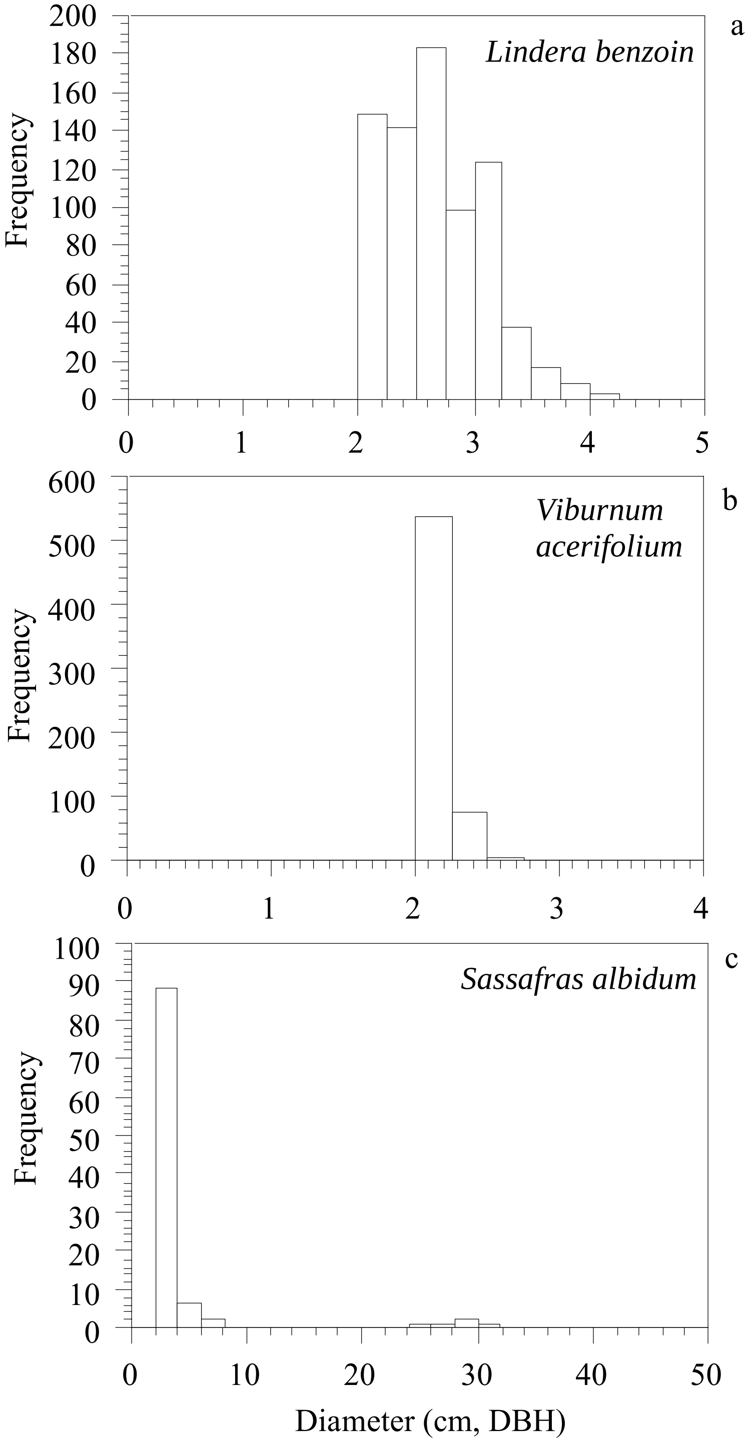
b) Descriptive Statistics

	DBH (cm)
Mean	5.62
Std. Dev.	10.92
Std. Error	1.09
Count	101
Minimum	2.00
Maximum	75.40

c) Descriptive Statistics

	DBH (cm)
Mean	57.13
Std. Dev.	40.56
Std. Error	6.96
Count	34
Minimum	4.20
Maximum	121.70

Figure 3.11 Frequency distribution of diameters for a) *Carya cordiformis* (n=97), b) *Fraxinus americana* (n=101) and, c) *Liriodendron tulipifera* (n=34) within the 45 m^2 quadrats in Inwood Hill Park.



a) Descriptive Statistics

	DBH (cm)
Mean	2.65
Std. Dev.	0.43
Std. Error	0.02
Count	760
Minimum	2.00
Maximum	4.10

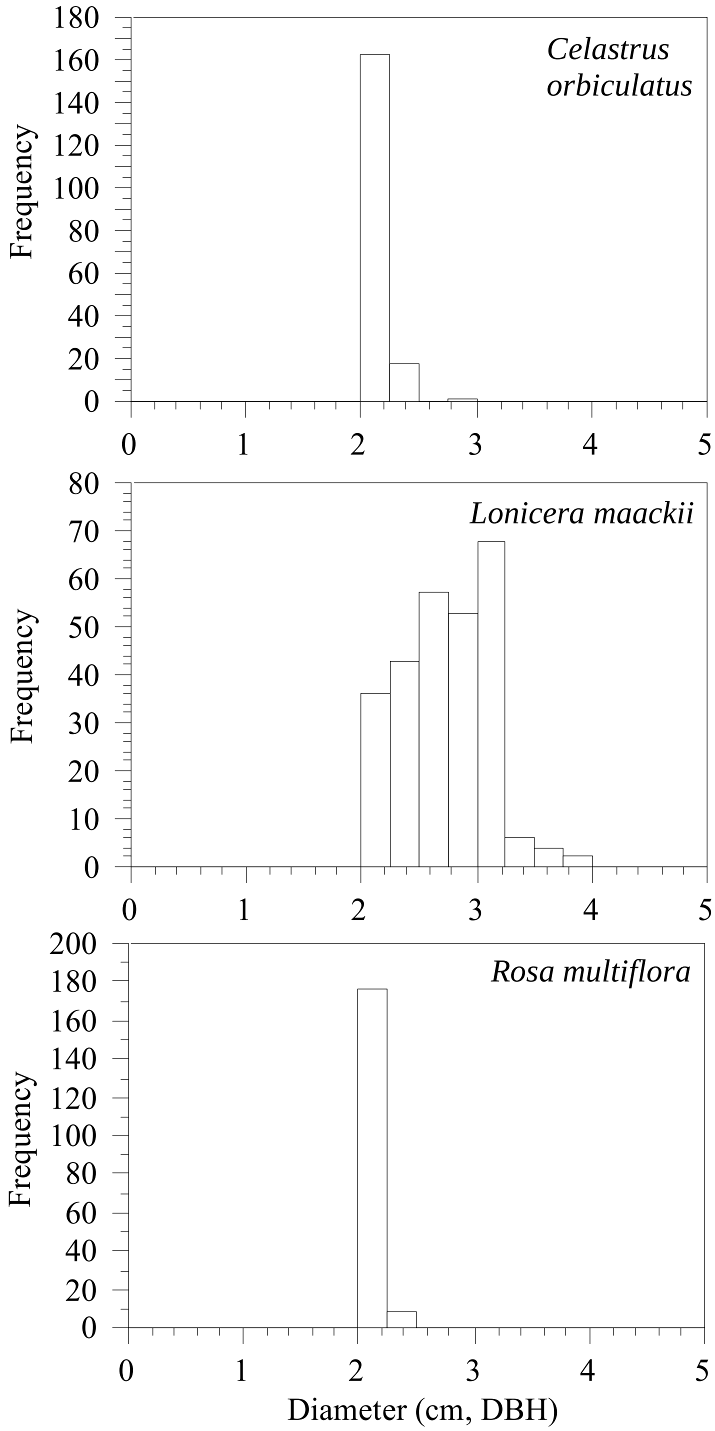
b) Descriptive Statistics

	DBH (cm)
Mean	2.11
Std. Dev.	0.13
Std. Error	0.01
Count	618
Minimum	2.00
Maximum	3.00

c) Descriptive Statistics

	DBH (cm)
Mean	4.04
Std. Dev.	5.68
Std. Error	0.56
Count	101
Minimum	2.00
Maximum	31.20

Figure 3.12 Frequency distribution of diameters for a) *Lindera benzoin* (n=760), b) *Viburnum acerifolium* (n=618) and, c) *Sassafras albidum* (n=101) within the 45 m^2 quadrats in Inwood Hill Park.



a

Descriptive Statistics

	DBH (cm)
Mean	2.10
Std. Dev.	0.12
Std. Error	0.01
Count	181
Minimum	2.00
Maximum	2.90

b

Descriptive Statistics

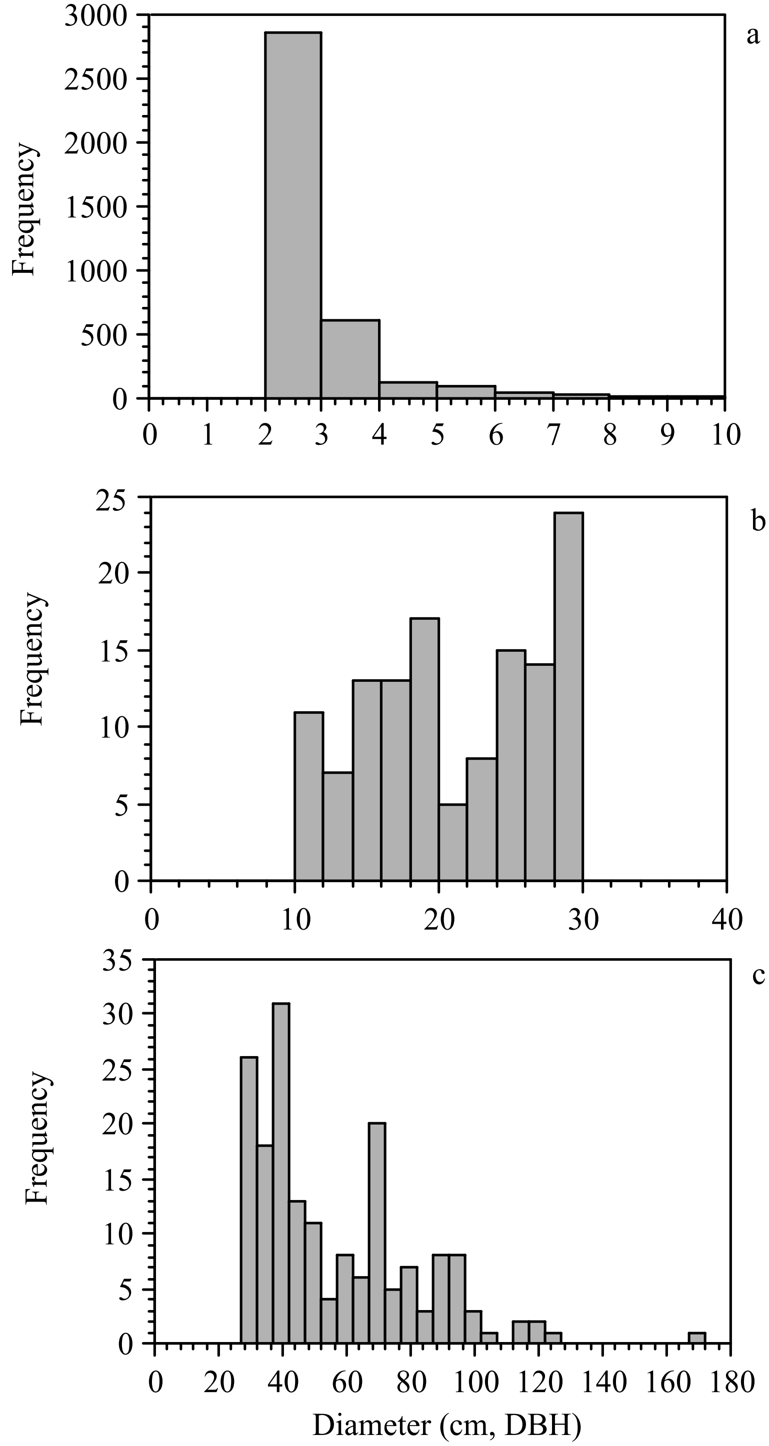
	DBH (cm)
Mean	2.72
Std. Dev.	0.38
Std. Error	0.02
Count	269
Minimum	2.00
Maximum	3.90

c

Descriptive Statistics

	DBH (cm)
Mean	2.08
Std. Dev.	0.09
Std. Error	0.01
Count	186
Minimum	2.00
Maximum	2.30

Figure 3.13 Frequency distribution of diameters for a) *Celastrus orbiculatus* (n=181), b) *Lonicera maackii* (n=269) and, c) *Rosa multiflora* (n=186) within the 45 m^2 quadrats in Inwood Hill Park.



a) Descriptive Statistics

	DBH (cm)
Mean	2.71
Std. Dev.	1.03
Std. Error	0.02
Count	3765
Minimum	2.00
Maximum	9.70

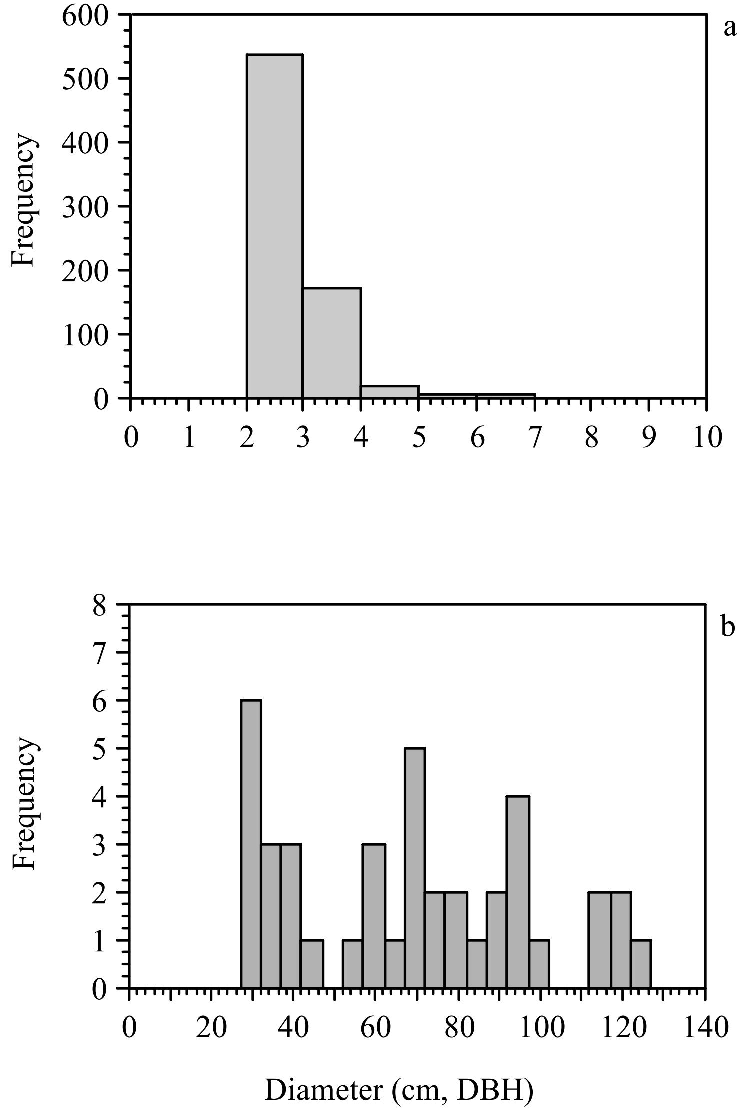
b) Descriptive Statistics

	DBH (cm)
Mean	21.02
Std. Dev.	5.98
Std. Error	0.53
Count	127
Minimum	10.20
Maximum	29.90

c) Descriptive Statistics

	DBH (cm)
Mean	56.26
Std. Dev.	24.84
Std. Error	1.86
Count	178
Minimum	30.20
Maximum	171.20

Figure 3.15 Frequency distributions and descriptive statistics for all woody stems within the 45 m^2 sampling quadrats in Inwood Hill Park. a) small-size class (2.00 - <10.00 cm DBH) (n=3765), b) mid-size class (10.00 - <30.00 cm DBH) (n=127) and, c) large-size class (>30.00 cm DBH) (n=178).



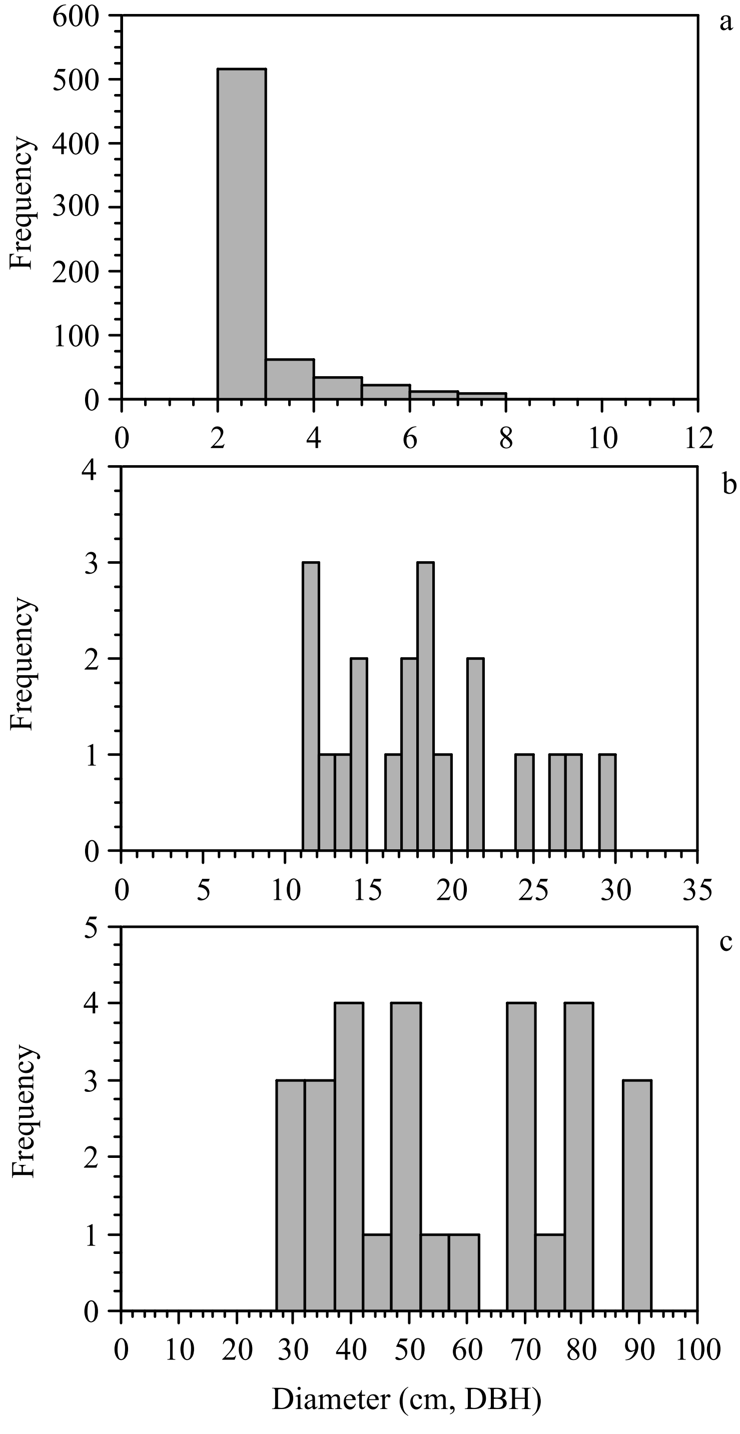
a) Descriptive Statistics

	DBH (cm)
Mean	2.74
Std. Dev.	0.78
Std. Error	0.03
Count	742
Minimum	2.00
Maximum	9.50

b) Descriptive Statistics

	DBH (cm)
Mean	68.36
Std. Dev.	29.15
Std. Error	4.61
Count	40
Minimum	30.20
Maximum	122.60

Figure 3.16 Frequency distributions of Valley-Clove woody taxa for different diameter size classes: a) small-size class (2.00 -<10.00 cm DBH) (n=742) and, b) large-size class (>30 cm DBH) (n=40). Note that there were too few individual stems to display a mid-size distribution (n=8).



a) Descriptive Statistics

	DBH (cm)
Mean	2.69
Std. Dev.	1.19
Std. Error	0.05
Count	658
Minimum	2.00
Maximum	9.50

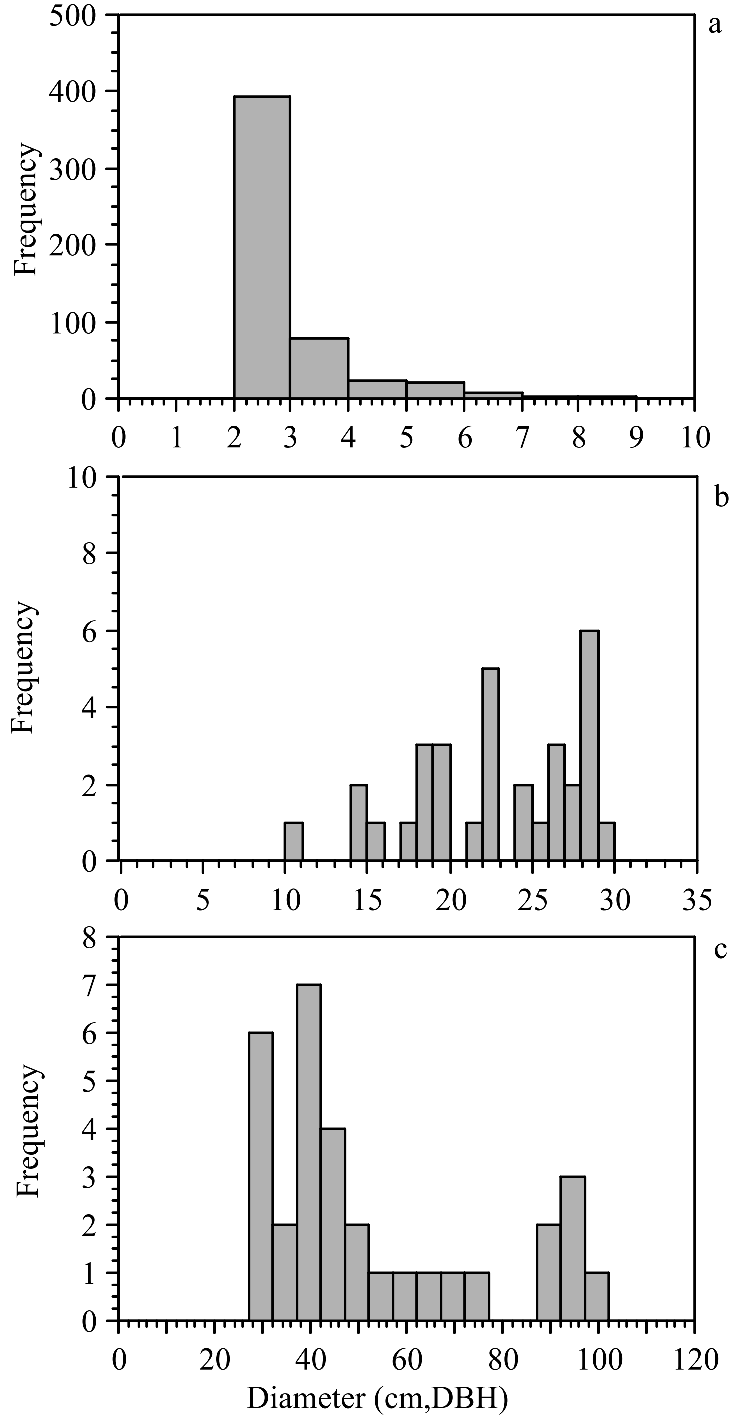
b) Descriptive Statistics

	DBH (cm)
Mean	18.37
Std. Dev.	5.57
Std. Error	1.25
Count	20
Minimum	11.20
Maximum	29.90

c) Descriptive Statistics

	DBH (cm)
Mean	56.38
Std. Dev.	19.73
Std. Error	3.66
Count	29
Minimum	31.50
Maximum	87.70

Figure 3.17 Frequency distributions of East Ridge woody taxa for different diameter size classes: a) small-size class (2.00 - < 10.00 cm DBH) (n=658), b) mid-size class (10.00 - < 30.00 cm DBH) (n=20) and, c) large size-class (>30.00 cm DBH) (n=29).



a

Descriptive Statistics

	DBH (cm)
Mean	2.77
Std. Dev.	1.13
Std. Error	0.05
Count	531
Minimum	2.00
Maximum	9.70

b

Descriptive Statistics

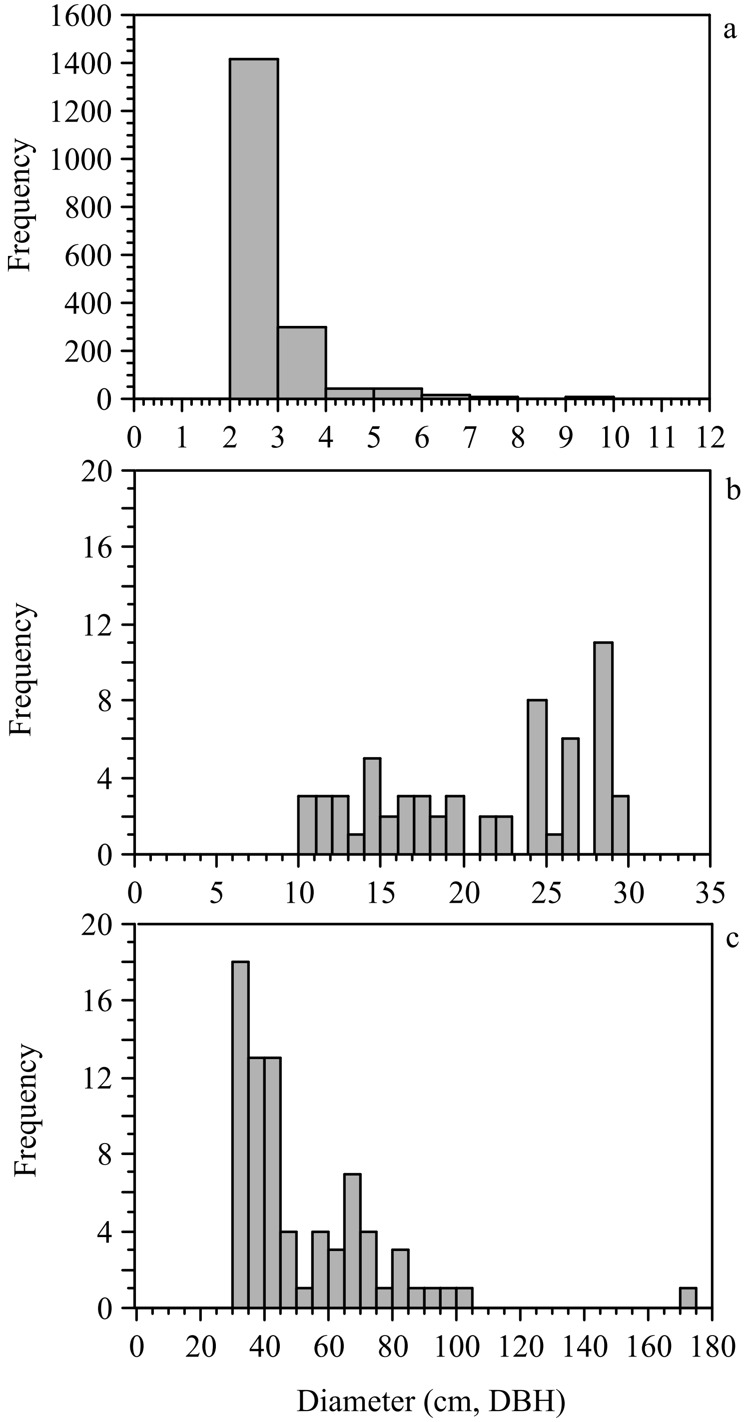
	DBH (cm)
Mean	22.88
Std. Dev.	5.06
Std. Error	0.90
Count	32
Minimum	10.40
Maximum	29.40

c

Descriptive Statistics

	DBH (cm)
Mean	52.67
Std. Dev.	23.07
Std. Error	4.08
Count	32
Minimum	30.50
Maximum	100.20

Figure 3.18 Frequency distributions of Ridge Tops woody taxa for different diameter size classes: a) small-size class (2.00 - <10.00 cm DBH) (n=531), b) mid-size class (10.00 - <30.00 cm DBH) (n=32) and, c) large-size class (>30.00 cm DBH) (n=32).



a Descriptive Statistics

	DBH (cm)
Mean	2.69
Std. Dev.	1.00
Std. Error	0.02
Count	1834
Minimum	2.00
Maximum	9.70

b Descriptive Statistics

	DBH (cm)
Mean	21.27
Std. Dev.	6.37
Std. Error	0.76
Count	67
Minimum	10.20
Maximum	29.60

c Descriptive Statistics

	DBH (cm)
Mean	51.42
Std. Dev.	23.10
Std. Error	2.65
Count	77
Minimum	30.40
Maximum	171.20

Figure 3.19 Frequency distributions of the West Ridge woody taxa for different diameter size classes: a) small-size class (2.00 - <10.00 cm DBH) (n=1834), b) mid-size class (10.00 - < 30.00 cm DBH) (n=67) and, c) large-size class (> 30.00 cm DBH) (n=77).

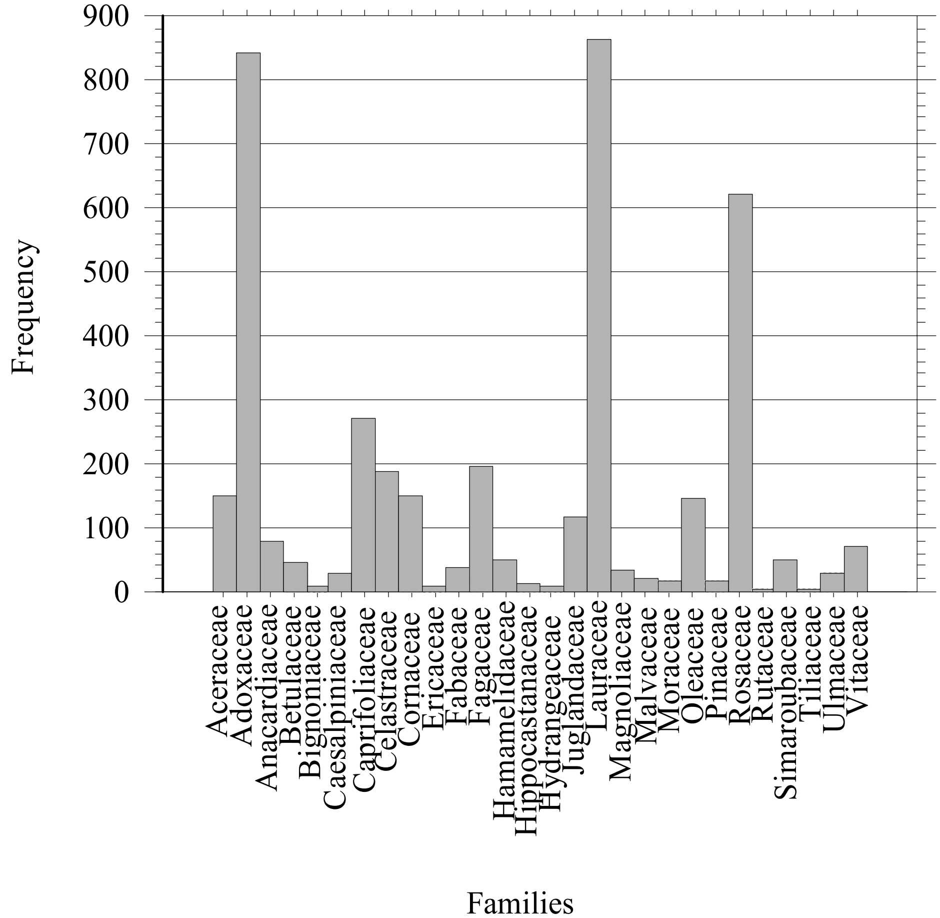


Figure 3.20 Bar graph displaying the frequency distribution of all woody plant families within the 45 10 X 10 m^2 quadrats of the Inwood Hill Park study area (n=4070).

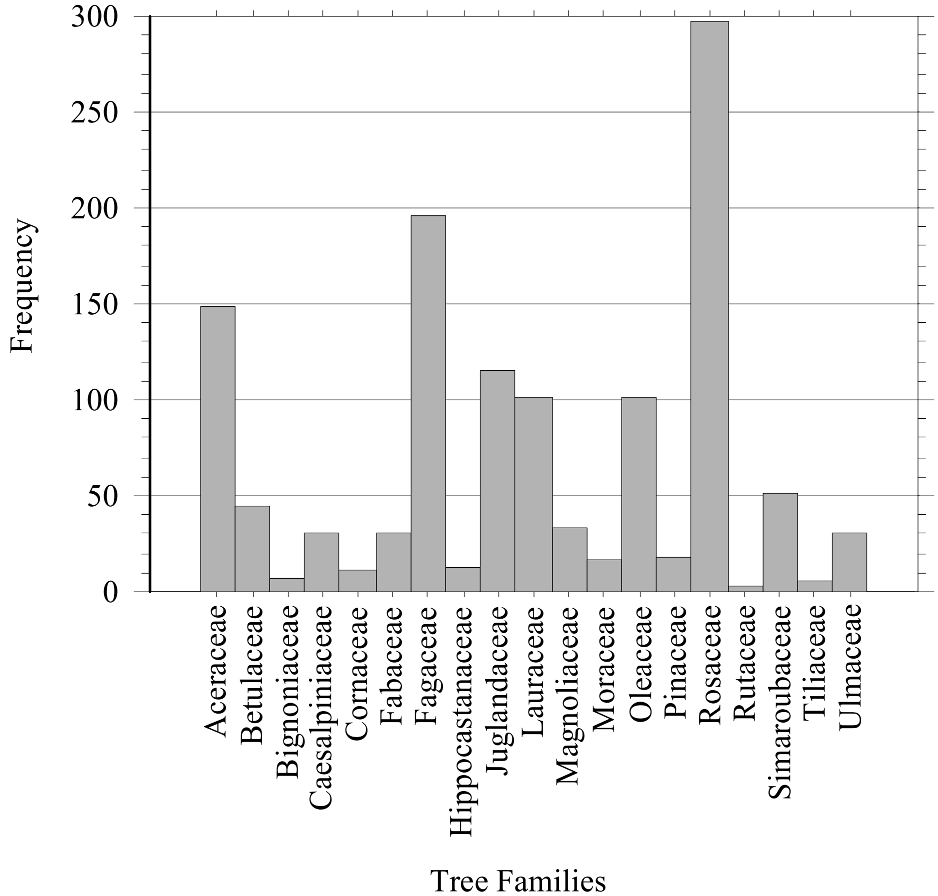


Figure 3.21 Bar graph displaying the frequency distribution of all tree families within the 45 10 X 10 m^2 quadrats of the Inwood Hill Park study area (n=1256).

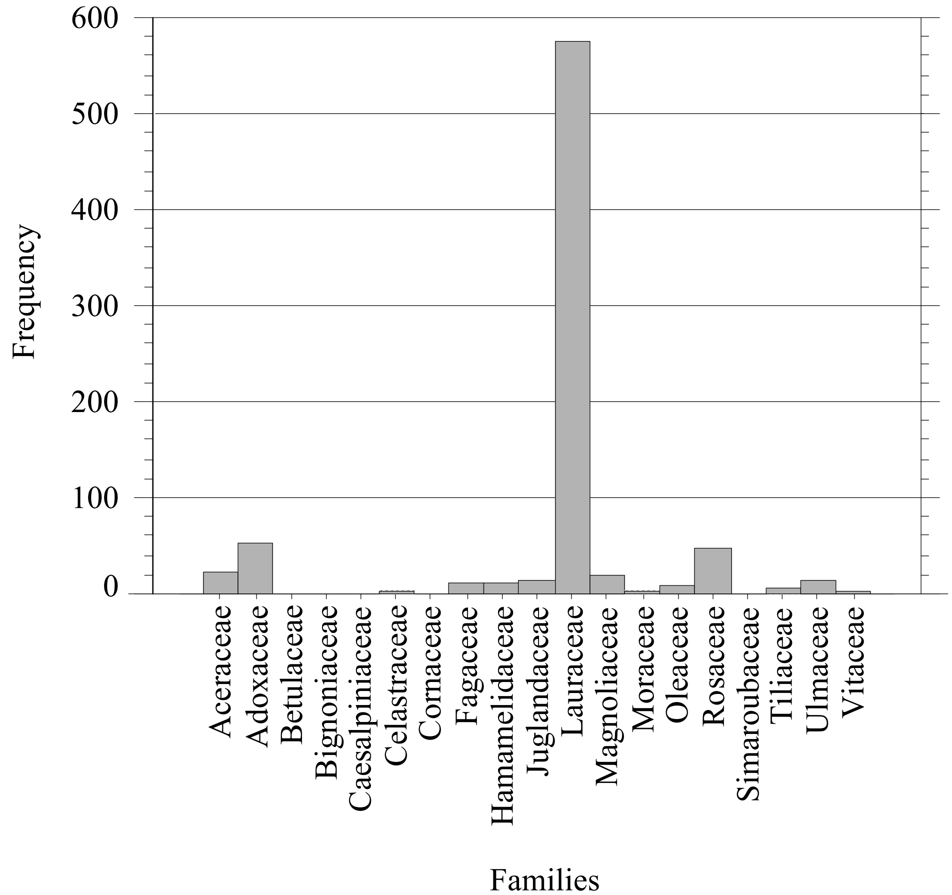


Figure 3.22 Bar graph displaying the frequency distribution of woody taxa families within the 11 10 X 10 m^2 quadrats of the Valley-Clove study area of Inwood Hill Park (n= 790). Those families listed that contain no bars are represented by <5 members within the families.

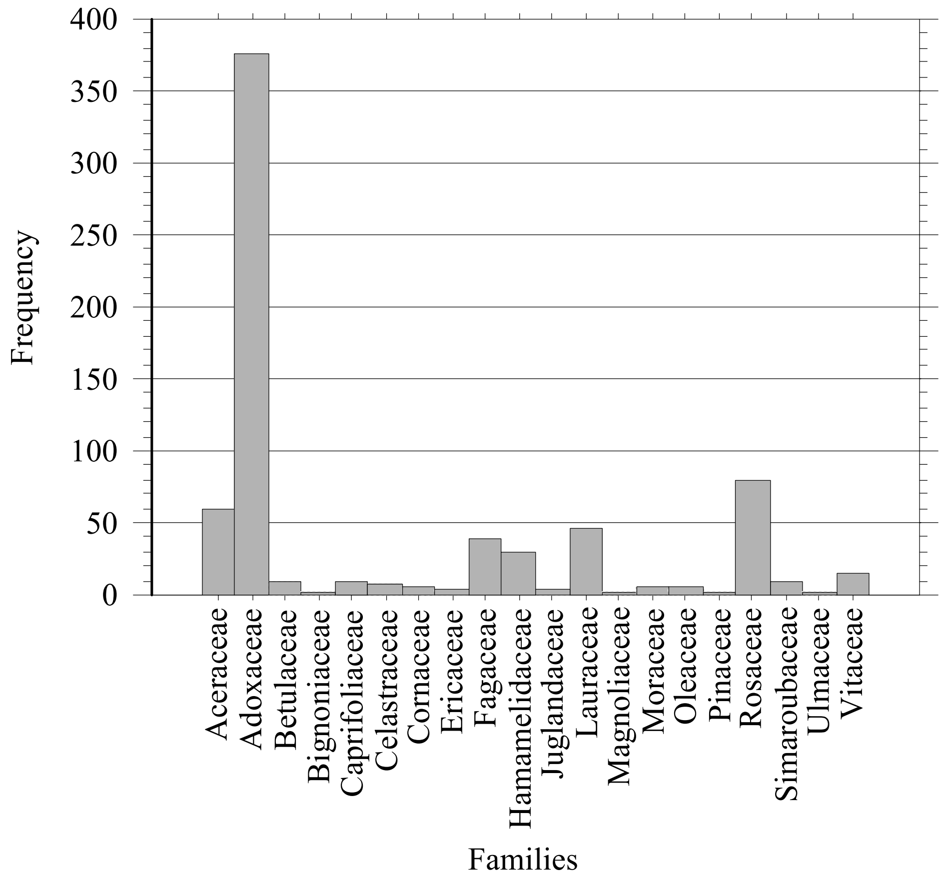


Figure 3.23 Bar graph displaying the frequency distribution of woody taxa families within the 8 10 X 10 m^2 quadrats for the East Ridge and slopes study area (n=707).

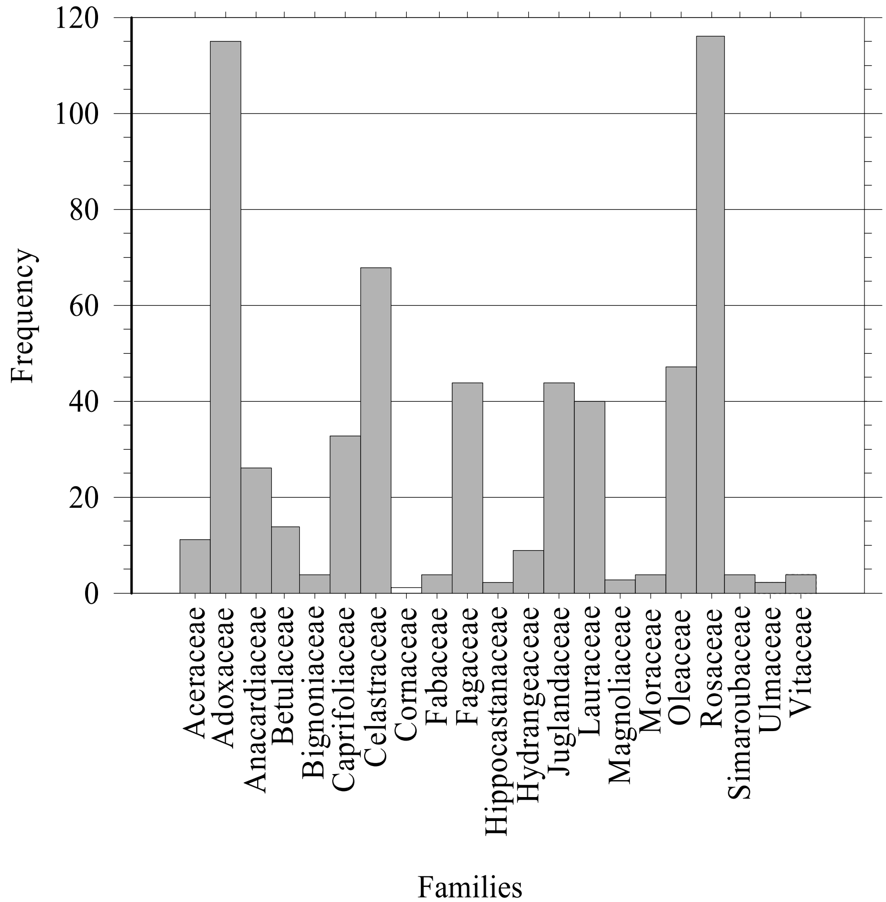


Figure 3.24 Bar graph displaying the frequency distribution of woody taxa families within the 8 10 X 10 m^2 quadrats for the Ridge Tops (east and west) forest (n=595).

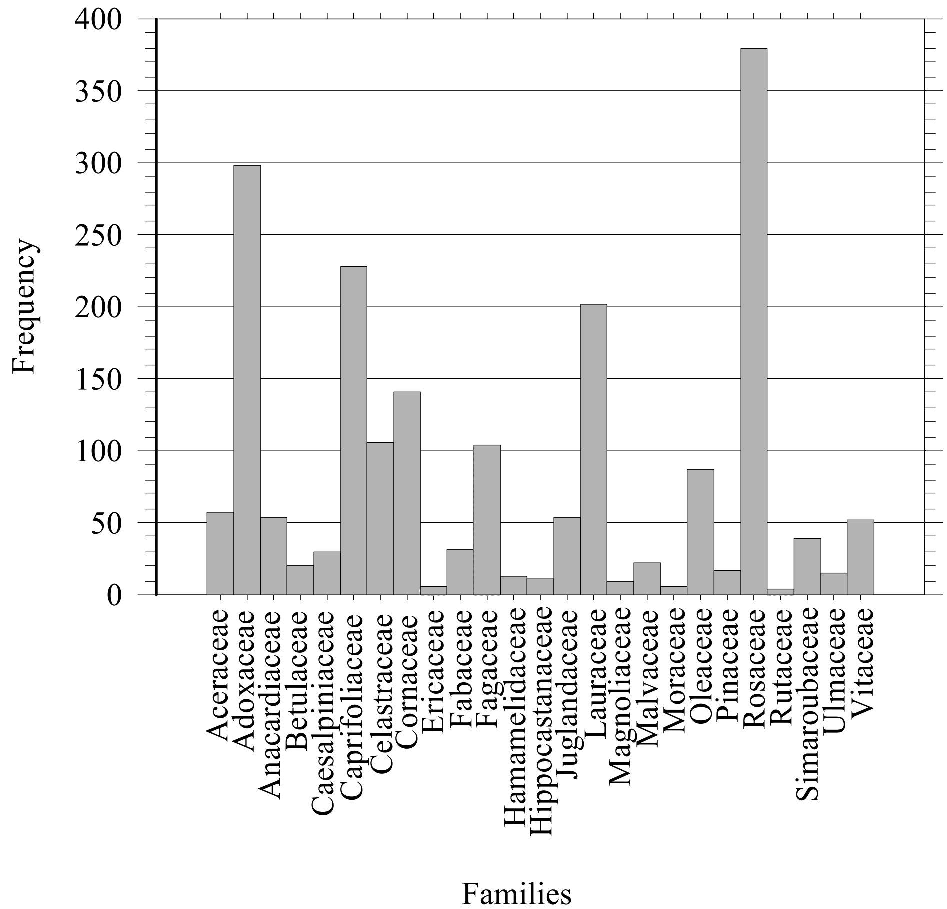


Figure 3.25 Bar graph displaying the frequency distributions of woody taxa families within the 18 10 X 10 m^2 quadrats of the West Ridge and slopes study area of Inwood Hill Park (n=1978).

Table 3.1 Inwood Hill Park Data: 51 Genera, 77 Species, 28 Families in 45 10 X 10 m^2 quadrats (n=4070).

Genera	Species	No	Family	N-NN-IV	N of Stems
1. *Acer*	*platanoides* L.	6	Aceraceae	NN-IV	
	pseudoplatanus L.	6	Aceraceae	NN-IV	
	rubrum L.	85	Aceraceae	N	
	saccharum Marshall	52	Aceraceae	N	
					149
2. *Aesculus*	*hippocastanum* L.	13	Aceraceae	NN	
					13
3. *Ailanthus*	*altissima* (Miller) Swingle	52	Simaroubaceae	NN-IV	
					52
4. *Amelanchier*	*canadensis* Wieg.	3	Rosaceae	N	
					3
5. *Ampelopsis*	*brevipedunculata* (Maxim.) Trautv.	36	Vitaceae	NN-IV	
					36
6. *Aronia*	*arbutifolia* (L.) Elliott	6	Rosaceae	N	
					6
7. *Betula*	*lenta* L.	44	Betulaceae	N	
					44
8. *Carya*	*cordiformis* (Wangenh.) K. Koch	97	Juglandaceae	N	
	ovata (Miller) K. Koch	3	Juglandaceae	N	
	tomentosa (Poiret) Nutt.	13	Juglandaceae	N	
					113
9. *Catalpa*	*bignonioides* Walter	4	Bignoniaceae	N-IV	
					4
10. *Celastrus*	*orbiculatus* Thunb.	181	Celastraceae	NN-IV	
					181

Table 3.1 Inwood Hill Park Data: 51 Genera, 77 Species, 28 Families in 45 10 X 10 m^2 quadrats (n=4070).

Genera	Species	No	Family	N-NN-IV	N of Stems
11. *Celtis*	*occidentalis* L.	29	Ulmaceae	N	
					29
12. *Cercis*	*canadensis* L.	1	Caesalpiniaceae	N	
					1
13. *Cornus*	*amomum* Miller	5	Cornaceae	N	
	florida L.	11	Cornaceae	N	
	foemina ssp. *racemosa* (Lam.) J. Wilson	111	Cornaceae	N	
	sericea L.	21	Cornaceae	N	
					148
14. *Crataegus*	ssp. L	1	Rosaceae	NN	
					1
15. *Euonymus*	*alatus* (Thunb.) Siebold	5	Oleaceae	NN-IV	
					5
16. *Fagus*	*grandifolia* L.	13	Fagaceae	N	
	sylvatica L.	2	Fagaceae	NN	
					15
17. *Forsythia*	*suspensa x viridissima* (Thunb.) Vahl	33	Oleaceae	NN	
					33
18. *Fraxinus*	*americana* L.	101	Oleaceae	N	
					101
19. *Gleditsia*	*triacanthos* L.	1	Caesalpiniaceae	N	
					1
20. *Gymnocladus*	*dioica* (L.) K. Koch	28	Caesalpiniaceae	N	
					28

Table 3.1 Inwood Hill Park Data: 51 Genera, 77 Species, 28 Families in 45 10 X 10 m^2 quadrats (n=4070).

Genera	Species	No	Family	N-NN-IV	N of Stems
21. *Hamamelis*	*virginiana* L.	52	Hamamelidaceae	N	
					52
22. *Hibiscus*	*syriacus* L.	22	Malvaceae	NN-IV	
					22
23. *Juglans*	*cinerea* L.	1	Juglandaceae	N	
	nigra L.	1	Juglandaceae	N	
					2
24. *Ligustrum*	*vulgare* L.	13	Oleaceae	NN-IV	
					13
25. *Lindera*	*benzoin* (L.) Blume	760	Lauraceae	N	
					760
26. *Liriodendron*	*tulipifera* L.	34	Magnoliaceae	N	
					34
27. *Lonicera*	*maackii* (Rupr.) Herder	269	Caprifoliaceae	NN-IV	
					269
28. *Maclura*	*pomifera* (Raf.) C. K. Schneider	2	Moraceae	NN	
					2
29. *Morus*	*alba* L.	15	Moraceae	NN-IV	
					15
30. *Paulownia*	*tomentosa* (Thunb.) Steudel	3	Bignoniaceae	NN-IV	
					3
31. *Phellodendron*	*amurense* Rupr.	3	Rutaceae	NN-IV	
					3
32. *Philadelphus*	*coronarius* L.	9	Hydrangeaceae	NN	
					9

Table 3.1 Inwood Hill Park Data: 51 Genera, 77 Species, 28 Families in 45 10 X 10 m^2 quadrats (n=4070).

Genera	Species	No	Family	N-NN-IV	N of Stems
33. *Pinus*	*nigra* Arnold	2	Pinaceae	NN-IV	
	strobus L.	15	Pinaceae	N	
					17
34. *Prunus*	*avium* L.	2	Rosaceae	N	
	serotina L.	286	Rosaceae	N	
					288
35. *Pyrus*	*baccata* L.	5	Rosaceae	NN	
	communis L.	1	Rosaceae	NN	
	malus L.	2	Rosaceae	NN	8
36. *Quercus*	*alba* L.	16	Fagaceae	N	
	coccinea Muenchh.	8	Fagaceae	N	
	prinus L.	17	Fagaceae	N	
	rubra L.	121	Fagaceae	N	
	velutina Lam.	19	Fagaceae	N	
					181
37. *Rhododendron*	*periclymenoides* (Michx).	6	Ericaceae	N	
					6
38. *Rhodotypos*	*scandens* (Thunb.) Makino	14	Rosaceae	NN-IV	
					14
39. *Rhus*	*aromatica* Aiton	6	Anacardiaceae	N	
	typhina L.	30	Anacardiaceae	N	
					36
40. *Robinia*	*pseudoacacia* L.	31	Fabaceae	NN-IV	
					31

Table 3.1 Inwood Hill Park Data: 51 Genera, 77 Species, 28 Families in 45 10 X 10 m^2 quadrats (n=4070).

Genera	Species	No	Family	N-NN-IV	N of Stems
41. *Rosa*	*multiflora* Thunb.	186	Rosaceae	NN-IV	
					186
42. *Rubus*	*allegheniensis* T. C. Porter	24	Rosaceae	N	
	laciniatus Willd.	44	Rosaceae	NN	
	occidentalis L.	47	Rosaceae	N	
					115
43. *Sassafras*	*albidum* (Nutt.) Nees	101	Lauraceae	N	
					101
44. *Tilia*	*americana* L.	6	Tilliaceae	N	
					6
45. *Toxicodendron*	*radicans* (L.) Kuntze.	43	Anacardiaceae	N	
					43
46. *Tsuga*	*canadensis* (L.) Carriere	1	Pinaceae	N	
					1
47. *Ulmus*	*americana* L.	2	Ulmaceae	N	
					2
48. *Vaccinium*	*corymbosum* L.	4	Ericaceae	N	
					4
49. *Viburnum*	*acerifolium* L.	618	Adoxaceae	N	
	dentatum L.	190	Adoxaceae	N	
	opulus var. americana Aiton	7	Adoxaceae	N	
	prunifolium L.	28	Adoxaceae	N	
					843

Table 3.1 Inwood Hill Park Data: 51 Genera, 77 Species, 28 Families in 45 10 X 10 m^2 quadrats (n=4070).

Genera	Species	No	Family	N-NN-IV	N of Stems
50. *Vitis*	*aestivalis* Michx.	5	Vitaceae	N	
	labrusca L.	14	Vitaceae	N	
	riparia Michx.	17	Vitaceae	N	
					36
51. *Wisteria*	*sinensis* (Sims) Sweet	5	Fabaceae	NN-IV	
					5
TOTAL	77		28		4070

Table 3.2 Woody taxa in the Valley-Clove Forest in Inwood Hill Park (n=790).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 1			65		285° WNW 15° NNE	16.4 (54)
Carya cordiformis (Wangenh.) K. Koch	1	Juglandaceae		N		
Hamamelis virginiana L.	5	Hamamelidaceae		N		
Lindera benzoin (L.) Blume	57	Lauraceae		N		
Liriodendron tulipifera L.	1	Magnoliaceae		N		
Ulmus americana L.	1	Ulmaceae		N		
Quadrat 2			36		310°NW 40°NE	10.3 (34)
Carya ovata (Miller) K. Koch	3	Juglandaceae		N		
Cornus florida L.	1	Cornaceae		N		
Lindera benzoin (L.) Blume	29	Lauraceae		N		
Liriodendron tulipifera L.	2	Magnoliaceae		N		
Morus alba L.	1	Moraceae		NN-IV		
Quadrat 3			64		310°NW 220°SW	20.1 (66)
Acer rubrum L.	3	Aceraceae		N		
Acer saccharum Marshall	4	Aceraceae		N		
Carya cordiformis (Wangenh.) K. Koch	2	Juglandaceae		N		
Celtis occidentalis L.	3	Ulmaceae		N		
Crataegus spp. L.	1	Rosaceae		NN		
Lindera benzoin (L.) Blume	42	Lauraceae		N		
Liriodendron tulipifera L.	1	Magnoliaceae		N		
Prunus serotina Ehrh.	2	Rosaceae		N		
Quercus rubra L.	2	Fagaceae		N		
Viburnum acerifolium L.	4	Adoxaceae		N		

Table 3.2 Woody taxa in the Valley-Clove Forest in Inwood Hill Park (n=790).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 5			86		135°SE 225°SW	17.6 (58)
Acer rubrum L.	5	Aceraceae		N		
Acer saccharum Marshall	1	Aceraceae		N		
Fraxinus americana L.	2	Oleaceae		N		
Lindera benzoin (L.) Blume	60	Lauraceae		N		
Liriodendron tulipifera L.	1	Magnoliaceae		N		
Quercus rubra L.	1	Fagaceae		N		
Viburnum acerifolium L.	4	Adoxaceae		N		
Viburnum prunifolium L.	10	Adoxaceae		N		
Vitis labrusca L.	2	Vitaceae		N		
Quadrat 6			56		234° SW 324° NW	13.4 (44)
Betula lenta L.	1	Betulaceae		N		
Celtis occidentalis L.	2	Ulmaceae		N		
Lindera benzoin (L.) Blume	49	Lauraceae		N		
Liriodendron tulipifera L.	3	Magnoliaceae		N		
Quercus rubra L.	1	Fagaceae		N		
Quadrat 7			102		220° SW 310° NW	20.1 (66)
Celtis occidentalis L.	2	Ulmaceae		N		
Lindera benzoin (L.) Blume	83	Lauraceae		N		
Liriodendron tulipfera L.	2	Magnoliaceae		N		
Quercus alba L.	1	Fagaceae		N		
Quercus rubra L.	2	Fagaceae		N		
Viburnum acerifolium L.	2	Adoxaceae		N		
Viburnum dentatum L.	9	Adoxaceae		N		
Tilia americana L.	1	Tiliaceae		N		

Table 3.2 Woody taxa in the Valley-Clove Forest in Inwood Hill Park (n=790).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 13			101		146°SE 236°SW	22.5 (74)
Lindera benzoin (L.) Blume	80	Lauraceae		N		
Liriodendron tulipifera L.	6	Magnoliaceae		N		
Rosa multiflora Thunb.	8	Rosaceae		NN-IV		
Viburnum opulus var. americana Aiton	7	Adoxaceae		N		
Quadrat 14			49		314° NW 44°NE	24.3 (80)
Celtis occidentalis L.	1	Ulmaceae		N		
Fraxinus americana L.	3	Oleaceae		N		
Lindera benzoin (L.) Blume	33	Lauraceae		N		
Morus alba L.	2	Moraceae		NN-IV		
Rosa multiflora Thunb.	7	Rosaceae		NN-IV		
Tilia americana L.	3	Tiliaceae		N		
Quadrat 17			88		40°NE 130° SE	39.6 (130)
Carya cordiformis (Wangenh.) K. Koch	6	Juglandaceae		N		
Fraxinus americana L.	1	Oleaceae		N		
Lindera benzoin (L.) Blume	53	Lauraceae		N		
Prunus serotina Ehrh.	2	Rosaceae		N		
Quercus rubra L.	2	Fagaceae		N		
Rosa multiflora Thunb.	22	Rosaceae		NN-IV		
Viburnum acerifolium L.	2	Adoxaceae		N		

Table 3.2 Woody taxa in the Valley-Clove Forest in Inwood Hill Park (n=790).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 18			86		108°ESE 198°SSW	18.2 (60)
Acer rubrum L.	5	Aceraceae		N		
Acer saccharum Marshall	2	Aceraceae		N		
Ailanthus altissima (Miller) Swingle	1	Simaroubaceae		NN-IV		
Celastrus orbiculatus Thunb.	4	Celastraceae		NN-IV		
Celtis occidentalis L.	4	Ulmaceae		N		
Cercis canadensis L.	1	Caesalpiniaceae		N		
Hamamelis virginiana L.	5	Hamamelidaceae		N		
Lindera benzoin (L.) Blume	40	Lauraceae		N		
Liriodendron tulipifera L.	2	Magnoliaceae		N		
Paulownia tomentosa (Thunb.) Steudel	1	Bignoniaceae		NN-IV		
Prunus serotina Ehrh.	1	Rosaceae		N		
Rosa multiflora Thunb.	3	Rosaceae		NN-IV		
Viburnum dentatum L.	15	Adoxaceae		N		
Tilia americana L.	2	Tiliaceae		N		
Quadrat 19			57		338°NNW 68°ENE	18.2 (60)
Acer saccharum Marshall	2	Aceraceae		N		
Carya cordiformis (Wangenh.) K. Koch	2	Juglandaceae		N		
Fraxinus americana L.	1	Oleaceae		N		
Lindera benzoin (L.) Blume	46	Lauraceae		N		
Liriodendron tulipifera L.	2	Magnoliaceae		N		
Quercus alba L.	1	Fagaceae		N		
Quercus rubra L.	1	Fagaceae		N		
Sassafras albidum (Nutt.) Nees	2	Lauraceae		N		
			790			

Table 3.3 Woody taxa in the East Ridge and Slopes Forest in Inwood Hill Park (n=707).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 4			84		330° NNW 60° ENE	24.3 (80)
Acer rubrum L.	2	Aceraceae		N		
Betula lenta L.	1	Betulaceae		N		
Cornus florida L.	2	Cornaceae		N		
Hamamelis virginiana L.	7	Hamamelidaceae		N		
Lindera benzoin (L.) Blume	20	Lauraceae		N		
Prunus serotina Ehrh.	1	Rosaceae		N		
Quercus prinus L.	3	Fagaceae		N		
Quercus velutina Lam.	2	Fagaceae		N		
Rubus allegheniensis T.C. Porter	3	Rosaceae		N		
Sassafras albidum (Nutt.) Nees	1	Lauraceae		N		
Viburnum acerifolium L.	34	Adoxaceae		N		
Viburnum dentatum L.	8	Adoxaceae		N		
Quadrat 8			75		28° NNE 118° ESE	30.4 (100)
Acer rubrum L.	11	Aceraceae		N		
Catalpa bignonioides Walter	2	Bignoniaceae		N-IV		
Hamamelis virginiana L.	12	Hamamelidaceae		N		
Lindera benzoin (L.) Blume	2	Lauraceae		N		
Prunus serotina Ehrh.	4	Rosaceae		N		
Quercus rubra L.	1	Fagaceae		N		
Quercus prinus L.	2	Fagaceae		N		
Sassafras albidum (Nutt.) Nees	2	Lauraceae		N		
Vaccinium corymbosum L.	4	Ericaceae		N		
Viburnum acerifolium L.	35	Adoxaceae		N		

Table 3.3 Woody taxa in the East Ridge and Slopes Forest in Inwood Hill Park (n=707).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 9			27		316° NW 46° NE	33.5 (110)
Acer rubrum L.	3	Aceraceae		N		
Fagus grandifolia Ehrh.	4	Fagaceae		N		
Hamamelis virginiana L.	8	Hamamelidaeae		N		
Quercus rubra L.	1	Fagaceae		N		
Quercus prinus L.	3	Fagaceae		N		
Viburnum acerifolium L.	8	Adoxaceae		N		
Quadrat 11			75		304° NW 34° NE	31.6 (104)
Acer rubrum L.	14	Aceraceae		N		
Carya tomentosa (Poiret) Nutt.	1	Juglandaceae		N		
Celastrus orbiculatus Thunb.	3	Celastraceae		NN-IV		
Fraxinus americana L.	1	Oleaceae		N		
Hamamelis virginiana L.	2	Hamamelidaceae		N		
Morus alba L.	1	Moraceae		NN-IV		
Prunus serotina Ehrh.	6	Rosaceae		N		
Quercus alba L.	1	Fagaceae		N		
Quercus rubra L.	2	Fagaceae		N		
Sassafras albidum (Nutt.) Nees	1	Lauraceae		N		
Viburnum acerifolium L.	39	Adoxaceae		N		
Vitis labrusca L.	4	Vitaceae		N		
Quadrat 12			113		320° NW 50° NE	32.9 (108)
Acer rubrum L.	8	Aceraceae		N		
Prunus serotina Ehrh.	1	Rosaceae		N		
Quercus rubra L.	4	Fagaceae		N		
Sassafras albidum (Nutt.) Nees	7	Lauraceae		N		
Viburnum acerifolium L.	93	Adoxaceae		N		

Table 3.3 Woody taxa in the East Ridge and Slopes Forest in Inwood Hill Park (n=707).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 16			125		232° SW 322° NW	36.5 (120)
Betula lenta L.	8	Betulaceae		N		
Carya cordiformis (Wangenh.) K. Koch	2	Juglandaceae		N		
Carya tomentosa (Poiret) Nutt.	1	Juglandaceae		N		
Cornus florida L.	3	Cornaceae		N		
Fraxinus americana L.	5	Oleaceae		N		
Morus alba L.	2	Moraceae		NN-IV		
Prunus serotina Ehrh.	6	Rosaceae		N		
Quercus alba L.	1	Fagaceae		N		
Quercus coccinea Muenchh.	1	Fagaceae		N		
Quercus rubra L.	5	Fagaceae		N		
Rosa multiflora Thunb.	5	Rosaceae		NN-IV		
Sassafras albidum (Nutt.) Nees	1	Lauraceae		N		
Viburnum acerifolium L.	85	Adoxaceae		N		
Quadrat 22			93		326° NW 56° NE	41.45 (136)
Acer rubrum L.	7	Aceraceae		N		
Prunus serotina Ehrh.	5	Rosaceae		N		
Quercus alba L.	5	Fagaceae		N		
Quercus rubra L.	1	Fagaceae		N		
Sassafras albidum (Nutt.) Nees	1	Lauraceae		N		
Viburnum acerifolium L.	74	Adoxaceae		N		

Table 3.3 Woody taxa in the East Ridge and Slopes Forest in Inwood Hill Park (n=707).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 27			115		350° N 80° E	35.3 (116)
Acer plantanoides L.	2	Aceraceae		NN-IV		
Acer rubrum L.	2	Aceraceae		N		
Acer saccharum Marshall	10	Aceraceae		N		
Ailanthus altissima (Miller) Swingle	9	Simaroubaceae		NN-IV		
Ampelopsis brevipedunculata (Maxim.) Trautv.	6	Vitaceae		NN-IV		
Celastrus orbiculatus Thunb.	5	Celastraceae		NN-IV		
Celtis occidentalis L.	2	Ulmaceae		N		
Lindera benzoin (L.) Blume	7	Lauraceae		N		
Liriodendron tulipifera L.	1	Magnoliaceae		N		
Lonicera maackii (Rupr.) Herder	9	Caprifoliaceae		NN-IV		
Morus alba L.	2	Moraceae		NN-IV		
Pinus nigra Arnold	1	Pinaceae		NN-IV		
Prunus serotina Ehrh.	8	Rosaceae		N		
Quercus rubra L.	2	Fagaceae		N		
Rosa multiflora Thunb.	41	Rosaceae		NN-IV		
Sassafras albidum (Nutt.) Nees	4	Lauraceae		N		
Vitis labrusca L.	4	Vitaceae		N		
			707			

Table 3.4 Woody taxa for the Ridge Tops (east and west) Forest in Inwood Hill Park (n=595).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 10			36		210° SSW 300° WNW	40.8 (134)
Acer rubrum L.	1	Aceraceae		N		
Amelanchier canadensis Wieg.	3	Rosaceae		N		
Betula lenta L.	2	Betulaceae		N		
Prunus serotina Ehrh.	3	Rosaceae		N		
Quercus coccinea Muenchh.	3	Fagaceae		N		
Quercus prinus L.	3	Fagaceae		N		
Quercus rubra L.	5	Fagaceae		N		
Sassafras albidum (Nutt.) Nees	10	Lauraceae		N		
Viburnum acerifolium L.	6	Adoxaceae		N		
Quadrat 15			16		150° SSE 60° ENE	44.5 (146)
Fraxinus americana L.	2	Oleaceae		N		
Prunus serotina Ehrh.	8	Rosaceae		N		
Quercus coccinea Muenchh.	2	Fagaceae		N		
Quercus rubra L.	3	Fagaceae		N		
Quercus velutina Lam.	1	Fagaceae		N		

Table 3.4 Woody taxa for the Ridge Tops (east and west) Forest in Inwood Hill Park (n=595).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 20			133		260° W 350° N	48.7 (160)
Acer saccharum Marshall	10	Aceraceae		N		
Betula lenta L.	1	Betulaceae		N		
Carya cordiformis (Wangenh.) K. Koch	7	Juglandaceae		N		
Celastrus orbiculatus Thunb.	33	Celastraceae		NN-IV		
Fraxinus americana L.	10	Oleaceae		N		
Lonicera maackii (Rupr.) Herder	8	Caprifoliaceae		NN-IV		
Prunus serotina Ehrh.	20	Rosaceae		N		
Quercus rubra L.	2	Fagaceae		N		
Quercus alba L.	1	Fagaceae		N		
Rosa multiflora Thunb.	15	Rosaceae		NN-IV		
Sassafras albidum (Nutt.) Nees	24	Lauraceae		N		
Toxicodendron radicans (L.) Kuntze.	2	Anacardiaceae		N		
Quadrat 21			72		330° NNW 60° ENE	49.3 (164)
Betula lenta L.	3	Betulaceae		N		
Carya cordiformis (Wangenh.) K. Koch	11	Juglandaceae		N		
Celastrus orbiculatus Thunb.	28	Celastraceae		NN-IV		
Fraxinus americana L.	5	Oleaceae		N		
Lonicera maackii (Rupr.) Herder	5	Caprifoliaceae		NN-IV		
Prunus serotina Ehrh.	10	Rosaceae		N		
Quercus rubra L.	2	Fagaceae		N		
Rhus typhina L.	4	Anacardiaceae		N		
Rubus occidentalis L.	4	Rosaceae		N		

Table 3.4 Woody taxa for the Ridge Tops (east and west) Forest in Inwood Hill Park (n=595).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 32			90		82° E 172° S	59.1 (194)
Carya cordiformis (Wangenh.) K. Koch	3	Juglandaceae		N		
Celtis occidentalis L.	2	Ulmaceae		N		
Euonymus alatus (Thunb.) Siebold	5	Celastraceae		NN-IV		
Fraxinus americana L.	2	Oleaceae		N		
Liriodendron tulipifera L.	2	Magnoliaceae		N		
Philadelphus coronarius L.	9	Hydrangeaceae		NN		
Prunus serotina Ehrh.	8	Rosaceae		N		
Pyrus baccata L.	2	Rosaceae		NN		
Quercus coccinea Muenchh.	1	Fagaceae		N		
Quercus rubra L.	3	Fagaceae		N		
Rosa multiflora Thunb.	4	Rosaceae		NN-IV		
Toxicodendron radicans (L.) Kuntze.	3	Anacardiaceae		N		
Viburnum dentatum L.	46	Adoxaceae		N		

Table 3.4 Woody taxa for the Ridge Tops (east and west) Forest in Inwood Hill Park (n=595).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 42			45		64° ENE 154° SSE	67.0 (220)
Aesculus hippocastanum L.	2	Hippocastanaceae		NN		
Ailanthus altissima (Miller) Swingle	4	Simaroubaceae		NN-IV		
Carya cordiformis (Wangenh.) K. Koch	4	Juglandaceae		N		
Cornus florida L.	1	Cornaceae		N		
Fraxinus americana L.	11	Oleaceae		N		
Maclura pomifera (Raf.) C.K.Schneider	1	Moraceae		NN		
Morus alba L.	2	Moraceae		NN-IV		
Paulownia tomentosa (Thunb.) Steudel	1	Bignoniaceae		NN-IV		
Prunus serotina Ehrh.	7	Rosaceae		N		
Quercus rubra L.	1	Fagaceae		N		
Rhus aromatica Aiton	6	Anacardiaceae		N		
Sassafras albidum (Nutt.) Nees	3	Lauraceae		N		
Wisteria sinensis (Sims) Sweet	2	Fabaceae		NN-IV		

Table 3.4 Woody taxa for the Ridge Tops (east and west) Forest in Inwood Hill Park (n=595).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 44			81		154° SSE 244° WSW	70.1 (230)
Ampelopsis brevipedunculata (Maxim.) Trautv.	4	Vitaceae		NN-IV		
Betula lenta L.	3	Betulaceae		N		
Carya cordiformis (Wangenh.) K. Koch	10	Juglandaceae		N		
Catalpa bignonioides Walter	2	Bignoniaceae		N-IV		
Celastrus orbiculatus Thunb.	2	Celastraceae		NN-IV		
Fraxinus americana L.	15	Oleaceae		N		
Juglans cinerea L.	1	Juglandaceae		N		
Liriodendron tulipifera L.	1	Magnoliaceae		N		
Lonicera maackii (Rupr.) Herder	20	Caprifoliaceae		NN-IV		
Morus alba L.	1	Moraceae		NN-IV		
Paulownia tomentosa (Thunb.) Steudel	1	Bignoniaceae		NN-IV		
Prunus serotina Ehrh.	3	Rosaceae		N		
Pyrus malus L.	2	Rosaceae		NN		
Quercus rubra L.	2	Fagaceae		N		
Quercus velutina Lam.	1	Fagaceae		N		
Rubus occidentalis L.	5	Rosaceae		N		
Rhus typhina L.	6	Anacardiaceae		N		
Wisteria sinensis (Sims) Sweet	2	Fabaceae		NN-IV		

Table 3.4 Woody taxa for the Ridge Tops (east and west) Forest in Inwood Hill Park (n=595).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 45			122		334° NW 64° NE	60.9 (200)
Betula lenta L.	5	Betulaceae		N		
Carya cordiformis (Wangenh.) K. Koch	4	Juglandaceae		N		
Carya tomentosa (Poiret) Nutt.	3	Juglandaceae		N		
Fraxinus americana L.	2	Oleaceae		N		
Juglans nigra L.	1	Juglandaceae		N		
Prunus serotina Ehrh.	21	Rosaceae		N		
Quercus rubra L.	12	Fagaceae		N		
Quercus velutina Lam.	2	Fagaceae		N		
Sassafras albidum (Nutt.) Nees	3	Lauraceae		N		
Toxicodendron radicans (L.) Kuntze.	5	Anacardiaceae		N		
Viburnum acerifolium L.	64	Adoxaceae		N		
			595			

Table 3.5 Woody taxa in the West Ridge and Slopes Forest in Inwood Hill Park (n=1978).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 23			54		30° NNE 120° ESE	48.7 (160)
Betula lenta L.	2	Betulaceae		N		
Carya cordiformis (Wangenh.) K. Koch	3	Juglandaceae		N		
Celastrus orbiculatus Thunb.	11	Celastraceae		NN-IV		
Celtis occidentalis L.	2	Ulmaceae		N		
Fagus grandifolia Ehrh.	9	Fagaceae		N		
Fraxinus americana L.	4	Oleaceae		N		
Lonicera maackii (Rupr.) Herder	4	Caprifoliaceae		NN-IV		
Prunus serotina Ehrh.	6	Rosaceae		N		
Quercus rubra L.	2	Fagaceae		N		
Toxicodendron radicans (L.) Kuntze.	4	Anacardiaceae		N		
Tsuga canadensis (L.) Carriere	1	Pinaceae		N		
Viburnum acerifolium L.	6	Adoxaceae		N		
Quadrat 24			59		284° W NW 14° NNE	33.5 (110)
Betula lenta L.	2	Betulaceae		N		
Carya cordiformis (Wangenh.) K. Koch	4	Juglandaceae		N		
Celastrus orbiculatus Thunb.	10	Celastraceae		NN-IV		
Celtis occidentalis L.	3	Ulmaceae		N		
Lonicera maackii (Rupr.) Herder	20	Caprifoliaceae		NN-IV		
Prunus serotina Ehrh.	4	Rosaceae		N		
Pyrus baccata L.	1	Rosaceae		NN		
Quercus alba L.	1	Fagaceae		N		
Quercus rubra L.	1	Fagaceae		N		
Rubus occidentalis L.	9	Rosaceae		N		
Vitis riparia Michx.	3	Vitaceae		N		
Toxicodendron radicans (L.) Kuntze.	1	Anacardiaceae		N		

Table 3.5 Woody taxa in the West Ridge and Slopes Forest in Inwood Hill Park (n=1978).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 25			114		132° SE 222° SW	30.4 (100)
Ailanthus altissima (Miller) Swingle	2	Simaroubaceae		NN-IV		
Ampelopsis brevipedunculata (Maxim.) Trautv.	16	Vitaceae		NN-IV		
Celtis occidentalis L.	3	Ulmaceae		N		
Gymnocladus dioica (L.) K. Koch	28	Caesalpiniaceae		N		
Lonicera maackii (Rupr.) Herder	14	Caprifoliaceae		NN-IV		
Morus alba L.	1	Moraceae		NN-IV		
Prunus serotina Ehrh.	1	Rosaceae		N		
Quercus alba L.	1	Fagaceae		N		
Quercus rubra L.	8	Fagaceae		N		
Robinia pseudoacacia L.	3	Fabaceae		NN-IV		
Rosa multiflora Thunb.	15	Rosaceae		NN-IV		
Rubus allegheniensis T.C. Porter	16	Rosaceae		N		
Rubus occidentalis L.	6	Rosaceae		N		
Quadrat 26			159		252° WSW 342° NNW	12.1 (40)
Acer platanoides L.	4	Aceraceae		NN-IV		
Acer pseudoplatanus L.	6	Aceraceae		NN-IV		
Ailanthus altissima (Miller) Swingle	28	Simaroubaceae		NN-IV		
Celastrus orbiculatus Thunb.	23	Celastraceae		NN-IV		
Celtis occidentalis L.	3	Ulmaceae		N		
Hibiscus syriacus L.	22	Malvaceae		NN-IV		
Ligustrum vulgare L.	11	Oleaceae		NN-IV		
Lonicera maackii (Rupr.) Herder	19	Caprifoliaceae		NN-IV		
Quercus rubra L.	2	Fagaceae		N		
Robinia pseudoacacia L.	3	Fabaceae		NN-IV		
Rosa multiflora Thunb.	28	Rosaceae		NN-IV		
Vitis riparia Michx.	9	Vitaceae		N		
Wisteria sinensis (Sims) Sweet	1	Fabaceae		NN		

Table 3.5 Woody taxa in the West Ridge and Slopes Forest in Inwood Hill Park (n=1978).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 28			98		144° SE 234° SW	50.2 (165)
Acer rubrum L.	4	Aceraceae		N		
Carya cordiformis (Wangenh.) K. Koch	3	Juglandaceae		N		
Carya tomentosa (Poiret) Nutt.	3	Juglandaceae		N		
Celastrus orbiculatus Thunb.	29	Celastraceae		NN-IV		
Fraxinus americana L.	3	Oleaceae		N		
Prunus serotina Ehrh.	18	Rosaceae		N		
Pyrus baccata L.	1	Rosaceae		NN		
Quercus rubra L.	3	Fagaceae		N		
Rhodotypos scandens (Thunb.) Makino	5	Rosaceae		NN-IV		
Rubus allegheniensis T.C. Porter	5	Rosaceae		N		
Rubus occidentalis L.	5	Rosaceae		N		
Sassafras albidum (Nutt.) Nees	10	Lauraceae		N		
Viburnum acerifolium L.	9	Adoxaceae		N		
Quadrat 29			93		130° SE 220° SW	51.8 (170)
Aesculus hippocastanum L.	1	Hippocastanaceae		NN		
Acer rubrum L.	2	Aceraceae		N		
Carya cordiformis (Wangenh.) K. Koch	2	Juglandaceae		N		
Fraxinus americana L.	2	Oleaceae		N		
Lindera benzoin (L.) Blume	11	Lauraceae		N		
Prunus serotina Ehrh.	4	Rosaceae		N		
Quercus coccinea Muenchh.	1	Fagaceae		N		
Robinia pseudoacacia L.	6	Fabaceae		NN-IV		
Viburnum dentatum L.	64	Adoxaceae		N		

Table 3.5 Woody taxa in the West Ridge and Slopes Forest in Inwood Hill Park (n=1978).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 30			59		324° NW 54° NE	56.6 (186)
Carya cordiformis (Wangenh.) K. Koch	6	Juglandaceae		N		
Carya tomentosa (Poiret) Nutt.	1	Juglandaceae		N		
Fraxinus americana L.	1	Oleaceae		N		
Lindera benzoin (L.) Blume	3	Lauraceae		N		
Lonicera maackii (Rupr.) Herder	9	Caprifoliaceae		NN-IV		
Prunus serotina Ehrh.	4	Rosaceae		N		
Quercus rubra L.	1	Fagaceae		N		
Quercus velutina Lam.	1	Fagaceae		N		
Rhodotypos scandens (Thunb.) Makino	9	Rosaceae		NN-IV		
Rhus typhina L.	5	Anacardiaceae		N		
Rosa multiflora Thunb.	6	Rosaceae		NN-IV		
Sassafras albidum (Nutt.) Nees	6	Lauraceae		N		
Toxicodendron radicans (L.) Kuntze.	2	Anacardiaceae		N		
Viburnum prunifolium L.	5	Adoxaceae		N		
Quadrat 31			80		42° NE 132° SE	57.3 (188)
Betula lenta L.	3	Betulaceae		N		
Carya cordiformis (Wangenh.) K. Koch	4	Juglandaceae		N		
Lindera benzoin (L.) Blume	8	Lauraceae		N		
Prunus serotina Ehrh.	14	Rosaceae		N		
Quercus velutina Lam.	3	Fagaceae		N		
Rubus laciniatus Willd.	44	Rosaceae		NN		
Toxicodendron radicans (L.) Kuntze.	2	Anacardiaceae		N		
Vitis labrusca L.	2	Vitaceae		N		

Table 3.5 Woody taxa in the West Ridge and Slopes Forest in Inwood Hill Park (n=1978).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 33			133		40° NE 130° SE	39.6 (130)
Acer rubrum L.	8	Aceraceae		N		
Betula lenta L.	2	Betulaceae		N		
Carya cordiformis (Wangenh.) K. Koch	3	Juglandaceae		N		
Celastrus orbiculatus Thunb.	5	Celastraceae		NN-IV		
Cornus florida L.	1	Cornaceae		N		
Liriodendron tulipifera L.	1	Magnoliaeae		N		
Prunus serotina Ehrh.	5	Rosaceae		N		
Quercus rubra L.	12	Fagaceae		N		
Quercus velutina Lam.	2	Fagaceae		N		
Sassafras albidum (Nutt.) Nees	3	Lauraceae		N		
Toxicodendron radicans (L.) Kuntze.	3	Anacardiaceae		N		
Viburnum acerifolium L.	83	Adoxaceae		N		
Vitis aestivalis Michx.	5	Vitaceae		N		
PLOT 34			175		18° NNE 108° ESE	27.4 (90)
Acer rubrum L.	3	Aceraceae		N		
Betula lenta L.	4	Betulaceae		N		
Carya cordiformis (Wangenh.) K. Koch	2	Juglandaceae		N		
Carya tomentosa (Poiret) Nutt.	3	Juglandaceae		N		
Cornus florida L.	3	Cornaceae		N		
Lindera benzoin (L.) Blume	45	Lauraceae		N		
Prunus serotina Ehrh.	19	Rosaceae		N		
Quercus prinus L.	4	Fagaceae		N		
Quercus rubra L.	15	Fagaceae		N		
Toxicodendron radicans (L.) Kuntze.	7	Anacardiaceae		N		
Viburnum acerifolium L.	70	Adoxaceae		N		

Table 3.5 Woody taxa in the West Ridge and Slopes Forest in Inwood Hill Park (n=1978).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 35			83		288° WNW 18° NNE	25.6 (84)
Acer rubrum L.	6	Aceraceae		N		
Ampelopsis brevipedunculata (Maxim.) Trautv.	1	Vitaceae		NN-IV		
Aronia arbutifolia (L.) Elliott	6	Rosaceae		N		
Betula lenta L.	1	Betulaceae		N		
Celastrus orbiculatus Thunb.	11	Celastraceae		NN-IV		
Fraxinus americana L.	4	Oleaceae		N		
Prunus serotina Ehrh.	4	Rosaceae		N		
Pyrus communis L.	1	Rosaceae		NN		
Quercus rubra L.	3	Fagaceae		N		
Sassafras albidum (Nutt.) Nees	2	Lauraceae		N		
Toxicodendron radicans (L.) Kuntze.	5	Anacardiaceae		N		
Viburnum dentatum L.	34	Adoxaceae		N		
Vitis riparia Michx.	5	Vitaceae		N		
PLOT 36			117		286° WNW 16° NNE	28.04 (92)
Ailanthus altissima (Miller) Swingle	4	Simaroubaceae		NN-IV		
Ampelopsis brevipedunculata (Maxim.) Trautv.	6	Vitaceae		NN-IV		
Carya cordiformis (Wangenh.) K. Koch	4	Juglandaceae		NN-IV		
Celastrus orbiculatus Thunb.	4	Celastraceae		NN-IV		
Fraxinus americana L.	4	Oleaceae		N		
Lonicera maackii (Rupr.) Herder	46	Caprifoliaceae		NN-IV		
Phellodendron amurense Rupr.	3	Rutaceae		NN-IV		
Pinus nigra Arnold	1	Pinaceae		NN-IV		
Prunus serotina Ehrh.	25	Rosaceae		N		
Quercus rubra L.	4	Fagaceae		N		
Rhus typhina L.	15	Anacardiaceae		N		
Toxicodendron radicans (L.) Kuntze.	1	Anacardiaceae		N		

Table 3.5 Woody taxa in the West Ridge and Slopes Forest in Inwood Hill Park (n=1978).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 35			83		288° WNW 18° NNE	25.6 (84)
Acer rubrum L.	6	Aceraceae		N		
Ampelopsis brevipedunculata (Maxim.) Trautv.	1	Vitaceae		NN-IV		
Aronia arbutifolia (L.) Elliott	6	Rosaceae		N		
Betula lenta L.	1	Betulaceae		N		
Celastrus orbiculatus Thunb.	11	Celastraceae		NN-IV		
Fraxinus americana L.	4	Oleaceae		N		
Prunus serotina Ehrh.	4	Rosaceae		N		
Pyrus communis L.	1	Rosaceae		NN		
Quercus rubra L.	3	Fagaceae		N		
Sassafras albidum (Nutt.) Nees	2	Lauraceae		N		
Toxicodendron radicans (L.) Kuntze.	5	Anacardiaceae		N		
Viburnum dentatum L.	34	Adoxaceae		N		
Vitis riparia Michx.	5	Vitaceae		N		
PLOT 36			117		286° WNW 16° NNE	28.04 (92)
Ailanthus altissima (Miller) Swingle	4	Simaroubaceae		NN-IV		
Ampelopsis brevipedunculata (Maxim.) Trautv.	6	Vitaceae		NN-IV		
Carya cordiformis (Wangenh.) K. Koch	4	Juglandaceae		NN-IV		
Celastrus orbiculatus Thunb.	4	Celastraceae		NN-IV		
Fraxinus americana L.	4	Oleaceae		N		
Lonicera maackii (Rupr.) Herder	46	Caprifoliaceae		NN-IV		
Phellodendron amurense Rupr.	3	Rutaceae		NN-IV		
Pinus nigra Arnold	1	Pinaceae		NN-IV		
Prunus serotina Ehrh.	25	Rosaceae		N		
Quercus rubra L.	4	Fagaceae		N		
Rhus typhina L.	15	Anacardiaceae		N		
Toxicodendron radicans (L.) Kuntze.	1	Anacardiaceae		N		

Table 3.5 Woody taxa in the West Ridge and Slopes Forest in Inwood Hill Park (n=1978).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 37			106		118° ESE 208° SSW	23.1 (76)
Aesculus hippocastanum L.	2	Hippocastanaceae		NN		
Carya cordiformis (Wangenh.) K. Koch	5	Juglandaceae		N		
Celastrus orbiculatus Thunb.	7	Celastraceae		NN-IV		
Fagus sylvatica L.	1	Fagaceae		NN		
Forsythia suspensa x viridissima (Thunb.) Vahl	13	Oleaceae		NN		
Fraxinus americana L.	8	Oleaceae		N		
Gleditsia triacanthos L.	1	Caesalpiniaceae		N		
Lonicera maackii (Rupr.) Herder	36	Caprifoliaceae		NN-IV		
Prunus serotina Ehrh.	4	Rosaceae		N		
Quercus prinus L.	2	Fagaceae		N		
Quercus rubra L.	3	Fagaceae		N		
Robinia pseudoacacia L.	2	Fabaceae		NN-IV		
Rosa multiflora Thunb.	8	Rosaceae		NN-IV		
Sassafras albidum (Nutt.) Nees	13	Lauraceae		N		
Vitis labrusca L.	1	Vitaceae		N		

Table 3.5 Woody taxa in the West Ridge and Slopes Forest in Inwood Hill Park (n=1978).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 38			138		26° NNE 116° ESE	15.8 (52)
Ampelopsis brevipedunculata (Maxim.) Trautv.	3	Vitaceae		NN-IV		
Celastrus orbiculatus Thunb.	4	Celastraceae		NN-IV		
Celtis occidentalis L.	1	Ulmaceae		N		
Cornus amomum Miller	5	Cornaceae		N		
Cornus sericea L.	21	Cornaceae		N		
Cornus foemina spp. *racemosa* (Lam.) J. Wilson	5	Cornaceae		N		
Forsythia suspensa x viridissima (Thunb.) Vahl	20	Oleaceae		NN		
Fraxinus americana L.	8	Oleaceae		N		
Ligustrum vulgare L.	2	Oleaceae		NN-IV		
Liriodendron tulipifera L.	1	Magnoliaceae		N		
Lonicera maackii (Rupr.) Herder	28	Caprifoliaceae		NN-IV		
Morus alba L.	1	Moraceae		NN-IV		
Prunus serotina Ehrh.	11	Rosaceae		N		
Quercus rubra L.	9	Fagaceae		N		
Robinia pseudoacacia L.	2	Fabaceae		NN-IV		
Rosa multiflora Thunb.	6	Rosaceae		NN-IV		
Rubus occidentalis L.	5	Rosaceae		N		
Sassafras albidum (Nutt.) Nees	4	Lauraceae		N		
Toxicodendron radicans (L.) Kuntze.	2	Anacardiaceae		N		

Table 3.5 Woody taxa in the West Ridge and Slopes Forest in Inwood Hill Park (n=1978).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 39			168		192° SSW 282° WNW	51.8 (170)
Acer rubrum L.	1	Aceraceae		N		
Aesculus hippocastanum L.	4	Hippocastanaceae		NN		
Betula lenta L.	1	Betulaceae		N		
Cornus foemina ssp. *racemosa* (Lam.) J. Wilson	106	Cornaceae		N		
Hamamelis virginiana L.	13	Hamamelidaceae		N		
Lindera benzoin (L.) Blume	27	Lauraceae		N		
Pinus strobus L.	9	Pinaceae		N		
Robinia pseudoacacia L.	3	Fabaceae		NN-IV		
Rosa multiflora Thunb.	4	Rosaceae		NN-IV		
Quadrat 40			102		324° NW 54° NE	53.6 176
Acer saccharum Marshall	23	Aceraceae		N		
Betula lenta L.	5	Betulaceae		N		
Carya cordiformis (Wangenh.) K. Koch	8	Juglandaceae		N		
Fagus sylvatica L.	1	Fagaceae		NN		
Fraxinus americana L.	5	Oleaceae		N		
Lindera benzoin (L.) Blume	14	Lauraceae		N		
Liriodendron tulipifera L.	8	Magnoliaceae		N		
Lonicera maackii (Rupr.) Herder	12	Caprifoliaceae		NN-IV		
Prunus serotina Ehrh.	7	Rosaceae		N		
Quercus rubra L.	1	Fagaceae		N		
Quercus velutina Lam.	2	Fagaceae		N		
Robinia pseudoacacia L.	1	Fabaceae		NN-IV		
Toxicodendron radicans (L.) Kuntze.	2	Anacardiaceae		N		
Viburnum prunifolium L.	13	Adoxaceae		N		

Table 3.5 Woody taxa in the West Ridge and Slopes Forest in Inwood Hill Park (n=1978).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 41			54		140° SE 230° SW	60.3 (198)
Carya cordiformis (Wangenh.) K. Koch	2	Juglandaceae		N		
Celastrus orbiculatus Thunb.	2	Celastraceae		NN-IV		
Pinus strobus L.	6	Pinaceae		N		
Prunus serotina Ehrh.	31	Rosaceae		N		
Quercus alba L.	4	Fagaceae		N		
Quercus rubra L.	2	Fagaceae		N		
Quercus velutina Lam.	4	Fagaceae		N		
Toxicodendron radicans (L.) Kuntze.	2	Anacardiaceae		N		
Vitis labrusca L.	1	Vitaceae		N		

Table 3.5 Woody taxa in the West Ridge and Slopes Forest in Inwood Hill Park (n=1978).

Taxa	No	Family	N of Stems	N-NN-IV	Compass	Elev/m (ft)
Quadrat 43			186		125° SE 215° SW	45.7 (150)
Aesculus hippocastanum L.	4	Hippocastanaceae		NN		
Ailanthus altissima (Miller) Swingle	4	Simaroubaceae		NN-IV		
Celtis occidentalis L .	1	Ulmaceae		N		
Fraxinus americana L.	2	Oleaceae		N		
Lindera benzoin (L.) Blume	51	Lauraceae		N		
Lonicera maackii (Rupr.) Herder	40	Caprifoliaceae		NN-IV		
Maclura pomifera (Raf.) C. K. Schneider	1	Moraceae		NN		
Morus alba L.	2	Moraceae		NN-IV		
Prunus avium L.	2	Rosaceae		N		
Prunus serotina Ehrh.	12	Rosaceae		N		
Pyrus baccata L.	1	Rosaceae		NN		
Quercus velutina Lam.	1	Fagaceae		N		
Rhododendron periclymenoides (Michx.)	6	Ericaceae		N		
Robinia pseudoacacia L.	10	Fabaceae		NN-IV		
Rosa multiflora Thunb.	14	Rosaceae		NN-IV		
Rubus occidentalis L.	13	Rosaceae		N		
Sassafras albidum (Nutt.) Nees	4	Lauraceae		N		
Toxicodendron radicans (L.) Kuntze.	2	Anacardiaceae		N		
Ulmus americana L.	1	Ulmaceae		N		
Viburnum dentatum L.	15	Adoxaceae		N		
			1978			

Table 3.6 Woody taxa in 45 10 X 10 m^2 quadrats in Inwood Hill Park listed in order of ecological dominance by species importance values (n=4070).

	Taxa	N of Stems	Relative Density	(cum.)	Relative Frequency	(cum.)	Relative Dominance	(cum.)	Importance Value	(cum.)
1	*Quercus rubra*	121	0.0297	(0.03)	0.0728	(0.07)	0.3845	(0.38)	48.696	(48.70)
2	*Liriodendron tulipifera*	34	0.0084	(0.04)	0.0312	(0.10)	0.2160	(0.60)	25.557	(74.25)
3	*Lindera benzoin*	760	0.1867	(0.23)	0.0437	(0.15)	0.0072	(0.61)	23.755	(98.01)
4	*Viburnum acerifolium*	618	0.1518	(0.38)	0.0353	(0.18)	0.0036	(0.61)	19.079	(117.09)
5	*Prunus serotina*	286	0.0703	(0.45)	0.0707	(0.25)	0.0106	(0.62)	15.155	(132.24)
6	*Lonicera maackii*	269	0.0661	(0.51)	0.0291	(0.28)	0.0026	(0.62)	9.784	(142.03)
7	*Fraxinus americana*	101	0.0248	(0.54)	0.0478	(0.33)	0.0198	(0.64)	9.240	(151.27)
8	*Carya cordiformis*	97	0.0238	(0.56)	0.0478	(0.38)	0.0134	(0.66)	8.506	(159.77)
9	*Celastrus orbiculatus*	181	0.0445	(0.61)	0.0333	(0.41)	0.0010	(0.66)	7.878	(167.65)
10	*Rosa multiflora*	186	0.0457	(0.65)	0.0312	(0.44)	0.0011	(0.66)	7.794	(175.44)
11	*Sassafras albidum*	101	0.0248	(0.68)	0.0395	(0.48)	0.0064	(0.67)	7.069	(182.51)
12	*Quercus velutina*	19	0.0047	(0.68)	0.0208	(0.50)	0.0452	(0.71)	7.067	(189.58)
13	*Acer rubrum*	85	0.0209	(0.70)	0.0353	(0.54)	0.0066	(0.72)	6.281	(195.86)
14	*Viburnum dentatum*	190	0.0467	(0.75)	0.0146	(0.55)	0.0011	(0.72)	6.234	(202.09)
15	*Quercus alba*	16	0.0039	(0.75)	0.0187	(0.57)	0.0368	(0.76)	5.948	(208.04)
16	*Quercus prinus*	17	0.0042	(0.76)	0.0125	(0.58)	0.0427	(0.80)	5.939	(213.98)
17	*Robinia pseudoacacia*	31	0.0076	(0.77)	0.0166	(0.60)	0.0275	(0.83)	5.176	(219.16)
18	*Betula lenta*	44	0.0108	(0.78)	0.0333	(0.63)	0.0071	(0.83)	5.115	(224.27)
19	*Fagus sylvatica*	2	0.0005	(0.78)	0.0042	(0.64)	0.0383	(0.87)	4.297	(228.57)
20	*Toxicodendron radicans*	43	0.0106	(0.79)	0.0312	(0.67)	0.0004	(0.87)	4.211	(232.78)
21	*Aesculus hippocastanum*	13	0.0032	(0.79)	0.0104	(0.68)	0.0276	(0.90)	4.120	(236.90)
22	*Acer saccharum*	52	0.0128	(0.80)	0.0146	(0.69)	0.0130	(0.91)	4.030	(240.93)
23	*Celtis occidentalis*	29	0.0071	(0.81)	0.0270	(0.72)	0.0040	(0.92)	3.815	(244.75)
24	*Cornus foemina* spp. *racemosa*	111	0.0273	(0.84)	0.0042	(0.73)	0.0010	(0.92)	3.238	(247.98)
25	*Ailanthus altissima*	52	0.0128	(0.85)	0.0146	(0.74)	0.0026	(0.92)	2.990	(250.97)
26	*Hamamelis virginiana*	52	0.0128	0.0128	0.0146	(0.76)	0.0009	(0.92)	2.821	(253.79)

Table 3.6 Woody taxa in 45 10 X 10 m^2 quadrats in Inwood Hill Park listed in order of ecological dominance by species importance values (n=4070).

	Taxa	N of Stems	Relative Density	(cum.)	Relative Frequency	(cum.)	Relative Dominance	(cum.)	Importance Value	(cum.)
27	*Rubus occidentalis*	47	0.0116	(0.87)	0.0146	(0.77)	0.0003	(0.92)	2.637	(256.43)
28	*Morus alba*	15	0.0037	(0.88)	0.0208	(0.79)	0.0018	(0.92)	2.630	(259.06)
29	*Quercus coccinea*	8	0.0020	(0.88)	0.0104	(0.80)	0.0095	(0.93)	2.185	(261.25)
30	*Ampelopsis brevipedunculata*	36	0.0089	(0.89)	0.0125	(0.81)	0.0002	(0.93)	2.153	(263.40)
31	*Tilia americana*	6	0.0015	(0.89)	0.0062	(0.82)	0.0124	(0.95)	2.006	(265.41)
32	*Pinus nigra*	2	0.0005	(0.89)	0.0042	(0.82)	0.0150	(0.96)	1.969	(267.38)
33	*Carya tomentosa*	13	0.0032	(0.89)	0.0125	(0.84)	0.0018	(0.96)	1.745	(269.12)
34	*Cornus florida*	11	0.0027	(0.90)	0.0125	(0.85)	0.0012	(0.96)	1.634	(270.75)
35	*Vitis labrusca*	14	0.0034	(0.90)	0.0125	(0.86)	0.0001	(0.96)	1.605	(272.36)
36	*Rhus typhina*	30	0.0074	(0.91)	0.0083	(0.87)	0.0004	(0.96)	1.604	(273.96)
37	*Paulownia tomentosa*	3	0.0007	(0.91)	0.0062	(0.88)	0.0073	(0.97)	1.432	(275.40)
38	*Fagus grandifolia*	13	0.0032	(0.91)	0.0042	(0.88)	0.0067	(0.98)	1.404	(276.80)
39	*Viburnum prunifolium*	28	0.0069	(0.92)	0.0062	(0.89)	0.0003	(0.98)	1.338	(278.14)
40	*Rubus laciniatus*	44	0.0108	(0.93)	0.0021	(0.89)	0.0002	(0.98)	1.313	(279.45)
41	*Forsythia suspensa* x *viridissima*	33	0.0081	(0.94)	0.0042	(0.89)	0.0003	(0.98)	1.260	(280.71)
42	*Rubus allegheniensis*	24	0.0059	(0.94)	0.0062	(0.90)	0.0001	(0.98)	1.227	(281.94)
43	*Gymnocladus dioica*	28	0.0069	(0.95)	0.0021	(0.90)	0.0022	(0.98)	1.120	(283.06)
44	*Vitis riparia*	17	0.0042	(0.95)	0.0062	(0.91)	0.0002	(0.98)	1.057	(284.11)
45	*Ulmus americana*	2	0.0005	(0.95)	0.0042	(0.91)	0.0056	(0.99)	1.029	(285.14)
46	*Pyrus baccata*	5	0.0012	(0.96)	0.0083	(0.92)	0.0002	(0.99)	0.972	(286.12)
47	*Pinus strobus*	15	0.0037	(0.96)	0.0042	(0.92)	0.0013	(0.99)	0.912	(287.03)
48	*Hibiscus syriacus*	22	0.0054	(0.97)	0.0021	(0.93)	0.0002	(0.99)	0.772	(287.80)
49	*Rhodotypos scandens*	14	0.0034	(0.97)	0.0042	(0.93)	0.0001	(0.99)	0.768	(288.57)
50	*Wisteria sinensis*	5	0.0012	(0.97)	0.0062	(0.94)	0.0001	(0.99)	0.753	(289.32)
51	*Ligustrum vulgare*	13	0.0032	(0.97)	0.0042	(0.94)	0.0001	(0.99)	0.749	(290.07)
52	*Cornus sericea*	21	0.0052	(0.98)	0.0021	(0.94)	0.0001	(0.99)	0.736	(290.80)

Table 3.6 Woody taxa in 45 10 X 10 m^2 quadrats in Inwood Hill Park listed in order of ecological dominance by species importance values (n=4070).

	Taxa	N of Stems	Relative Density	(cum.)	Relative Frequency	(cum.)	Relative Dominance	(cum.)	Importance Value	(cum.)
53	*Tsuga canadensis*	1	0.0003	(0.98)	0.0021	(0.94)	0.0044	(0.99)	0.669	(291.47)
54	*Acer platanoides*	6	0.0015	(0.98)	0.0042	(0.95)	0.0007	(0.99)	0.631	(292.10)
55	*Maclura pomifera*	2	0.0005	(0.98)	0.0042	(0.95)	0.0013	(1.00)	0.596	(292.70)
56	*Catalpa bignonioides*	4	0.0010	(0.98)	0.0042	(0.96)	0.0001	(1.00)	0.520	(293.22)
57	*Philadelphus coronarius*	9	0.0022	(0.98)	0.0021	(0.96)	0.0001	(1.00)	0.434	(293.66)
58	*Carya ovata*	3	0.0007	(0.98)	0.0021	(0.96)	0.0013	(1.00)	0.412	(294.07)
59	*Viburnum opulus*	7	0.0017	(0.99)	0.0021	(0.96)	0.0001	(1.00)	0.386	(294.45)
60	*Acer pseudoplatanus*	6	0.0015	(0.99)	0.0021	(0.97)	0.0001	(1.00)	0.362	(294.82)
61	*Rhus aromatica*	6	0.0015	(0.99)	0.0021	(0.97)	0.0001	(1.00)	0.362	(295.18)
62	*Aronia arbutifolia*	6	0.0015	(0.99)	0.0021	(0.97)	0.0000	(1.00)	0.360	(295.54)
63	*Rhododendron periclymenoides*	6	0.0015	(0.99)	0.0021	(0.97)	0.0000	(1.00)	0.359	(295.90)
64	*Juglans cinerea*	1	0.0003	(0.99)	0.0021	(0.97)	0.0011	(1.00)	0.338	(296.23)
65	*Euonymous alatus*	5	0.0012	(0.99)	0.0021	(0.98)	0.0000	(1.00)	0.335	(296.57)
66	*Vitis aestivalis*	5	0.0012	(0.99)	0.0021	(0.98)	0.0000	(1.00)	0.334	(296.90)
67	*Cornus amomum*	5	0.0012	(1.00)	0.0021	(0.98)	0.0000	(1.00)	0.334	(297.24)
68	*Juglans nigra*	1	0.0003	(1.00)	0.0021	(0.98)	0.0010	(1.00)	0.334	(297.57)
69	*Vaccinium corymbosum*	4	0.0010	(1.00)	0.0021	(0.98)	0.0000	(1.00)	0.309	(297.88)
70	*Phellodendron amurense*	3	0.0007	(1.00)	0.0021	(0.99)	0.0002	(1.00)	0.305	(298.18)
71	*Gleditsia triacanthos*	1	0.0003	(1.00)	0.0021	(0.99)	0.0006	(1.00)	0.296	(298.48)
72	*Amelanchier canadensis*	3	0.0007	(1.00)	0.0021	(0.99)	0.0001	(1.00)	0.289	(298.77)
73	*Prunus avium*	2	0.0005	(1.00)	0.0021	(0.99)	0.0001	(1.00)	0.266	(299.04)
74	*Pyrus malus*	2	0.0005	(1.00)	0.0021	(0.99)	0.0000	(1.00)	0.261	(299.30)
75	*Crataegus* spp.	1	0.0003	(1.00)	0.0021	(1.00)	0.0000	(1.00)	0.235	(299.53)
76	*Cercis canadensis*	1	0.0003	(1.00)	0.0021	(1.00)	0.0000	(1.00)	0.234	(299.77)
77	*Pyrus communis*	1	0.0003	(1.00)	0.0021	(1.00)	0.0000	(1.00)	0.234	(300.00)
	TOTAL	4070								300.00

Table 3.7 Ecological dominance ranking for trees only by species importance values, n of stems, % quadrat representation, and basal area cm^2 (n=1256).

	Taxa	N of Stems	Quadrats, %	BA (sq.cm^2)	Importance Value
1	*Quercus rubra*	121	78	230973.00	60.13
2	*Prunus serotina*	286	76	6364.90	34.72
3	*Liriodendron tulipifera*	34	33	129787.00	29.59
4	*Fraxinus americana*	101	51	11875.20	17.41
5	*Carya cordiformis*	97	51	8055.80	16.44
6	*Sassafras albidum*	101	42	3826.60	14.76
7	*Acer rubrum*	85	38	3954.60	12.87
8	*Betula lenta*	44	36	4247.50	9.34
9	*Quercus velutina*	19	22	27163.10	9.33
10	*Quercus alba*	16	20	22133.10	7.92
11	*Robinia pseudoacacia*	31	18	16530.00	7.84
12	*Acer saccharum*	52	16	7792.30	7.70
13	*Quercus prinus*	17	13	25673.50	7.64
14	*Celtis occidentalis*	29	29	2400.40	6.87
15	*Ailanthus altissima*	52	16	1541.40	6.64
16	*Aesculus hippocastanum*	13	11	16588.90	5.46
17	*Fagus sylvatica*	2	4	23023.70	4.72
18	*Morus alba*	15	22	1098.10	4.58
19	*Quercus coccinea*	8	11	5702.70	3.20
20	*Carya tomentosa*	13	13	1067.40	3.13
21	*Cornus florida*	11	13	699.80	2.91
22	*Gymnocladus dioica*	28	2	1347.30	2.78
23	*Tilia americana*	6	7	7421.10	2.70
24	*Fagus grandifolia*	13	4	4015.50	2.36
25	*Pinus nigra*	2	4	9036.10	2.34
26	*Pinus strobus*	15	4	767.60	1.96
27	*Paulownia tomentosa*	3	7	4411.40	1.95
28	*Pyrus baccata*	5	9	107.30	1.69
29	*Ulmus americana*	2	4	3389.90	1.38
30	*Acer platanoides*	6	4	405.60	1.19
31	*Catalpa bignonioides*	4	4	35.20	0.96
32	*Maclura pomifera*	2	4	789.60	0.93
33	*Tsuga canadensis*	1	2	2623.90	0.85
34	*Acer pseudoplatanus*	6	2	39.60	0.80
35	*Carya ovata*	3	2	783.90	0.69
36	*Phellodendron amurense*	3	2	140.30	0.58

Table 3.7 Ecological dominance ranking for trees only by species importance values, n of stems, % quadrat representation, and basal area cm^2 (n=1256).

	Taxa	N of Trees	Quadrats,%	BA (sq.cm)	Importance Value
37	*Juglans cinerea*	1	2	633.50	0.51
38	*Juglans nigra*	1	2	607.00	0.50
39	*Prunus avium*	2	2	55.10	0.49
40	*Pyrus malus*	2	2	24.50	0.48
41	*Gleditsia triacanthos*	1	2	383.60	0.46
42	*Crataegus* spp.	1	2	16.60	0.40
43	*Cercis canadensis*	1	2	11.30	0.40
44	*Pyrus communis*	1	2	8.60	0.40
	TOTAL	1256			300.00

Table 3.8 Dominance ranking by importance values of the top 12 out of 77 woody species in 45 10 X 10 m^2 quadrats in Inwood Hill Park.

Taxa	N of Stems	Relative Density	(cum.)	Relative Frequency	(cum.)	Relative Dominance	(cum.)	Importance Value	(cum.)
1. *Quercus rubra*	121	0.0297	(0.03)	0.0728	(0.07)	0.3845	(0.38)	48.696	(48.70)
2. *Liriodendron tulipifera*	34	0.0084	(0.04)	0.0312	(0.10)	0.2160	(0.60)	25.557	(74.25)
3. *Lindera benzoin*	760	0.1867	(0.23)	0.0437	(0.15)	0.0072	(0.61)	23.755	(98.01)
4. *Viburnum acerifolium*	618	0.1518	(0.38)	0.0353	(0.18)	0.0036	(0.61)	19.079	(117.09)
5. *Prunus serotina*	286	0.0703	(0.45)	0.0707	(0.25)	0.0106	(0.62)	15.155	(132.24)
6. *Lonicera maackii*	269	0.0661	(0.51)	0.0291	(0.28)	0.0026	(0.62)	9.784	(142.03)
7. *Fraxinus americana*	101	0.0248	(0.54)	0.0478	(0.33)	0.0198	(0.64)	9.240	(151.27)
8. *Carya cordiformis*	97	0.0238	(0.56)	0.0478	(0.38)	0.0134	(0.66)	8.506	(159.77)
9. *Celastrus orbiculatus*	181	0.0445	(0.61)	0.0333	(0.41)	0.0010	(0.66)	7.878	(167.65)
10. *Rosa multiflora*	186	0.0457	(0.65)	0.0312	(0.44)	0.0011	(0.66)	7.794	(175.44)
11. *Sassafras albidum*	101	0.0248	(0.68)	0.0395	(0.48)	0.0064	(0.67)	7.069	(182.51)
12. *Quercus velutina*	19	0.0047	(0.68)	0.0208	(0.50)	0.0452	(0.71)	7.067	(189.58)

Table 3.9 Woody taxa in 11 10 X 10 m^2 quadrats of the Valley-Clove forest listed in order of ecological dominance by species importance values (n=790).

	Taxa	N of Stems	Relative Density	(cum.)	Relative Frequency	(cum.)	Relative Dominance	(cum.)	Importance Value	(cum.)
1	*Lindera benzoin*	572	0.7241	(0.72)	0.1358	(0.14)	0.0179	(0.02)	87.773	(87.77)
2	*Liriodendron tulipifera*	20	0.0253	(0.75)	0.1111	(0.25)	0.5917	(0.61)	72.815	(160.59)
3	*Quercus rubra*	9	0.0114	(0.76)	0.0741	(0.32)	0.1945	(0.80)	27.992	(188.58)
4	*Fraxinus americana*	7	0.0089	(0.77)	0.0494	(0.37)	0.0472	(0.85)	10.548	(199.13)
5	*Rosa multiflora*	40	0.0506	(0.82)	0.0494	(0.42)	0.0008	(0.85)	10.078	(209.21)
6	*Tilia americana*	6	0.0076	(0.83)	0.0370	(0.46)	0.0413	(0.89)	8.590	(217.80)
7	*Acer saccharum*	9	0.0114	(0.84)	0.0494	(0.51)	0.0204	(0.91)	8.114	(225.91)
8	*Celtis occidentalis*	12	0.0152	(0.85)	0.0617	(0.57)	0.0024	(0.92)	7.934	(233.84)
9	*Carya cordiformis*	11	0.0139	(0.87)	0.0494	(0.62)	0.0120	(0.93)	7.531	(241.38)
10	*Viburnum acerifolium*	12	0.0152	(0.88)	0.0494	(0.67)	0.0002	(0.93)	6.481	(247.86)
11	*Viburnum dentatum*	24	0.0304	(0.91)	0.0247	(0.69)	0.0005	(0.93)	5.559	(253.41)
12	*Acer rubrum*	13	0.0165	(0.93)	0.0370	(0.73)	0.0008	(0.93)	5.427	(258.84)
13	*Prunus serotina*	5	0.0063	(0.94)	0.0370	(0.77)	0.0051	(0.94)	4.849	(263.69)
14	*Hamamelis virginiana*	10	0.0127	(0.95)	0.0247	(0.79)	0.0006	(0.94)	3.794	(267.49)
15	*Quercus alba*	2	0.0025	(0.95)	0.0247	(0.82)	0.0093	(0.95)	3.651	(271.14)
16	*Morus alba*	3	0.0038	(0.96)	0.0247	(0.84)	0.0028	(0.95)	3.129	(274.27)
17	*Paulownia tomentosa*	1	0.0013	(0.96)	0.0124	(0.85)	0.0167	(0.96)	3.035	(277.30)
18	*Ulmus americana*	1	0.0013	(0.96)	0.0124	(0.86)	0.0152	(0.98)	2.882	(280.18)
19	*Betula lenta*	1	0.0013	(0.96)	0.0124	(0.88)	0.0150	(0.99)	2.861	(283.04)
20	*Viburnum prunifolium*	10	0.0127	(0.97)	0.0124	(0.89)	0.0004	(1.00)	2.536	(285.58)
21	*Viburnum opulus*	7	0.0089	(0.98)	0.0124	(0.90)	0.0002	(1.00)	2.142	(287.72)
22	*Carya ovata*	3	0.0038	(0.99)	0.0124	(0.91)	0.0044	(1.00)	2.050	(289.77)

Table 3.9 Woody taxa in 11 10 X 10 m^2 quadrats of the Valley-Clove forest listed in order of ecological dominance by species importance values (n=790).

	Taxa	N of Stems	Relative Density	(cum.)	Relative Frequency	(cum.)	Relative Dominance	(cum.)	Importance Value	(cum.)
23	*Celastrus orbiculatus*	4	0.0051	(0.99)	0.0124	(0.93)	0.0001	(1.00)	1.749	(291.52)
24	*Sassafras albidum*	2	0.0025	(0.99)	0.0124	(0.94)	0.0002	(1.00)	1.511	(293.03)
25	*Vitis labrusca*	2	0.0025	(1.00)	0.0124	(0.95)	0.0001	(1.00)	1.496	(294.53)
26	*Ailanthus altissima*	1	0.0013	(1.00)	0.0124	(0.96)	0.0001	(1.00)	1.371	(295.90)
27	*Crataegus spp .*	1	0.0013	(1.00)	0.0124	(0.98)	0.0001	(1.00)	1.370	(297.27)
28	*Cercis canadensis*	1	0.0013	(1.00)	0.0124	(0.99)	0.0001	(1.00)	1.368	(298.64)
29	*Cornus florida*	1	0.0013	(1.00)	0.0124	(1.00)	0.0000	(1.00)	1.365	(300.00)
	TOTAL	790								300.00

Table 3.10 Woody taxa in 8 10 x 10 m^2 quadrats of the East Ridge/Slopes forest listed in order of ecological dominance by species importance values (n=707).

	Taxa	N of Stems	Relative Density	(cum.)	Relative Frequency	(cum.)	Relative Dominance	(cum.)	Importance Value	(cum.)
1	*Viburnum acerifolium*	368	0.5205	(0.52)	0.0864	(0.09)	0.0142	(0.01)	62.114	(62.11)
2	*Quercus rubra*	16	0.0226	(0.54)	0.0864	(0.17)	0.4615	(0.48)	57.050	(119.16)
3	*Quercus prinus*	8	0.0113	(0.55)	0.0370	(0.21)	0.1777	(0.65)	22.605	(141.77)
4	*Quercus alba*	7	0.0099	(0.56)	0.0370	(0.25)	0.1195	(0.77)	16.643	(158.41)
5	*Acer rubrum*	47	0.0665	(0.63)	0.0864	(0.33)	0.0127	(0.79)	16.557	(174.97)
6	*Prunus serotina*	31	0.0439	(0.68)	0.0864	(0.42)	0.0056	(0.79)	13.582	(188.55)
7	*Sassafras albidum*	17	0.0241	(0.70)	0.0864	(0.51)	0.0091	(0.80)	11.952	(200.50)
8	*Hamamelis virginiana*	29	0.0410	(0.74)	0.0494	(0.56)	0.0038	(0.80)	9.416	(209.92)
9	*Rosa multiflora*	46	0.0651	(0.81)	0.0247	(0.58)	0.0017	(0.81)	9.145	(219.06)
10	*Lindera benzoin*	29	0.0410	(0.85)	0.0370	(0.62)	0.0019	(0.81)	7.991	(227.05)
11	*Pinus nigra*	1	0.0014	(0.85)	0.0124	(0.63)	0.0653	(0.87)	7.910	(234.96)
12	*Acer saccharum*	10	0.0141	(0.86)	0.0124	(0.64)	0.0405	(0.91)	6.700	(241.66)
13	*Fraxinus americana*	6	0.0085	(0.87)	0.0247	(0.67)	0.0129	(0.93)	4.608	(246.27)
14	*Morus alba*	5	0.0071	(0.88)	0.0370	(0.70)	0.0019	(0.93)	4.597	(250.87)
15	*Quercus velutina*	2	0.0028	(0.88)	0.0124	(0.72)	0.0262	(0.95)	4.138	(255.01)
16	*Betula lenta*	9	0.0127	(0.89)	0.0247	(0.74)	0.0014	(0.96)	3.885	(258.89)
17	*Cornus florida*	5	0.0071	(0.90)	0.0247	(0.77)	0.0064	(0.96)	3.817	(262.71)
18	*Ailanthus altissima*	9	0.0127	(0.91)	0.0124	(0.78)	0.0124	(0.98)	3.752	(266.46)
19	*Vitis labrusca*	8	0.0113	(0.92)	0.0247	(0.80)	0.0005	(0.98)	3.652	(270.11)
20	*Celastrus orbiculatus*	8	0.0113	(0.94)	0.0247	(0.83)	0.0003	(0.98)	3.632	(273.74)
21	*Carya tomentosa*	2	0.0028	(0.94)	0.0247	(0.85)	0.0015	(0.98)	2.901	(276.64)
22	*Lonicera maackii*	9	0.0127	(0.95)	0.0124	(0.86)	0.0005	(0.98)	2.555	(279.20)
23	*Quercus coccinea*	1	0.0014	(0.95)	0.0124	(0.88)	0.0116	(0.99)	2.536	(281.74)
24	*Viburnum dentatum*	8	0.0113	(0.96)	0.0124	(0.89)	0.0003	(0.99)	2.396	(284.13)

Table 3.10 Woody taxa in 8 10 x 10 m^2 quadrats of the East Ridge/Slopes forest listed in order of ecological dominance by species importance values (n=707).

	Taxa	N of Stems	Relative Density	(cum.)	Relative Frequency	(cum.)	Relative Dominance	(cum.)	Importance Value	(cum.)
25	*Ampelopsis brevipedunculata*	6	0.0085	(0.97)	0.0124	(0.90)	0.0002	(0.99)	2.107	(286.24)
26	*Acer platanoides*	2	0.0028	(0.98)	0.0124	(0.91)	0.0041	(0.99)	1.931	(288.17)
27	*Fagus grandifolia*	4	0.0057	(0.98)	0.0124	(0.93)	0.0012	(1.00)	1.920	(290.09)
28	*Celtis occidentalis*	2	0.0028	(0.98)	0.0124	(0.94)	0.0031	(1.00)	1.829	(291.92)
29	*Vaccinium corymbosum*	4	0.0057	(0.99)	0.0124	(0.95)	0.0002	(1.00)	1.820	(293.74)
30	*Rubus allegheniensis*	3	0.0042	(0.99)	0.0124	(0.96)	0.0001	(1.00)	1.670	(295.41)
31	*Carya cordiformis*	2	0.0028	(1.00)	0.0124	(0.98)	0.0006	(1.00)	1.573	(296.98)
32	*Catalpa bignonioides*	2	0.0028	(1.00)	0.0124	(0.99)	0.0002	(1.00)	1.533	(298.51)
33	*Liriodendron tulipifera*	1	0.0014	(1.00)	0.0124	(1.00)	0.0011	(1.00)	1.486	(300.00)
	TOTAL	707								300.00

Table 3.11 Woody taxa in 8 10 x 10 m^2 quadrats of the Ridge Tops (east and west) listed in order of ecological dominance by species importance values (n=595).

	Taxa	N of Stems	Relative Density	(cum.)	Relative Frequency	(cum.)	Relative Dominance	(cum.)	Importance Value	(cum.)
1	*Quercus rubra*	30	0.0504	(0.05)	0.0805	(0.08)	0.5921	(0.59)	72.301	(72.30)
2	*Prunus serotina*	80	0.1361	(0.19)	0.0805	(0.16)	0.0242	(0.62)	24.083	(96.38)
3	*Fraxinus americana*	47	0.0790	(0.27)	0.0690	(0.23)	0.0193	(0.64)	16.726	(113.11)
4	*Liriodendron tulipifera*	3	0.0050	(0.27)	0.0230	(0.25)	0.1373	(0.77)	16.529	(129.64)
5	*Viburnum acerifolium*	70	0.1177	(0.39)	0.0230	(0.28)	0.0024	(0.78)	14.306	(143.95)
6	*Celastrus orbiculatus*	63	0.1059	(0.49)	0.0345	(0.31)	0.0022	(0.78)	14.252	(158.20)
7	*Carya cordiformis*	38	0.0639	(0.56)	0.0575	(0.37)	0.0053	(0.78)	12.666	(170.86)
8	*Sassafras albidum*	40	0.0672	(0.63)	0.0460	(0.41)	0.0022	(0.79)	11.540	(182.40)
9	*Quercus velutina*	4	0.0067	(0.63)	0.0230	(0.44)	0.0736	(0.86)	10.327	(192.73)
10	*Lonicera maackii*	33	0.0555	(0.69)	0.0345	(0.47)	0.0021	(0.86)	9.204	(201.93)
11	*Viburnum dentatum*	46	0.0756	(0.76)	0.0115	(0.48)	0.0015	(0.86)	8.865	(210.80)
12	*Quercus coccinea*	6	0.0101	(0.77)	0.0345	(0.52)	0.0401	(0.90)	8.465	(219.26)
13	*Betula lenta*	14	0.0235	(0.80)	0.0460	(0.56)	0.0057	(0.91)	7.519	(226.78)
14	*Rosa multiflora*	19	0.0319	(0.83)	0.0230	(0.59)	0.0007	(0.91)	5.557	(232.34)
15	*Toxicodendron radicans*	10	0.0168	(0.85)	0.0345	(0.62)	0.0005	(0.91)	5.174	(237.51)
16	*Quercus prinus*	3	0.0050	(0.85)	0.0115	(0.63)	0.0272	(0.94)	4.373	(241.89)
17	*Acer saccharum*	10	0.0168	(0.87)	0.0230	(0.66)	0.0007	(0.94)	4.054	(245.94)
18	*Rhus typhina*	10	0.0168	(0.88)	0.0230	(0.68)	0.0007	(0.94)	4.052	(249.99)
19	*Paulownia tomentosa*	2	0.0034	(0.89)	0.0230	(0.70)	0.0140	(0.95)	4.034	(254.03)
20	*Morus alba*	3	0.0050	(0.89)	0.0345	(0.74)	0.0006	(0.95)	4.015	(258.04)
21	*Rubus occidentalis*	9	0.0151	(0.91)	0.0230	(0.76)	0.0003	(0.95)	3.843	(261.88)

Table 3.11 Woody taxa in 8 10 x 10 m^2 quadrats of the Ridge Tops (east and west) listed in order of ecological dominance by species importance values (n=595).

	Taxa	N of Stems	Relative Density	(cum.)	Relative Frequency	(cum.)	Relative Dominance	(cum.)	Importance Value	(cum.)
22	*Wisteria sinensis*	4	0.0067	(0.91)	0.0230	(0.78)	0.0003	(0.95)	2.998	(264.88)
23	*Aesculus hippocastanum*	2	0.0034	(0.92)	0.0115	(0.79)	0.0151	(0.97)	2.994	(267.87)
24	*Philadelphus coronarius*	9	0.0151	(0.93)	0.0115	(0.81)	0.0003	(0.97)	2.694	(270.57)
25	*Pyrus baccata*	2	0.0034	(0.94)	0.0230	(0.83)	0.0003	(0.97)	2.666	(273.23)
26	*Quercus alba*	1	0.0017	(0.94)	0.0115	(0.84)	0.0099	(0.98)	2.311	(275.55)
27	*Rhus aromatica*	6	0.0101	(0.95)	0.0115	(0.85)	0.0004	(0.98)	2.196	(277.74)
28	*Euonymus alatus*	5	0.0084	(0.96)	0.0115	(0.86)	0.0002	(0.98)	2.013	(279.75)
29	*Juglans cinerea*	1	0.0017	(0.96)	0.0115	(0.87)	0.0063	(0.99)	1.950	(281.70)
30	*Juglans nigra*	1	0.0017	(0.96)	0.0115	(0.89)	0.0061	(0.99)	1.923	(283.63)
31	*Carya tomentosa*	4	0.0067	(0.97)	0.0115	(0.90)	0.0006	(0.99)	1.886	(285.51)
32	*Ailanthus altissima*	4	0.0067	(0.97)	0.0115	(0.91)	0.0006	(0.99)	1.881	(287.39)
33	*Maclura pomifera*	1	0.0017	(0.98)	0.0115	(0.92)	0.0056	(1.00)	1.876	(289.27)
34	*Ampelopsis brevipedunculata*	4	0.0067	(0.98)	0.0115	(0.93)	0.0001	(1.00)	1.836	(291.11)
35	*Amelanchier canadensis*	3	0.0050	(0.99)	0.0115	(0.94)	0.0005	(1.00)	1.700	(292.81)
36	*Pyrus malus*	2	0.0034	(0.99)	0.0115	(0.95)	0.0002	(1.00)	1.510	(294.32)
37	*Catalpa bignonioides*	2	0.0034	(0.99)	0.0115	(0.97)	0.0002	(1.00)	1.507	(295.82)
38	*Celtis occidentalis*	2	0.0034	(1.00)	0.0115	(0.98)	0.0001	(1.00)	1.498	(297.32)
39	*Acer rubrum*	1	0.0017	(1.00)	0.0115	(0.99)	0.0002	(1.00)	1.341	(298.66)
40	*Cornus florida*	1	0.0017	(1.00)	0.0115	(1.00)	0.0002	(1.00)	1.338	(300.00)
	TOTAL	595								300.00

Table 3.12 Woody taxa in 18 10 X 10 m^2 quadrats for West Ridge/Slopes forest listed in order of ecological dominance by species importance values (n=1978).

Taxa	N of Stems	Relative Density	(cum.)	Relative Frequency	(cum.)	Relative Dominance	(cum.)	Importance Value	(cum.)
1 *Quercus rubra*	66	0.0334	(0.03)	0.0611	(0.06)	0.4121	(0.41)	50.660	(50.70)
2 *Prunus serotina*	169	0.0854	(0.12)	0.0699	(0.13)	0.0109	(0.42)	16.620	(67.30)
3 *Lonicera maackii*	227	0.1148	(0.23)	0.0437	(0.18)	0.0058	(0.43)	16.420	(83.70)
4 *Robinia pseudoacacia*	31	0.0157	(0.25)	0.0349	(0.21)	0.0720	(0.50)	12.260	(96.00)
5 *Lindera benzoin*	159	0.0804	(0.33)	0.0306	(0.24)	0.0040	(0.51)	11.500	(107.50)
6 *Fagus sylvatica*	2	0.0010	(0.33)	0.0087	(0.25)	0.1003	(0.61)	11.000	(118.50)
7 *Quercus velutina*	13	0.0066	(0.34)	0.0262	(0.28)	0.0758	(0.68)	10.860	(129.30)
8 *Viburnum acerifolium*	168	0.0849	(0.42)	0.0175	(0.29)	0.0025	(0.68)	10.490	(139.80)
9 *Celastrus orbiculatus*	106	0.0536	(0.48)	0.0437	(0.34)	0.0016	(0.69)	9.890	(149.70)
10 *Carya cordiformis*	46	0.0233	(0.50)	0.0524	(0.39)	0.0232	(0.71)	9.880	(159.60)
11 *Aesculus hippocastanum*	11	0.0056	(0.51)	0.0175	(0.41)	0.0657	(0.77)	8.870	(168.50)
12 *Rosa multiflora*	81	0.0410	(0.55)	0.0306	(0.44)	0.0012	(0.78)	7.270	(175.70)
13 *Viburnum dentatum*	113	0.0571	(0.60)	0.0131	(0.45)	0.0017	(0.78)	7.190	(182.90)
14 *Toxicodendron radicans*	33	0.0167	(0.62)	0.0524	(0.50)	0.0007	(0.78)	6.980	(189.90)
15 *Cornus foemina* spp. *racemosa*	111	0.0561	(0.68)	0.0087	(0.51)	0.0025	(0.78)	6.730	(196.60)
16 *Fraxinus americana*	41	0.0207	(0.70)	0.0437	(0.56)	0.0012	(0.78)	6.560	(203.20)
17 *Sassafras albidum*	42	0.0212	(0.72)	0.0306	(0.59)	0.0119	(0.79)	6.370	(209.60)
18 *Liriodendron tulipifera*	10	0.0051	(0.72)	0.0131	(0.60)	0.0415	(0.84)	5.970	(215.50)
19 *Quercus alba*	6	0.0030	(0.73)	0.0131	(0.61)	0.0373	(0.87)	5.350	(220.90)
20 *Acer rubrum*	24	0.0121	(0.74)	0.0262	(0.64)	0.0115	(0.88)	4.980	(225.90)
21 *Betula lenta*	20	0.0101	(0.75)	0.0349	(0.67)	0.0037	(0.89)	4.880	(230.70)
22 *Rubus occidentalis*	38	0.0192	(0.77)	0.0218	(0.69)	0.0006	(0.89)	4.160	(234.90)
23 *Quercus prinus*	6	0.0030	(0.77)	0.0087	(0.70)	0.0294	(0.92)	4.110	(239.00)
24 *Celtis occidentalis*	13	0.0066	(0.78)	0.0262	(0.73)	0.0073	(0.92)	4.000	(243.00)
25 *Ailanthus altissima*	38	0.0192	(0.80)	0.0175	(0.75)	0.0014	(0.93)	3.810	(246.80)

Table 3.12 Woody taxa in 18 10 X 10 m^2 quadrats for West Ridge/Slopes forest listed in order of ecological dominance by species importance values (n=1978).

Taxa	N of Stems	Relative Density	(cum.)	Relative Frequency	(cum.)	Relative Dominance	(cum.)	Importance Value	(cum.)
26 *Ampelopsis brevipedunculata*	26	0.0131	(0.81)	0.0175	(0.76)	0.0004	(0.93)	3.100	(249.90)
27 *Rubus laciniatus*	44	0.0222	(0.83)	0.0044	(0.77)	0.0006	(0.93)	2.720	(252.70)
28 *Forsythia suspensa* x *viridissima*	33	0.0167	(0.85)	0.0087	(0.78)	0.0009	(0.93)	2.630	(255.30)
29 *Fagus grandifolia*	9	0.0046	(0.85)	0.0044	(0.78)	0.0170	(0.95)	2.590	(257.90)
30 *Gymnocladus dioica*	28	0.0142	(0.87)	0.0044	(0.79)	0.0059	(0.95)	2.440	(260.30)
31 *Vitis riparia*	17	0.0086	(0.88)	0.0131	(0.80)	0.0004	(0.95)	2.210	(262.50)
32 *Carya tomentosa*	7	0.0035	(0.88)	0.0131	(0.81)	0.0038	(0.96)	2.040	(264.60)
33 *Pinus strobus*	15	0.0076	(0.89)	0.0087	(0.82)	0.0033	(0.96)	1.970	(266.50)
34 *Rubus allegheniensis*	21	0.0106	(0.90)	0.0087	(0.83)	0.0003	(0.96)	1.970	(268.50)
35 *Rhus typhina*	20	0.0101	(0.91)	0.0087	(0.84)	0.0006	(0.96)	1.950	(270.40)
36 *Pinus nigra*	1	0.0005	(0.91)	0.0044	(0.84)	0.0134	(0.97)	1.830	(272.30)
37 *Viburnum prunifolium*	18	0.0091	(0.92)	0.0087	(0.85)	0.0004	(0.97)	1.830	(274.10)
38 *Acer saccharum*	23	0.0116	(0.93)	0.0044	(0.86)	0.0016	(0.97)	1.760	(275.90)
39 *Morus alba*	4	0.0020	(0.93)	0.0131	(0.87)	0.0016	(0.98)	1.670	(277.50)
40 *Tsuga canadensis*	1	0.0005	(0.93)	0.0044	(0.87)	0.0114	(0.99)	1.630	(279.20)
41 *Hibiscus syriacus*	22	0.0111	(0.94)	0.0044	(0.88)	0.0006	(0.99)	1.610	(280.80)
42 *Rhodotypos scandens*	14	0.0071	(0.95)	0.0087	(0.89)	0.0002	(0.99)	1.600	(282.40)
43 *Ligustrum vulgare*	13	0.0066	(0.96)	0.0087	(0.90)	0.0004	(0.99)	1.570	(283.90)
44 *Cornus sericea*	21	0.0106	(0.97)	0.0044	(0.90)	0.0003	(0.99)	1.530	(285.50)
45 *Vitis labrusca*	4	0.0020	(0.97)	0.0131	(0.91)	0.0001	(0.99)	1.520	(287.00)
46 *Pyrus baccata*	3	0.0015	(0.97)	0.0131	(0.93)	0.0003	(0.99)	1.490	(288.50)
47 *Hamamelis virginiana*	13	0.0066	(0.98)	0.0044	(0.93)	0.0004	(0.99)	1.130	(289.60)
48 *Cornus florida*	4	0.0020	(0.98)	0.0087	(0.94)	0.0004	(0.99)	1.110	(290.70)
49 *Ulmus americana*	1	0.0005	(0.98)	0.0044	(0.94)	0.0029	(0.99)	0.770	(291.50)
50 *Quercus coccinea*	1	0.0005	(0.98)	0.0044	(0.95)	0.0027	(1.00)	0.760	(292.30)

Table 3.12 Woody taxa in 18 10 X 10 m^2 quadrats for West Ridge/Slopes forest listed in order of ecological dominance by species importance values (n=1978).

Taxa	N of Stems	Relative Density	(cum.)	Relative Frequency	(cum.)	Relative Dominance	(cum.)	Importance Value	(cum.)
51 *Acer pseudoplatanus*	6	0.0030	(0.98)	0.0044	(0.95)	0.0002	(1.00)	0.760	(293.00)
52 *Aronia arbutifolia*	6	0.0030	(0.99)	0.0044	(0.96)	0.0001	(1.00)	0.750	(293.80)
53 *Rhododendron periclymenoides*	6	0.0030	(0.99)	0.0044	(0.96)	0.0001	(1.00)	0.750	(294.50)
54 *Vitis aestivalis*	5	0.0025	(0.99)	0.0044	(0.97)	0.0001	(1.00)	0.700	(295.20)
55 *Cornus amomum*	5	0.0025	(0.99)	0.0044	(0.97)	0.0001	(1.00)	0.700	(295.90)
56 *Gleditsia triacanthos*	1	0.0005	(0.99)	0.0044	(0.97)	0.0017	(1.00)	0.650	(296.60)
57 *Acer platanoides*	4	0.0020	(1.00)	0.0044	(0.98)	0.0001	(1.00)	0.650	(297.20)
58 *Phellodendron amurense*	3	0.0015	(1.00)	0.0044	(0.98)	0.0006	(1.00)	0.650	(297.90)
59 *Maclura pomifera*	1	0.0005	(1.00)	0.0044	(0.99)	0.0010	(1.00)	0.590	(298.50)
60 *Prunus avium*	2	0.0010	(1.00)	0.0044	(0.99)	0.0002	(1.00)	0.560	(299.00)
61 *Pyrus communis*	1	0.0005	(1.00)	0.0044	(1.00)	0.0000	(1.00)	0.490	(299.50)
62 *Wisteria sinensis*	1	0.0005	(1.00)	0.0044	(1.00)	0.0000	(1.00)	0.490	(300.00)
TOTAL	1978								300.00

Table 3.13 Ecological dominance ranking for families listed in order of importance values for all woody taxa within the 45 m^2 quadrats in Inwood Hill Park (n=4070).

	Family	N of Stems	Relative Density	(cum.)	Relative Frequency	(cum.)	Relative Dominance	(cum.)	Family Importance Value	(cum.)
1	Fagaceae	196	0.0482	(0.05)	0.1024	(0.10)	0.5638	(0.56)	71.427	(71.43)
2	Lauraceae	861	0.2116	(0.26)	0.0892	(0.19)	0.0135	(0.58)	31.432	(102.86)
3	Adoxaceae	843	0.2071	(0.47)	0.0656	(0.26)	0.0050	(0.58)	27.778	(130.64)
4	Rosaceae	621	0.1526	(0.62)	0.0997	(0.36)	0.0129	(0.60)	26.517	(157.15)
5	Magnoliaceae	34	0.0084	(0.63)	0.0394	(0.40)	0.2160	(0.81)	26.376	(183.53)
6	Oleaceae	147	0.0361	(0.66)	0.0630	(0.46)	0.0202	(0.83)	11.934	(195.46)
7	Juglandaceae	115	0.0283	(0.69)	0.0656	(0.53)	0.0186	(0.85)	11.243	(206.71)
8	Aceraceae	149	0.0366	(0.73)	0.0551	(0.58)	0.0203	(0.87)	11.202	(217.91)
9	Caprifoliaceae	269	0.0661	(0.80)	0.0368	(0.62)	0.0026	(0.87)	10.548	(228.46)
10	Celastraceae	186	0.0457	(0.84)	0.0446	(0.66)	0.0011	(0.87)	9.140	(237.60)
11	Anacardiaceae	79	0.0194	(0.86)	0.0472	(0.71)	0.0008	(0.88)	6.743	(244.34)
12	Fabaceae	36	0.0089	(0.87)	0.0263	(0.74)	0.0276	(0.90)	6.267	(250.61)
13	Betulaceae	44	0.0108	(0.88)	0.0420	(0.78)	0.0071	(0.91)	5.988	(256.59)
14	Cornaceae	148	0.0364	(0.92)	0.0210	(0.80)	0.0023	(0.91)	5.963	(262.56)
15	Vitaceae	72	0.0177	(0.93)	0.0368	(0.84)	0.0005	(0.91)	5.498	(268.05)
16	Ulmaceae	31	0.0076	(0.94)	0.0368	(0.87)	0.0096	(0.92)	5.400	(273.45)
17	Hippocastanaceae	13	0.0032	(0.94)	0.0131	(0.89)	0.0276	(0.95)	4.393	(277.85)
18	Pinaceae	18	0.0044	(0.95)	0.0131	(0.90)	0.0207	(0.97)	3.823	(281.67)
19	Simaroubaceae	52	0.0128	(0.96)	0.0184	(0.92)	0.0026	(0.97)	3.372	(285.04)
20	Moraceae	17	0.0042	(0.97)	0.0263	(0.94)	0.0031	(0.98)	3.357	(288.40)
21	Hamamelidaceae	52	0.0128	(0.98)	0.0184	(0.96)	0.0009	(0.98)	3.203	(291.60)
22	Tiliaceae	6	0.0015	(0.98)	0.0079	(0.97)	0.0124	(0.99)	2.170	(293.77)

Table 3.13 Ecological dominance ranking for families listed in order of importance values for all woody taxa within the 45 m^2 quadrats in Inwood Hill Park (n=4070).

Family	N of Stems	Relative Density	(cum.)	Relative Frequency	(cum.)	Relative Dominance	(cum.)	Family Importance Value	(cum.)
23 Bignoniaceae	7	0.0017	(0.98)	0.0105	(0.98)	0.0074	(1.00)	1.962	(295.73)
24 Caesalpiniaceae	30	0.0074	(0.99)	0.0079	(0.99)	0.0029	(1.00)	1.815	(297.55)
25 Malvaceae	22	0.0054	(1.00)	0.0026	(0.99)	0.0002	(1.00)	0.826	(298.37)
26 Ericaceae	10	0.0025	(1.00)	0.0053	(1.00)	0.0001	(1.00)	0.778	(299.15)
27 Hydrangeaceae	9	0.0022	(1.00)	0.0026	(1.00)	0.0001	(1.00)	0.489	(299.64)
28 Rutaceae	3	0.0007	(1.00)	0.0026	(1.00)	0.0002	(1.00)	0.360	(300.00)
TOTAL	4070								300.00

Table 3.14 Dominance ranking for families listed in order of importance values, number of stems, % representation in quadrats, and basal area (n=4070).

	Family	N of Stems	Quadrat, %	BA (sq. cm^2)	Importance Value
1	Fagaceae	196	87	338685.00	71.430
2	Lauraceae	861	76	8128.40	31.430
3	Adoxaceae	843	56	3025.10	27.780
4	Rosaceae	621	84	7718.90	26.520
5	Magnoliaceae	34	33	129787.00	26.380
6	Oleaceae	147	53	12156.20	11.930
7	Juglandaceae	115	56	11147.60	11.240
8	Aceraceae	149	47	12192.10	11.200
9	Caprifoliaceae	269	31	1588.60	10.550
10	Celastraceae	186	38	650.40	9.140
11	Anacardiaceae	79	40	465.10	6.740
12	Fabaceae	36	22	16565.50	6.270
13	Betulaceae	44	36	4247.50	5.990
14	Cornaceae	148	18	1360.30	5.960
15	Vitaceae	72	31	323.70	5.500
16	Ulmaceae	31	31	5790.30	5.400
17	Hippocastanaceae	13	11	16588.90	4.390
18	Pinaceae	18	11	12427.60	3.820
19	Simaroubaceae	52	16	1541.40	3.370
20	Moraceae	17	22	1887.60	3.360
21	Hamamelidaceae	52	16	530.50	3.200
22	Tiliaceae	6	7	7421.10	2.170
23	Bignoniaceae	7	9	4446.60	1.960
24	Caesalpiniaceae	30	7	1742.20	1.810
25	Malvaceae	22	2	140.20	0.830
26	Ericaceae	10	4	41.00	0.780
27	Hydrangeaceae	9	2	31.90	0.490
28	Rutaceae	3	2	140.30	0.360
	TOTAL	4070			300.00

Table 3.15 Ecological dominance ranking by family importance values for trees only within the 45 m^2 quadrats in Inwood Hill Park (n=1256).

	Family	N of Trees	Relative Density	(cum.)	Relative Frequency	(cum.)	Relative Dominance	(cum.)	Importance Value	(cum.)
1	Fagaceae	196	0.1561	(0.16)	0.1512	(0.15)	0.5764	(0.58)	88.365	(88.37)
2	Rosaceae	297	0.2365	(0.39)	0.1318	(0.28)	0.0112	(0.59)	37.944	(126.31)
3	Magnoliaceae	34	0.0271	(0.42)	0.0581	(0.34)	0.2209	(0.81)	30.610	(156.92)
4	Aceraceae	149	0.1186	(0.54)	0.0814	(0.42)	0.0208	(0.83)	22.078	(179.00)
5	Juglandaceae	115	0.0916	(0.63)	0.0969	(0.52)	0.0190	(0.85)	20.743	(199.74)
6	Oleaceae	101	0.0804	(0.71)	0.0892	(0.61)	0.0202	(0.87)	18.977	(218.72)
7	Lauraceae	101	0.0804	(0.79)	0.0736	(0.68)	0.0065	(0.88)	16.057	(234.77)
8	Betulaceae	44	0.0350	(0.83)	0.0620	(0.74)	0.0072	(0.88)	10.428	(245.20)
9	Ulmaceae	31	0.0247	(0.85)	0.0543	(0.80)	0.0099	(0.89)	8.880	(254.08)
10	Fabaceae	31	0.0247	(0.88)	0.0310	(0.83)	0.0281	(0.92)	8.382	(262.46)
11	Simaroubaceae	52	0.0414	(0.92)	0.0271	(0.86)	0.0026	(0.92)	7.116	(269.58)
12	Hippocastanaceae	13	0.0104	(0.93)	0.0194	(0.88)	0.0282	(0.95)	5.796	(275.38)
13	Moraceae	17	0.0135	(0.94)	0.0388	(0.92)	0.0032	(0.95)	5.551	(280.93)
14	Pinaceae	18	0.0143	(0.96)	0.0194	(0.93)	0.0212	(0.98)	5.486	(286.41)
15	Caesalpiniaceae	30	0.0239	(0.98)	0.0116	(0.95)	0.0030	(0.98)	3.848	(290.26)
16	Cornaceae	11	0.0088	(0.99)	0.0233	(0.97)	0.0012	(0.98)	3.321	(293.58)
17	Tiliaceae	6	0.0048	(0.99)	0.0116	(0.98)	0.0126	(0.99)	2.904	(296.49)
18	Bignoniaceae	7	0.0056	(1.00)	0.0155	(1.00)	0.0076	(1.00)	2.865	(299.35)
19	Rutaceae	3	0.0024	(1.00)	0.0039	(1.00)	0.0002	(1.00)	0.650	(300.00)
	TOTAL	1256								300.00

Table 3.16 Dominance ranking by family importance value for trees only. N of stems, % representation in quadrats, and basal area (n=1256).

	Family	N of Trees	Quadrat, %	BA (sq.cm^2)	Importance Value
1	Fagaceae	196	87	338685.00	88.36
2	Rosaceae	297	76	6577.00	37.94
3	Magnoliaceae	34	33	129787.00	30.61
4	Aceraceae	149	47	12192.10	22.08
5	Juglandaceae	115	56	11147.60	20.74
6	Oleaceae	101	51	11875.20	18.98
7	Lauraceae	101	42	3826.60	16.06
8	Betulaceae	44	36	4247.50	10.43
9	Ulmaceae	31	31	5790.30	8.88
10	Fabaceae	31	18	16530.00	8.38
11	Simaroubaceae	52	16	1541.40	7.12
12	Hippocastanaceae	13	11	16588.90	5.80
13	Moraceae	17	22	1887.60	5.55
14	Pinaceae	18	11	12427.60	5.49
15	Caesalpiniaceae	30	7	1742.20	3.85
16	Cornaceae	11	13	699.80	3.32
17	Tiliaceae	6	7	7421.10	2.90
18	Bignoniaceae	7	9	4446.60	2.86
19	Rutaceae	3	2	140.30	0.65
	TOTAL	1256			300.00

Table 3.17 Woody taxa families for the Valley-Clove forest listed in order of ecological dominance by importance values (n=790).

	Family	N of Stems	Relative Density	(cum.)	Relative Frequency	(cum.)	Relative Dominance	(cum.)	Importance Value	(cum.)
1	Lauraceae	574	0.7266	(0.73)	0.1571	(0.16)	0.0181	(0.02)	90.183	(90.18)
2	Magnoliaceae	20	0.0253	(0.75)	0.1286	(0.29)	0.5917	(0.61)	74.561	(164.75)
3	Fagaceae	11	0.0139	(0.77)	0.0857	(0.37)	0.2037	(0.81)	30.338	(195.08)
4	Adoxaceae	53	0.0671	(0.83)	0.0857	(0.46)	0.0013	(0.82)	15.413	(210.50)
5	Rosaceae	46	0.0582	(0.89)	0.0714	(0.53)	0.0060	(0.82)	13.564	(224.06)
6	Ulmaceae	13	0.0165	(0.91)	0.0857	(0.61)	0.0176	(0.84)	11.979	(236.04)
7	Oleaceae	7	0.0089	(0.92)	0.0571	(0.67)	0.0472	(0.89)	11.324	(247.36)
8	Aceraceae	22	0.0279	(0.94)	0.0571	(0.73)	0.0211	(0.91)	10.613	(257.98)
9	Juglandaceae	14	0.0177	(0.96)	0.0714	(0.80)	0.0164	(0.92)	10.551	(268.53)
10	Tiliaceae	6	0.0076	(0.97)	0.0429	(0.84)	0.0413	(0.97)	9.172	(277.70)
11	Hamamelidaceae	10	0.0127	(0.98)	0.0286	(0.87)	0.0006	(0.97)	4.182	(281.88)
12	Moraceae	3	0.0038	(0.99)	0.0286	(0.90)	0.0028	(0.97)	3.517	(285.40)
13	Bignoniaceae	1	0.0013	(0.99)	0.0143	(0.91)	0.0167	(0.99)	3.229	(288.63)
14	Betulaceae	1	0.0013	(0.99)	0.0143	(0.93)	0.0150	(1.00)	3.055	(291.68)
15	Celastraceae	4	0.0051	(0.99)	0.0143	(0.94)	0.0001	(1.00)	1.943	(293.62)
16	Vitaceae	2	0.0025	(1.00)	0.0143	(0.96)	0.0001	(1.00)	1.690	(295.31)
17	Simaroubaceae	1	0.0013	(1.00)	0.0143	(0.97)	0.0001	(1.00)	1.565	(296.88)
18	Caesalpiniaceae	1	0.0013	(1.00)	0.0143	(0.99)	0.0001	(1.00)	1.562	(298.44)
19	Cornaceae	1	0.0013	(1.00)	0.0143	(1.00)	0.0000	(1.00)	1.559	(300.00)
	TOTAL	790								300.00

Table 3.18 Dominance ranking by family importance values for the Valley-Clove forest, n of stems, % representation in quadrats, and basal area (n=790).

	Family	N of Stems	Quadrats,%	BA (sq.cm^2)	Importance Value
1	Lauraceae	574	100	3256.20	90.18
2	Magnoliaceae	20	82	106405.00	74.56
3	Fagaceae	11	55	36637.20	30.34
4	Adoxaceae	53	55	237.90	15.41
5	Rosaceae	46	45	1076.60	13.56
6	Ulmaceae	13	55	3168.60	11.98
7	Oleaceae	7	36	8494.80	11.32
8	Aceraceae	22	36	3801.20	10.61
9	Juglandaceae	14	45	2941.40	10.55
10	Tiliaceae	6	27	7421.10	9.17
11	Hamamelidaceae	10	18	106.70	4.18
12	Moraceae	3	18	503.20	3.52
13	Bignoniaceae	1	9	3009.30	3.23
14	Betulaceae	1	9	2697.00	3.05
15	Celastraceae	4	9	14.20	1.94
16	Vitaceae	2	9	14.90	1.69
17	Simaroubaceae	1	9	17.30	1.56
18	Caesalpiniaceae	1	9	11.30	1.56
19	Cornaceae	1	9	7.50	1.56
	TOTAL	790			300.00

Table 3.19 Woody taxa families for the East Ridge/Slopes forest listed in order of ecological dominance by importance values (n=707).

	Family	N of Stems	Relative Density	(cum.)	Relative Frequency	(cum.)	Relative Dominance	(cum.)	Importance Value	(cum.)
1	Fagaceae	38	0.0538	(0.05)	0.12903	(0.13)	0.7977	(0.80)	98.043	(98.04)
2	Adoxaceae	376	0.5318	(0.59)	0.11290	(0.24)	0.0145	(0.81)	65.923	(163.97)
3	Aceraceae	59	0.0835	(0.67)	0.11290	(0.36)	0.0573	(0.87)	25.367	(189.33)
4	Rosaceae	80	0.1132	(0.78)	0.11290	(0.47)	0.0074	(0.88)	23.341	(212.67)
5	Lauraceae	46	0.0651	(0.85)	0.11290	(0.58)	0.0109	(0.89)	18.887	(231.56)
6	Hamamelidaceae	29	0.0410	(0.89)	0.06452	(0.65)	0.0038	(0.89)	10.929	(242.49)
7	Pinaceae	1	0.0014	(0.89)	0.01613	(0.66)	0.0653	(0.96)	8.288	(250.78)
8	Moraceae	5	0.0071	(0.90)	0.04839	(0.71)	0.0019	(0.96)	5.732	(256.51)
9	Oleaceae	6	0.0085	(0.91)	0.03226	(0.74)	0.0129	(0.97)	5.364	(261.87)
10	Vitaceae	14	0.0198	(0.93)	0.03226	(0.77)	0.0007	(0.97)	5.280	(267.16)
11	Betulaceae	9	0.0127	(0.94)	0.03226	(0.81)	0.0014	(0.97)	4.641	(271.80)
12	Cornaceae	5	0.0071	(0.95)	0.03226	(0.84)	0.0064	(0.98)	4.574	(276.37)
13	Celastraceae	8	0.0113	(0.96)	0.03226	(0.87)	0.0003	(0.98)	4.389	(280.76)
14	Simaroubaceae	9	0.0127	(0.97)	0.01613	(0.89)	0.0124	(0.99)	4.130	(284.89)
15	Juglandaceae	4	0.0057	(0.98)	0.03226	(0.92)	0.0020	(1.00)	3.996	(288.89)
16	Caprifoliaceae	9	0.0127	(0.99)	0.01613	(0.94)	0.0005	(1.00)	2.934	(291.82)
17	Ulmaceae	2	0.0028	(0.99)	0.01613	(0.95)	0.0031	(1.00)	2.208	(294.03)
18	Ericaceae	4	0.0057	(1.00)	0.01613	(0.97)	0.0002	(1.00)	2.199	(296.22)
19	Bignoniaceae	2	0.0028	(1.00)	0.01613	(0.98)	0.0002	(1.00)	1.911	(298.14)
20	Magnoliaceae	1	0.0014	(1.00)	0.01613	(1.00)	0.0011	(1.00)	1.864	(300.00)
	TOTAL	707								300.00

Table 3.20 Dominance ranking for families of the East Ridge listed in order of importance values, number of stems, % representation, and basal area (n=707).

	Family	N of Stems	Quadrats, %	BA (sq.cm^2)	Importance Value
1	Fagaceae	38	100	72738.00	98.04
2	Adoxaceae	376	88	1322.40	65.92
3	Aceraceae	59	88	5226.90	25.37
4	Rosaceae	80	88	670.20	23.34
5	Lauraceae	46	88	994.50	18.89
6	Hamamelidaceae	29	50	342.80	10.93
7	Pinaceae	1	13	5958.40	8.29
8	Moraceae	5	38	169.30	5.73
9	Oleaceae	6	25	1176.10	5.36
10	Vitaceae	14	25	67.90	5.28
11	Betulaceae	9	25	130.10	4.64
12	Cornaceae	5	25	584.00	4.57
13	Celastraceae	8	25	28.80	4.39
14	Simaroubaceae	9	13	1134.80	4.13
15	Juglandaceae	4	25	186.10	4.00
16	Caprifoliaceae	9	13	43.70	2.93
17	Ulmaceae	2	13	284.30	2.21
18	Ericaceae	4	13	18.20	2.20
19	Bignoniaceae	2	13	14.20	1.91
20	Magnoliaceae	1	13	100.30	1.86
	TOTAL	707			300.00

Table 3.21 Woody taxa families for the Ridge Tops (east and west) forest listed in order of ecological dominance by importance values (n=595).

	Family	N of Stems	Relative Density	(cum.)	Relative Frequency	(cum.)	Relative Dominance	(cum.)	Importance Value	(cum.)
1	Fagaceae	44	0.0740	(0.07)	0.1061	(0.11)	0.7429	(0.74)	92.291	(92.29)
2	Rosaceae	115	0.1950	(0.27)	0.1061	(0.21)	0.0262	(0.77)	32.723	(125.01)
3	Adoxaceae	116	0.1933	(0.46)	0.0455	(0.26)	0.0039	(0.77)	24.268	(149.28)
4	Oleaceae	47	0.0790	(0.54)	0.0909	(0.35)	0.0193	(0.79)	18.921	(168.20)
5	Celastraceae	68	0.1143	(0.66)	0.0606	(0.41)	0.0024	(0.80)	17.728	(185.93)
6	Magnoliaceae	3	0.0050	(0.66)	0.0303	(0.44)	0.1373	(0.93)	17.261	(203.19)
7	Juglandaceae	44	0.0740	(0.73)	0.0758	(0.52)	0.0183	(0.95)	16.805	(220.00)
8	Lauraceae	40	0.0672	(0.80)	0.0606	(0.58)	0.0022	(0.95)	13.003	(233.00)
9	Anacardiaceae	26	0.0437	(0.85)	0.0758	(0.65)	0.0016	(0.95)	12.101	(245.10)
10	Caprifoliaceae	33	0.0555	(0.90)	0.0455	(0.70)	0.0021	(0.96)	10.301	(255.40)
11	Betulaceae	14	0.0235	(0.92)	0.0606	(0.76)	0.0057	(0.96)	8.982	(264.38)
12	Aceraceae	11	0.0185	(0.94)	0.0455	(0.80)	0.0010	(0.96)	6.492	(270.87)
13	Moraceae	4	0.0067	(0.95)	0.0455	(0.85)	0.0062	(0.97)	5.839	(276.71)
14	Bignoniaceae	4	0.0067	(0.96)	0.0303	(0.88)	0.0142	(0.98)	5.123	(281.84)
15	Fabaceae	4	0.0067	(0.96)	0.0303	(0.91)	0.0003	(0.98)	3.730	(285.57)
16	Hippocastanaceae	2	0.0034	(0.97)	0.0152	(0.92)	0.0151	(1.00)	3.360	(288.92)
17	Hydrangeaceae	9	0.0151	(0.98)	0.0152	(0.94)	0.0003	(1.00)	3.060	(291.98)
18	Simaroubaceae	4	0.0067	(0.99)	0.0152	(0.96)	0.0006	(1.00)	2.247	(294.23)
19	Vitaceae	4	0.0067	(1.00)	0.0152	(0.97)	0.0001	(1.00)	2.202	(296.43)
20	Ulmaceae	2	0.0034	(1.00)	0.0152	(0.99)	0.0001	(1.00)	1.864	(298.30)
21	Cornaceae	1	0.0017	(1.00)	0.0152	(1.00)	0.0002	(1.00)	1.704	(300.00)
	TOTAL	595								300.00

Table 3.22 Dominance ranking for families of the Ridge Tops forest listed in order of importance values, number of stems, % representation, and basal area (n=595).

	Family	N of Stems	Quadrat, %	BA (sq.cm^2)	Importance Value
1	Fagaceae	44	100	74430.80	92.29
2	Rosaceae	115	100	2626.20	32.72
3	Adoxaceae	116	43	395.10	24.27
4	Oleaceae	47	86	1934.10	18.92
5	Celastraceae	68	57	239.10	17.73
6	Magnoliaceae	3	29	13752.10	17.26
7	Juglandaceae	44	71	1837.70	16.80
8	Lauraceae	40	57	220.20	13.00
9	Anacardiaceae	26	71	155.50	12.10
10	Caprifoliaceae	33	43	209.60	10.30
11	Betulaceae	14	57	569.60	8.98
12	Aceraceae	11	43	97.90	6.49
13	Moraceae	4	43	622.10	5.84
14	Bignoniaceae	4	29	1423.10	5.12
15	Fabaceae	4	29	27.00	3.73
16	Hippocastanaceae	2	14	1511.10	3.36
17	Hydrangeaceae	9	14	31.90	3.06
18	Simaroubaceae	4	14	59.60	2.25
19	Vitaceae	4	14	14.20	2.20
20	Ulmaceae	2	14	12.90	1.86
21	Cornaceae	1	14	20.40	1.70
	TOTAL	595			300.00

Table 3.23 Woody taxa families for the West Ridge forest listed in order of ecological dominance by importance values (n=1978).

	Family	N of Stems	Relative Density	(cum.)	Relative Frequency	(cum.)	Relative Dominance	(cum.)	Importance Value	(cum.)
1	Fagaceae	103	0.0521	(0.05)	0.0950	(0.10)	0.6747	(0.68)	82.170	(82.17)
2	Rosaceae	379	0.1916	(0.24)	0.1006	(0.20)	0.0146	(0.69)	30.674	(112.84)
3	Adoxaceae	299	0.1512	(0.40)	0.0503	(0.25)	0.0047	(0.69)	20.610	(133.45)
4	Lauraceae	201	0.1016	(0.50)	0.0670	(0.31)	0.0159	(0.71)	18.459	(151.91)
5	Caprifoliaceae	227	0.1148	(0.61)	0.0559	(0.37)	0.0058	(0.72)	17.645	(169.56)
6	Fabaceae	32	0.0162	(0.63)	0.0447	(0.41)	0.0720	(0.79)	13.291	(182.85)
7	Juglandaceae	53	0.0268	(0.65)	0.0670	(0.48)	0.0269	(0.82)	12.076	(194.93)
8	Celastraceae	106	0.0536	(0.71)	0.0559	(0.54)	0.0016	(0.82)	11.106	(206.03)
9	Oleaceae	87	0.0440	(0.75)	0.0615	(0.60)	0.0024	(0.82)	10.784	(216.82)
10	Cornaceae	141	0.0713	(0.82)	0.0224	(0.62)	0.0033	(0.82)	9.689	(226.50)
11	Anacardiaceae	53	0.0268	(0.85)	0.0670	(0.69)	0.0014	(0.82)	9.518	(236.02)
12	Hippocastanaceae	11	0.0056	(0.86)	0.0224	(0.71)	0.0657	(0.89)	9.359	(245.38)
13	Aceraceae	57	0.0288	(0.88)	0.0447	(0.75)	0.0134	(0.90)	8.687	(254.07)
14	Vitaceae	52	0.0263	(0.91)	0.0559	(0.81)	0.0010	(0.90)	8.314	(262.38)
15	Magnoliaceae	10	0.0051	(0.92)	0.0168	(0.83)	0.0415	(0.95)	6.333	(268.71)
16	Pinaceae	17	0.0086	(0.92)	0.0224	(0.85)	0.0282	(0.97)	5.912	(274.63)
17	Betulaceae	20	0.0101	(0.93)	0.0447	(0.89)	0.0037	(0.98)	5.851	(280.48)
18	Ulmaceae	14	0.0071	(0.94)	0.0335	(0.93)	0.0101	(0.99)	5.072	(285.55)
19	Simaroubaceae	38	0.0192	(0.96)	0.0224	(0.95)	0.0014	(0.99)	4.299	(289.85)
20	Caesalpiniaceae	29	0.0147	(0.98)	0.0112	(0.96)	0.0075	(1.00)	3.337	(293.19)
21	Moraceae	5	0.0025	(0.98)	0.0168	(0.98)	0.0026	(1.00)	2.187	(295.37)
22	Malvaceae	22	0.0111	(0.99)	0.0056	(0.98)	0.0006	(1.00)	1.732	(297.11)
23	Hamamelidaceae	13	0.0066	(1.00)	0.0056	(0.99)	0.0004	(1.00)	1.251	(298.36)
24	Ericaceae	6	0.0030	(1.00)	0.0056	(0.99)	0.0001	(1.00)	0.872	(299.23)
25	Rutaceae	3	0.0015	(1.00)	0.0056	(1.00)	0.0006	(1.00)	0.771	(300.00)
	TOTAL	1978								300.00

Table 3.24 Dominance ranking for families of the West Ridge forest listed in order of importance values, number of stems, % representation, and basal area (n=1978).

Family	N of Stems	Quadrat,%	BA (sq.cm^2)	Importance Value
1 Fagaceae	103	94	154878.00	82.17
2 Rosaceae	379	100	3345.90	30.67
3 Adoxaceae	299	50	1069.60	20.61
4 Lauraceae	201	67	3657.50	18.46
5 Caprifoliaceae	227	56	1335.40	17.64
6 Fabaceae	32	44	16538.50	13.29
7 Juglandaceae	53	67	6182.30	12.08
8 Celastraceae	106	56	368.20	11.11
9 Oleaceae	87	61	551.60	10.78
10 Cornaceae	141	22	748.30	9.69
11 Anacardiaceae	53	67	309.30	9.52
12 Hippocastanaceae	11	22	15077.70	9.36
13 Aceraceae	57	44	3066.10	8.69
14 Vitaceae	52	56	226.70	8.31
15 Magnoliaceae	10	17	9529.50	6.33
16 Pinaceae	17	22	6469.20	5.91
17 Betulaceae	20	44	850.80	5.85
18 Ulmaceae	14	33	2324.60	5.07
19 Simaroubaceae	38	22	329.60	4.30
20 Caesalpiniaceae	29	11	1730.90	3.34
21 Moraceae	5	17	592.90	2.19
22 Malvaceae	22	6	140.20	1.73
23 Hamamelidaceae	13	6	81.00	1.25
24 Ericaceae	6	6	22.80	0.87
25 Rutaceae	3	6	140.30	0.77
TOTAL	1978			300.00

Table 3.25 Herbaceous taxa: 76 Genera, 96 Species, 41 Families in 45 2 X 2 m^2 quadrats in Inwood Hill Park.

Genera	Species	Family	Common Name	N-NN-IV
1. *Aegopodium*	*podagraria* L.	Apiaceae	Goutweed	NN-IV
2. *Alliaria*	*petiolata* (Bieb.) Cavara & Grande	Brassicaceae	Garlic Mustard	NN-IV
3. *Allium*	*canadense* L.	Liliaceae	Wild Garlic	N
	vineale L.	Liliaceae	Field Garlic	NN
4. *Ambrosia*	*artemisifolia* L.	Asteraceae	Common Ragweed	NN-IV
	trifida L.	Asteraceae	Great Ragweed	NN-IV
5. *Apios*	*americana* Medikus.	Fabaceae	Groundnut	N
6. *Arctium*	*minus* Schk.	Asteraceae	Common Burdock	NN-IV
7. *Arisaema*	*triphyllum* (L.) Schott	Araceae	Jack-in-the-Pulpit	N
8. *Arrhenatherum*	*elatius* (L.) J. & C. Presl.	Poaceae	Tall Oats Grass	NN-IV
9. *Artemisia*	*vulgaris* L.	Asteraceae	Mugwort	NN-IV
10. *Aster*	*cordifolius* L.	Asteraceae	Heart-leaved Aster	N
	divaricatus L.	Asteraceae	White Wood Aster	N
	novae-angliae L.	Asteraceae	New England Aster	N
11. *Bidens*	*bipinnata* L.	Asteraceae	Spanish Needles	N
12. *Boehmeria*	*cylindrica* (L.) Sw.	Urticaceae	False Nettle	N
13. *Cardamine*	*concatenata* (Michx.) O. Schwartz	Brassicaceae	Cut-leaved Toothwort	N
14. *Carex*	*laxifolia* Lam.	Cyperaceae	Loosely-flowered Sedge	N
	pensylvanica Lam.	Cyperaceae	Pennsylvania Sedge	N
	vulpinoidea Michx.	Cyperaceae	Fox Carex	N
15. *Chimaphila*	*maculata* (L.) Pursh.	Pyrolaceae	Spotted Wintergreen	N
16. *Circaea*	*lutetiana* L.	Onagraceae	Enchanter's Nightshade	N
17 *Claytonia*	*virginica* L.	Portulacaceae	Spring Beauty	N
18. *Commelina*	*communis* L.	Commelinaceae	Asiatic Dayflower	NN

Table 3.25 Herbaceous taxa: 76 Genera, 96 Species, 41 Families in 45 2 X 2 m^2 quadrats in Inwood Hill Park.

Genera	Species	Family	Common Name	N-NN-IV
19. *Convallaria*	*majalis* L.	Liliaceae	Lily of the Valley	NN
20. *Cuscuta*	*gronovii* Willd.	Cuscutaceae	Dodder	N
21. *Dactylis*	*glomerata* L.	Poaceae	Orchard Grass	NN
22. *Danthonia*	*spicata* (L.) F. Beauv.	Poaceae	Poverty Grass	N
23. *Deschampsia*	*flexuosa* (L.) Trin.	Poaceae	Hair Grass	NN
24. *Desmodium*	*paniculatum* (L.) DC.	Fabaceae	Panicled Tick Trefoil	N
25. *Dicentra*	*cucullaria* (L.) Bernh.	Fumariaceae	Dutchman's Breeches	N
26. *Epipactis*	*helleborine* (L.) Cranz.	Orchidaceae	Helleborine	NN
27. *Erigeron*	*annuus* (L.) Pers.	Asteraceae	Annual Fleabane	N
	philadelphicus L.	Asteraceae	Philadelphia Daisy	N
28. *Eupatorium*	*purpureum* L.	Asteraceae	Sweet-scented joe-pye weed	N
	rugosum Houttuyn.	Asteraceae	White Snakeroot	N
29. *Festuca*	*ovata* L.	Poaceae	Sheep Fescue	NN
30. *Galium*	*aparine* L.	Rubiaceae	Cleavers	N
31. *Geranium*	*maculatum* L.	Geraniaceae	Wild Geranium	N
	robertianum L.	Geraniaceae	Herb Robert	NN
32. *Geum*	*canadense* Jacq.	Rosaceae	White Avens	N
33. *Hedera*	*helix* L.	Araliaceae	English Ivy	NN-IV
34. *Helianthus*	*divaricatus* L.	Asteraceae	Woodland Sunflower	N
35. *Hemerocallis*	*fulva* (L.) L.	Liliaceae	Day Lilly	NN-IV
36. *Hesperus*	*matronalis* L.	Brassicaceae	Dame's Rocket	NN
37. *Hieracium*	*venosum* L.	Asteraceae	Rattlesnake Weed	N
	paniculatum L.	Asteraceae	Panicled Hawkweed	N
38. *Impatiens*	*capensis* Meerb.	Balsaminaceae	Jewelweed	N

Table 3.25 Herbaceous taxa: 76 Genera, 96 Species, 41 Families in 45 2 X 2 m^2 quadrats in Inwood Hill Park.

Genera	Species	Family	Common Name	N-NN-IV
39. *Juncus*	*tenuis* Willd.	Juncaceae	Path Rush	N
40. *Leonurus*	*cardiaca* L.	Lamiaceae	Motherwort	NN
41. *Lonicera*	*japonica* Thunb.	Caprifoliaceae	Japanese Honeysuckle	NN-IV
42. *Luzula*	*multiflora* (Retz.) Lejune	Juncaceae	Wood Rush	N
43. *Maianthemum*	*canadense* Desf.	Liliaceae	Canada Mayflower	N
44. *Menispermum*	*canadense* L.	Menispermaceae	Moonseed	N
45. *Monotropa*	*uniflora* L.	Monotropaceae	Indian Pipe	N
46. *Oenothera*	*biennis* L.	Onagraceae	Evening Primrose	N
47. *Orobanche*	*uniflora* L.	Orobanchaceae	One-flowered Cancerroot	N
48. *Oxalis*	*stricta* L.	Oxalidaceae	Yellow Wood Sorrel	NN
49. *Pachysandra*	*terminalis* Sieb. & Zucc.	Buxaceae	Pachysandra	NN
50. *Panicum*	*virgatum* L.	Poaceae	Switch Grass	N
51. *Parthenocissus*	*quinquefolia* (L.) Planch.	Vitaceae	Virginia Creeper	N
52. *Phytolacca*	*americana* L.	Phytolaccaceae	Pokeweed	N
53. *Pilea*	*pumila* (L.) A. Gray	Urticaceae	Clearweed	N
54. *Plantago*	*lanceolata* L.	Plantaginaceae	English Plaintain	NN
	major L.	Plantaginaceae	Common Plantain	NN
55. *Poa*	*annua* L.	Poaceae	Low Speargrass	N
	pratensis L.	Poaceae	Kentucky Blue Grass	NN
56. *Podophyllum*	*peltatum* L.	Berberidaceae	Mayapple	N
57. *Polygonatum*	*biflorum* (Walt.) Elliott	Liliaceae	Solomon's Seal	N
58. *Polygonum*	*cespitosum* Blume	Polygonaceae	Smartweed	NN
	virginianum L.	Polygonaceae	Jumpseed	N
59. *Prunella*	*vulgaris* L.	Lamiaceae	Self-Heal	NN

Table 3.25 Herbaceous taxa: 76 Genera, 96 Species, 41 Families in 45 2 X 2 m^2 quadrats in Inwood Hill Park.

Genera	Species	Family	Common Name	N-NN-IV
60. *Rubus*	*flagellaris* Willd.	Rosaceae	Dewberry	N
	hispidus L.	Rosaceae	Swamp Dewberry	N
	phoenicolasius Maxim.	Rosaceae	Wineberry	NN-IV
61. *Rumex*	*crispus* L.	Polygonaceae	Curled Dock	N
62. *Sanguinaria*	*canadensis* L.	Papaveraceae	Blood Root	N
63. *Schizachyrium*	*scoparium* (Michx.) Nash	Poaceae	Little Bluestem Grass	N
64. *Silene*	*vulgaris* (Moench.) Garke.	Caryophyllaceae	Common Bladderwort	NN
65. *Sisyrinchium*	*angustifolium* Miller	Iridaceae	Blue-eyed Grass	N
66. *Smilacina*	*racemosa* (L.) Desf.	Liliaceae	False Solomon's Seal	NN-IV
67. *Smilax*	*rotundifolia* L.	Smilaceae	Catbriar	N
68. *Solidago*	*bicolor* L.	Asteraceae	Silverrod	N
	caesia L.	Asteraceae	Blue-Stem Goldenrod	N
	canadensis L.	Asteraceae	Canada Goldenrod	N
	juncea Aiton	Asteraceae	Early Goldenrod	N
69. *Tragopogon*	*pratensis* L.	Asteraceae	Goat's Beard	N
70. *Trillium*	*cernuum* L.	Liliaceae	Nodding Trillium	N
71. *Uvularia*	*perfoliata* L.	Liliaceae	Bellwort	N
72. *Verbena*	*hastata* L.	Verbenaceae	Blue Vervain	N
	urticifolia L.	Verbenaceae	White Vervain	N
73. *Vernonia*	*novaboracensis* (L.) Michx.	Asteraceae	Ironweed	N
74. *Vinca*	*minor* L.	Apocynaceae	Periwinkle	NN
75. *Vincetoxicum*	*nigrum* (L.) Moench.	Asclepiadaceae	Black Swallow-wort	NN-IV
76. *Viola*	*rotundifolia* L.	Violaceae	Round-leaved Violet	N
	sororia L.	Violaceae	Common Blue Violet	N
76	96	41		

Table 3.26 Herbacious taxa in 11 2 X 2 m^2 quadrats in the Valley-Clove Forest in Inwood Hill Park (n=701).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 1												285° WNW 15° NNE	66
Asteraceae	*Aster divaricatus* L.	6					X	X	X	X	N		
Balsaminaceae	*Impatiens capensis* Meerb.	19		X	X	X	X				N		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	8	X	X	X						NN-IV		
Fumariaceae	*Dicentra cucullaria* (L.) Bernh.	11	X	X							N		
Liliaceae	*Smilacina racemosa* (L.) Desf.	2		X	X						N		
Onagraceae	*Circaea lutetiana* L.	9			X	X	X				N		
Polygonaceae	*Polygonum virginianum* L.	5			X	X	X				N		
Violaceae	*Viola rotundifolia* Michx.	2		X	X						N		
Violaceae	*Viola sororia* L.	4	X	X	X	X					N		
Quadrat 2												310° NW 40° NE	61
Apiaceae	*Aegopodium podagraria* L.	29			X	X					NN-IV		
Balsaminaceae	*Impatiens capensis* Meerb.	13		X	X	X	X				N		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	10	X	X	X						NN-IV		
Polygonaceae	*Polygonum virginianum* L.	9			X	X	X				N		

Table 3.26 Herbaceous taxa in 11 2 X 2 m^2 quadrats in the Valley-Clove Forest in Inwood Hill Park (n=701).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 3												310° NW 220° SW	59
Araceae	*Arisaema triphyllum var. triphyllum* (L.) Schott.	3		X	X						N		
Balsaminaceae	*Impatiens capensis* Meerb.	9			X	X	X	X			N		
Brassicaeae	*Alliaria petiolata* (Bieb.) Cavara & Grande	8	X	X	X						NN-IV		
Fumariaceae	*Dicentra cucullaria* (L.) Bernh.	3	X	X							N		
Liliaceae	*Smilacina racemosa* (L.) Desf.	6		X	X						N		
Onagraceae	*Circaea lutetiana* L.	11			X	X	X				N		
Polygonaceae	*Polygonum virginianum* L.	5			X	X	X				N		
Violaceae	*Viola rotundifolia* Michx.	4	X	X							N		
Violaceae	*Viola sororia* L.	10	X	X	X						N		
Quadrat 5												135° SE 225° SW	36
Araceae	*Arisaema triphyllum var. triphyllum* (L.) Schott.	1		X	X						N		
Balsaminaceae	*Impatiens capensis* Meerb.	7			X	X	X	X			N		
Liliaceae	*Smilacina racemosa* (L.) Desf.	14		X	X						N		
Liliaceae	*Trillium cernuum* L.	3	X	X							N		
Onagraceae	*Circaea lutetiana* L.	3			X	X	X				N		
Polygonaceae	*Polygonum virginianum* L.	8			X	X	X				N		
Quadrat 6												234° SW 324° NW	13
Brassicaceae	Alliaria petiolata (Bieb.) Cavara & Grande	13	X	X	X						NN-IV		

Table 3.26 Herbaceous taxa in 11 2 X 2 m^2 quadrats in theValley-Clove Forest in Inwood Hill Park (n=701).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 7												220° SW 310° NW	88
Asteraceae	*Aster divaricatus* L.	11					X	X	X	X	N		
Asteraceae	*Solidago caesia* L.	9					X	X	X	X	N		
Cyperaceae	*Carex laxifolia* Lam.	3	X	X	X						N		
Balsaminaceae	*Impatiens capensis* Meerb.	9			X	X	X				N		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	13	X	X	X						NN-IV		
Liliaceae	*Smilacina racemosa* (L.) Desf.	4		X	X						N		
Onagraceae	*Circaea lutetinana* L.	7			X	X	X				N		
Oxalidaceae	*Oxalis stricta* L.	6					X	X			N		
Polygonaceae	*Polygonum cespitosum* Blume	8			X	X	X	X			NN		
Polygonaceae	*Polygonum virginianum* L.	8			X	X	X				N		
Violaceae	*Viola sororia* L.	10	X	X	X						N		
Quadrat 13												146° SE 236 SW	72
Balsaminaceae	*Impatiens capensis* Meerb.	16			X	X	X	X			N		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	36	X	X	X						NN-IV		
Onagraceae	*Circaea lutetiana* L.	10			X	X	X				N		
Polygonaceae	*Polygonum virginianum* L.	6			X	X	X				N		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	4			X	X	X				N		

Table 3.26 Herbaceous taxa in 11 2 X 2 m^2 quadrats in the Valley-Clove Forest in Inwood Hill Park (n=701).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N	N-NN-IV		
Quadrat 14												314° NW 44° NE	66
Balsaminaceae	*Impatiens capensis* Meerb.	8				X	X	X	X		N		
Berberidaceae	*Podophyllum peltatum* L.	6			X	X					N		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	16	X	X	X	X					NN-IV		
Buxaceae	*Pachysandra terminalis* Sieb. & Zucc.	9	X	X	X						NN		
Papaveraceae	*Sanguinaria canadensis* L.	12	X	X	X						N		
Polygonaceae	*Polygonum virginianum* L.	3				X	X	X			N		
Portulacaceae	*Claytonia virginica* L.	6	X	X	X						N		
Violaceae	*Viola sororia* L.	6	X	X	X	X					N		
Quadrat 17												40° NE 130° SE	72
Asteraceae	*Aster divaricatus* L.	16					X	X	X	X	N		
Asteraceae	*Eupatorium rugosum* Houttuyn.	7				X	X	X	X		N		
Asteraceae	*Helianthus divaricatus* L.	6					X	X	X		N		
Balsaminaceae	*Impatiens capensis* Meerb.	5		X	X	X	X				N		
Liliaceae	*Smilacina racemosa* (L.) Desf.	1	X	X							N		
Onagraceae	*Circaea lutetiana* L.	14			X	X	X				N		
Polygonaceae	*Polygonum virginianum* L.	3			X	X	X				N		
Rosaceae	*Geum canadense* Jacq.	4		X	X						N		
Verbenaceae	*Verbena urticifolia* L.	5			X	X	X	X			N		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	11			X	X	X				N		

Table 3.26 Herbaceous taxa in 11 2 X 2 m^2 quadrats in the Valley-Clove Forest in Inwood Hill Park (n=701).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 18												108° ESE 198° SSW	77
Asteraceae	*Aster divaricatus* L.	8					X	X	X	X	N		
Asteraceae	*Erigeron philadelphicus* L.	1			X	X	X				N		
Balsaminaceae	*Impatiens capensis* Meerb.	6		X	X	X	X				N		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	11		X	X	X					NN-IV		
Cyperaceae	*Carex laxifolia* Lam.	1	X	X	X						N		
Liliaceae	*Allium vineale* L.	4			X	X					NN		
Liliaceae	*Smilacina racemosa* (L.) Desf.	10		X	X						N		
Onagraceae	*Circaea lutetiana* L.	7			X	X	X				N		
Oxidaliaceae	*Oxalis stricta* L.	6					X	X			N		
Polygonaceae	*Polygonum cespitosum* Blume	6			X	X	X	X			NN		
Polygonaceae	*Polygonum virginianum* L.	9			X	X	X				N		
Rosaceae	*Geum canadense* Jacq.	3		X	X						N		
Rosaceae	*Rubus flagellaris* Willd.	3		X	X						N		
Urticaceae	*Pilea pumila var. pumila* (L.) A. Gray	2				X	X				N		

Table 3.26 Herbaceous taxa in 11 2 X 2 m^2 quadrats in the Valley-Clove Forest in Inwood Hill Park (n=701).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 19												338° NNW 68° ENE	91
Asteraceae	*Aster divaricatus* L.	3					X	X	X	X	N		
Balsaminaceae	*Impatiens capensis* Meerb.	16		X	X	X	X				N		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	18	X	X	X						NN-IV		
Commelinaceae	*Commelina communis* L.	3			X	X	X	X			NN-IV		
Fumariaceae	*Dicentra cucullaria* (L.) Bernh.	24	X	X							N		
Liliaceae	*Allium vineale* L.	3			X	X					NN		
Liliaceae	*Smilacina racemosa* (L.) Desf.	3		X	X						N		
Onagraceae	*Circaea lutetiana* L.	7			X	X	X				N		
Polygonaceae	*Polygonum virginianum* L.	12			X	X	X				N		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	2			X	X					N		

Table 3.27 Herbaceous taxa in 8 2 X 2 m^2 quadrats in the East Ridge/Slopes Forest in Inwood Hill Park (n=398).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 4												330° NNW 60° ENE	43
Asteraceae	*Aster divaricatus* L.	22					X	X	X	X	N		
Liliaceae	*Maianthemum canadense* Desf.	16		X	X						N		
Orobanchaceae	*Orobanche uniflora* L.	1		X	X						N		
Rosaceae	*Rubus flagellaris* Willd.	4		X	X						N		
Quadrat 8												28° NNE 118° ESE	20
Asteraceae	*Aster divaricatus* L.	9					X	X	X	X	N		
Asteraceae	*Eupatorium rugosum* Houttuyn.	6				X	X	X	X		N		
Rosaceae	*Rubus flagellaris* Willd.	5		X	X						N		
Quadrat 9												316° NW 46° NE	32
Asteraceae	*Aster divaricatus* L.	11					X	X	X	X	N		
Juncaceae	*Juncus tenuis* Willd.	13			X	X	X	X			N		
Poaceae	*Danthonia spicata* (L.) F. Beauv.	8			X	X	X				N		

Table 3.27 Herbaceous taxa in 8 2 X 2 m^2 quadrats in the East Ridge/Slopes Forest in Inwood Hill Park (n=398).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 11												304° NW 34° NE	78
Asteraceae	*Aster cordifolius* L.	3					X	X	X		N		
Asteraceae	*Aster divaricatus* L.	9					X	X	X	X	N		
Asteraceae	*Eupatorium rugosum* Houttuyn.	6				X	X	X	X		N		
Asteraceae	*Solidago caesia* L.	8					X	X	X		N		
Asteraceae	*Solidago juncea* Aiton	11				X	X	X			N		
Cyperaceae	*Carex vulpinoidea* Michx.	1			X	X	X				N		
Juncaceae	*Juncus tenuis* Willd.	10			X	X	X	X			N		
Juncaceae	*Luzula multiflora* (Retz.) Lejune	2	X	X	X						N		
Liliaceae	*Allium vineale* L.	3			X	X	X				NN		
Plantaginaceae	*Plantago lanceolata* L.	3		X	X	X					NN		
Plantaginaceae	*Plantago major* L.	4		X	X	X					NN		
Poaceae	*Dactylis glomerata* L.	7		X	X	X	X				NN		
Poaceae	*Poa annua* L.	3		X	X	X					N		
Polygonaceae	*Polygonum cespitosum* Blume	4			X	X	X	X			NN		
Polygonaceae	*Polygonum virginianum* L.	2			X	X	X				N		
Rosaceae	*Rubus flagellaris* Willd.	2		X	X						N		

Table 3.27 Herbaceous taxa in 8 2 X 2 m^2 quadrats in the East Ridge/Slopes Forest in Inwood Hill Park (n=398).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 12												320° NW 50° NE	46
Asteraceae	*Aster divaricatus* L.	9					X	X	X	X	N		
Liliaceae	*Maianthemum canadense* (Desf.	6		X	X						N		
Liliaceae	*Polygonatum biflorum* (Walt.) Elliott	5		X	X						N		
Liliaceae	*Uvularia perfoliata* L.	2		X	X						N		
Monotropaceae	*Monotropa uniflora* L.	13			X	X	X				N		
Pyrolaceae	*Chimaphila maculata* (L.) Pursh.	11				X	X				N		
Quadrat 16												232° SW 322° NW	62
Asteraceae	*Aster divaricatus* L.	16					X	X	X	X	N		
Asteraceae	*Eupatorium rugosum* Houttuyn.	4				X	X	X	X		N		
Cyperaceae	*Carex laxifolia* Lam.	2	X	X	X						N		
Juncaceae	*Luzula multiflora* (Retz.) Lejune	6	X	X							N		
Liliaceae	*Polygonatum biflorum* (Walt.) Elliott	7		X	X						N		
Liliaceae	*Smilacina racemosa* (L.) Desf.	6		X	X						N		
Liliaceae	*Smilax rotundifolia* L.	3		X	X						N		
Liliaceae	*Maianthemum canadense* (Desf.	8		X	X						N		
Rosaceae	*Rubus flagellaris* Willd.	3		X	X						N		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	7			X	X	X				N		

Table 3.27 Herbaceous taxa in 8 2 X 2 m^2 quadrats in the East Ridge/Slopes Forest in Inwood Hill Park (n=398).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 22												326° NW 56° NE	64
Asteraceae	*Aster divaricatus* L.	6					X	X	X		N		
Asteraceae	*Aster cordifolius* L.	2					X	X	X		N		
Liliaceae	*Maianthemum canadense* Desf.	29		X	X						N		
Liliaceae	*Polygonatum biflorum* (Walt.) Elliott	6		X	X						N		
Liliaceae	*Smilacina racemosa* (L.) Desf.	4		X	X						N		
Monotropaceae	*Monotropa uniflora* L.	16				X					N		
Rosaceae	*Rubus flagellaris* (Willd.)	1		X	X						N		
Quadrat 27												350° N 80° E	53
Asteraceae	*Aster divaricatus* L.	6					X	X	X		N		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	22		X	X						NN-IV		
Caprifoliaceae	*Lonicera japonica* Thunb.	6		X	X	X					NN-IV		
Liliaceae	*Allium vineale* L.	4			X	X					NN		
Onagraceae	*Circaea lutetiana* L.	4			X	X	X				N		
Rosaceae	*Rubus phoenicolasius* Maxim.	3			X	X					NN-IV		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	8		X	X	X					N		

Table 3.28 Herbaceous taxa in 8 2 X 2 m^2 quadrats for the Ridge Tops (east and west) Forest in Inwood Hill Park (n=498).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 10												210° SSW 300° WNW	51
Poaceae	*Danthonia spicata* (L.) F. Beauv.	36		X	X	X					N		
Poaceae	*Festuca ovina* L.	4		X	X	X					NN		
Poaceae	*Schizachyrium scoparium* (Michx.) Nash	11				X	X	X			N		
Quadrat 15												150° SSE 60° ENE	82
Asteraceae	*Ambrosia artemisifolia* L.	14					X	X	X		NN-IV		
Asteraceae	*Aster cordifolius* L.	6					X	X	X		N		
Asteraceae	*Aster divaricatus* L.	13					X	X	X		N		
Asteraceae	*Solidago bicolor* L.	3					X	X	X		N		
Asteraceae	*Solidago juncea* Aiton	15				X	X	X			N		
Iridaceae	*Sisyrinchium angustifolium* Miller	3		X	X	X					N		
Juncaceae	*Luzula multiflora* (Retz.)	5	X	X							N		
Plantaginaceae	*Plantago lanceolata* L.	2		X	X						NN		
Plantaginaceae	*Plantago major* L.	3		X	X	X					NN		
Poaceae	*Dactylis glomerata* L.	8		X	X	X					NN		
Poaceae	*Danthonia spicata* (L.) F. Beauv.	4		X	X	X					N		
Polygonaceae	*Polygonum cespitosum* Blume	6			X	X	X	X			NN		

Table 3.28 Herbaceous taxa in 2 X 2 m^2 quadrats for the Ridge Tops (east and west) Forest in Inwood Hill Park (n=498).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 20												260° W 350° N	60
Asteraceae	*Aster divaricatus* L.	12					X	X	X		N		
Asteraceae	*Aster cordifolius* L.	4					X	X	X		N		
Asteraceae	*Solidago caesia* L.	4					X	X	X		N		
Asteraceae	*Solidago juncea* Aiton	5				X	X	X	X		N		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	10	X	X	X						NN-IV		
Caprifoliaceae	*Lonicera japonica* Thunb.	14				X	X	X			NN-IV		
Liliaceae	*Smilacina racemosa* (L.) Desf.	2		X	X						N		
Polygonaceae	*Polygonum virginianum* L.	4			X	X	X				N		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	5			X	X	X				N		

Table 3.28 Herbaceous taxa in 8 2 X 2 m^2 quadrats for the Ridge Tops (east and west) Forest in Inwood Hill Park (n=498).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 21												330° NNW 60° ENE	86
Asteraceae	*Aster divaricatus* L.	11					X	X	X		N		
Asteraceae	*Aster cordifolius* L.	5					X	X	X		N		
Asteraceae	*Eupatorium purpureum* L.	3				X	X	X			N		
Asteraceae	*Eupatorium rugosum* Houttuyn.	4				X	X	X	X		N		
Asteraceae	*Helianthus divaricatus* L.	6					X	X	X		N		
Asteraceae	*Solidago caesia* L.	2					X	X	X		N		
Asteraceae	*Solidago juncea* Aiton	3				X	X	X	X		N		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	7		X	X	X					NN-IV		
Cyperaceae	*Carex laxifolia* Lam.	2	X	X							N		
Geraniaceae	*Geranium maculatum* L.	3		X	X	X					N		
Liliaceae	*Hemerocallis fulva* (L.) L.	7			X	X	X				NN-IV		
Onagraceae	*Circaea lutetiana* L.	9			X	X	X				N		
Polygonaceae	*Polygonum virginianum* L.	8			X	X	X				N		
Rosaceae	*Geum canadense* Jacq.	4		X	X						N		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	12			X	X	X				N		
Quadrat 32												82° E 172 S°	54
Asteraceae	*Aster divaricatus* L.	14					X	X	X		N		
Asteraceae	*Eupatorium rugosum* Houttuyn.	7				X	X	X	X		N		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	6	X	X	X						NN-IV		
Geraniaceae	*Geranium maculatum* L.	1		X	X						N		
Liliaceae	*Polygonatum biflorum* (Walt.) Elliott	7		X	X						N		
Liliaceae	*Smilacina racemosa* (L.) Desf.	2		X	X						N		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	17			X	X					N		

Table 3.28 Herbaceous taxa in 8 2 X 2 m^2 quadrats for the Ridge Tops (east and west) Forest (n=498).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 42												64° ENE 154° SSE	57
Asteraceae	*Arctium minus* Schk.	2			X	X					NN-IV		
Asteraceae	*Artemisia vulgaris* L.	8					X	X	X		NN-IV		
Asteraceae	*Aster novae-angliae* L.	3					X	X	X		N		
Asteraceae	*Erigeron philadelphicus* L.	1			X	X					N		
Asteraceae	*Solidago canadensis* L.	5					X	X	X		N		
Asteraceae	*Tragopogon pratensis* L.	2		X	X	X					NN		
Asteraceae	*Vernonia novaboracensis* (L.) Michx.	4					X	X			N		
Caprifoliaceae	*Lonicera japonica* Thunb.	4				X	X				NN-IV		
Caryophyllaceae	*Silene vulgaris* (Moench.) Garke.	6			X	X	X				NN-IV		
Commelinaceae	*Commelina communis* L.	5		X	X	X	X				NN-IV		
Fabaceae	*Apios americana* Medikus.	3				X	X				N		
Poaceae	*Arrhenatherum elatius* (L.) J. & C. Presl.	2			X	X					NN-IV		
Poaceae	*Panicum virgatum* L.	7					X	X			N		
Rosaceae	*Rubus phoenicolasius* Maxim.	3			X	X					NN-IV		
Verbenaceae	*Verbena hastata* L.	2				X	X	X			N		

Table 3.28 Herbaceous taxa in 8 2 X 2 m^2 quadrats for the Ridge Tops (east and west) Forest in Inwood Hill Park (n=498).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 44												154° SSE 244° WSW	53
Asteraceae	*Aster divaricatus* L.	17					X	X	X	X	N		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	9	X	X	X						NN-IV		
Caprifoliaceae	*Lonicera japonica* Thunb.	4		X	X	X					NN-IV		
Liliaceae	*Convallaria majalis* L.	19		X							NN		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	4			X	X	X				N		
Quadrat 45												334° NW 64° NE	55
Asteraceae	*Aster divaricatus* L.	13					X	X	X		N		
Asteraceae	*Hieracium paniculatum* L.	4				X	X				N		
Asteraceae	*Solidago bicolor* L.	7					X	X	X	X	N		
Cyperaceae	*Carex pensylvanica var. pensylvanica* Lam.	1	X	X	X						N		
Fabaceae	*Desmodium paniculatum* (L.) DC.	6					X	X			N		
Liliaceae	*Smilacina racemosa* (L.) Desf.	17		X	X						N		
Poaceae	*Poa pratensis* L.	7			X	X	X				NN		

Table 3.29 Herbaceous taxa in 18 2 X 2 m^2 quadrats for the West Ridge/Slopes Forest in Inwood Hill Park (n=1245).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 23												30° NNE 120° ESE	
Asteraceae	*Aster divaricatus* L.	18					X	X	X	X	N		50
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	11	X	X	X						NN-IV		
Liliaceae	*Polygonatum biflorum* (Walt.) Elliott	7		X	X						N		
Liliaceae	*Smilacina racemosa* (L.) Desf.	5	X	X							N		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	9									N		
Quadrat 24												284° WNW 14° NNE	93
Asteraceae	*Ambrosia trifida* L.	4				X	X	X			NN-IV		
Asteraceae	*Aster divaricatus* L.	17					X	X	X	X	N		
Asteraceae	*Eupatorium rugosum* Houttuyn.	5				X	X	X			N		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	12	X	X	X						NN-IV		
Caprifoliaceae	*Lonicera japonica* Thunb.	8		X	X	X					NN-IV		
Commelinaceae	*Commelina communis* L.	5		X	X	X	X				NN		
Cyperaceae	*Carex laxifolia* Lam.	1	X	X	X						N		
Liliaceae	*Hemerocallis fulva* (L.) L.	9			X	X	X				NN-IV		
Poaceae	*Poa pratensis* L.	3			X	X	X				NN		
Polygonaceae	*Polygonum virginianum* L.	10			X	X	X				N		
Rosaceae	*Geum canadense* Jacq.	3		X	X						N		
Rosaceae	*Rubus flagellaris* Willd.	4		X	X						N		
Rubiaceae	*Galium aparine* L.	6		X	X						NN		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	6			X	X					N		

Table 3.29 Herbaceous taxa in 18 2 X 2 m^2 quadrats for the West Ridge/Slopes Forest in Inwood Hill Park (n=1245).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 25												132° SE 222° SW	83
Araliaceae	*Hedera helix* L.	9						*nb	nb	nb	NN-IV		
Asteraceae	*Ambrosia trifida* L.	3					X	X	X		NN-IV		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	8	X	X	X						NN-IV		
Brassicaceae	*Hesperis matronalis* L.	10		X	X						NN		
Caprifoliaceae	*Lonicera japonica* Thunb.	7				X	X	X			NN-IV		
Lamiaceae	*Leonurus cardiaca* L.	14			X	X	X				NN		
Menispermaceae	*Menispermum canadense* L.	2			X	X					N		
Onagraceae	*Oenothera biennis* L.	2				X	X	X			N		
Oxalidaceae	*Oxalis stricta* L.	3					X	X			N		
Phytolaccaceae	*Phytolacca americana* L.	3				X	X	X			N		
Polygonaceae	*Polygonum cespitosum* Blume	6			X	X	X	X			NN		
Rubiaceae	*Galium aparine* L.	13		X	X						NN		
Violaceae	*Viola sororia* L.	3		X	X	X					N		
Quadrat 26												252° WSW 342° NNW	63
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	17	X	X	X						NN-IV		
Caprifoliaceae	*Lonicera japonica* Thunb.	9				X	X	X			NN-IV		
Lamiaceae	*Leonurus cardiaca* L.	12			X	X	X				NN		
Phytolaccaceae	*Phytolacca americana* L.	3				X	X	X			N		
Rosaceae	*Rubus phoenicolasius* Maxim	5			X	X					NN-IV		
Rubiaceae	*Galium aparine* L.	14		X	X						NN		
Violaceae	*Viola sororia* L.	3		X	X	X					N		

*not blooming

Table 3.29 Herbaceous taxa in 18 2 X 2 m^2 quadrats for the West Ridge/Slopes Forest in Inwood Hill Park (n=1245).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 28												144° SE 234° SW	69
Asteraceae	*Aster divaricatus* L.	16					X	X	X	X	N		
Asteraceae	*Eupatorium rugosum* Houttuyn.	3				X	X	X	X		N		
Asteraceae	*Solidago bicolor* L.	5					X	X	X		N		
Asteraceae	*Solidago caesia* L.	9					X	X	X		N		
Asteraceae	*Solidago juncea* Aiton	6					X	X	X		N		
Fabaceae	*Desmodium paniculatum* (L.) DC.	4				X	X				N		
Geraniaceae	*Geranium robertianum* L.	8		X	X	X	X	X			NN		
Liliaceae	*Smilacina racemosa* (L.) Desf.	2		X	X						N		
Rosaceae	*Rubus flagellaris* (Willd.)	5		X	X						N		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	11		X	X	X					N		
Quadrat 29												130° SE 220° SW	66
Asteraceae	*Aster divaricatus* L.	26					X	X	X	X	N		
Asteraceae	*Aster cordifolius* L.	5					X	X	X		N		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	13	X	X	X						NN-IV		
Liliaceae	*Smilacina racemosa* (L.) Desf.	7		X	X						N		
Violaceae	*Viola sororia* L.	6		X	X	X					N		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	9		X	X	X					N		

Table 3.29 Herbaceous taxa in 18 2 X 2 m^2 quadrats for the West Ridge/Slopes Forest in Inwood Hill Park (n=1245).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 30												324° NW 44° NE	68
Asteraceae	*Aster divaricatus* L.	7					X	X	X	X	N		
Asteraceae	*Bidens bipinnata* L.	1				X	X	X			N		
Asteraceae	*Helianthus divaricatus* L.	8					X	X	X		N		
Asteraceae	*Solidago caesia* L.	17					X	X	X	X	N		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	6	X	X	X						NN-IV		
Commelinaceae	*Commelina communis* L.	5		X	X	X	X				NN		
Liliaceae	*Hemerocallis fulva* (L.) L.	11			X	X	X				NN-IV		
Onagraceae	*Circaea lutetiana* L.	4			X	X	X				N		
Rosaceae	*Rubus flagellaris* Willd.	4		X	X						N		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	5		X	X	X					N		
Quadrat 31												42° NE 132° SE	80
Asteraceae	*Aster divaricatus* L.	18					X	X	X	X	N		
Asteraceae	*Eupatorium rugosum* Houttuyn.	13				X	X	X	X		N		
Asteraceae	*Hieracium venosum* L.	3		X	X	X					N		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	8	X	X	X						NN-IV		
Brassicaceae	*Cardamine concatenata* (Michx.) O. Schwartz	6	X	X							N		
Cuscutaceae	*Cuscuta gronovii var. gronovii* Willd.	4				X	X	X			N		
Liliaceae	*Smilacina racemosa* (L.) Desf.	2		X	X						N		
Orchidaceae	*Epipactis helleborine* (L.) Cranz.	1				X	X				NN		
Polygonaceae	*Polygonum virginianum* L.	3			X	X	X				N		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	22			X	X	X				N		

Table 3.29 Herbaceous taxa in 18 2 X 2 m^2 quadrats for the West Ridge/Slopes Forest in Inwood Hill Park (n=1245).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 33												40° NE 130° SE	83
Asteraceae	*Aster divaricatus* L.	19					X	X	X		N		
Asteraceae	*Eupatorium rugosum* Houttuyn.	2					X	X	X		N		
Asteraceae	*Eupatorium purpureum* L.	3				X	X	X			N		
Asteraceae	*Hieracium paniculatum* L.	4				X	X	X			N		
Asteraceae	*Solidago bicolor* L.	7					X	X	X		N		
Asteraceae	*Solidago caesia* L.	9					X	X	X		N		
Asteraceae	*Solidago juncea* Aiton	5					X	X	X		N		
Cyperaceae	*Carex pensylvanica var. pensylvanica* Lam.	3	X	X	X						N		
Fabaceae	*Desmodium paniculatum* (L.) DC.	2				X	X				N		
Juncaceae	*Juncus tenuis* Willd.	10			X	X	X				N		
Liliaceae	*Polygonatum biflorum* (Walt.) Elliott	2		X	X						N		
Liliaceae	*Smilacina racemosa* (L.) Desf.	3		X	X						N		
Poaceae	*Deschampsia flexuosa var. flexuosa* (L.) Trin.	3				X	X				NN		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	11			X	X					N		

Table 3.29 Herbaceous taxa in 18 2 X 2 m^2 quadrats for the West Ridge/Slopes Forest in Inwood Hill Park (n=1245).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 34												18° NNE 108° ESE	54
Asteraceae	*Aster divaricatus* L.	24					X	X	X		N		
Asteraceae	*Eupatorium purpureum* L.	5					X	X	X		N		
Asteraceae	*Solidago bicolor* L.	2					X	X	X		N		
Cyperaceae	*Carex laxifolia* Lam.	4	X	X	X						N		
Fabaceae	*Desmodium paniculatum* (L.) DC.	5					X	X			N		
Liliaceae	*Polygonatum biflorum* (Walt.) Elliott	10		X	X						N		
Liliaceae	*Smilacina racemosa* (L.) Desf.	2		X	X						N		
Orchidaceae	*Epipactis helleborine* (L.) Cranz.	1				X	X				NN		
Smilaceae	*Smilax rotundifolia* L.	1		X	X						N		
Quadrat 35												288° WNW 18° NNE	55
Asteraceae	*Aster divaricatus* L.	19					X	X	X	X	N		
Cyperaceae	*Carex laxifolia* Lam.	4	X	X	X						N		
Cyperaceae	*Carex vulpinoidea* Michx.	4			X	X	X				N		
Liliaceae	*Hemerocallis fulva* (L.) L.	16			X	X	X				NN-IV		
Liliaceae	*Smilacina racemosa* (L.) Desf.	2		X	X						N		
Rosaceae	*Rubus hispidus* L.	1			X	X	X				N		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	9			X	X					N		

Table 3.29 Herbaceous taxa in 18 2 X 2 m^2 quadrats for the West Ridge/Slopes Forest in Inwood Hill Park (n=1245).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 36												286° WNW 16° NNE	57
Asteraceae	*Artemisia vulgaris* L.	27				X	X	X			NN-IV		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	11	X	X	X						NN-IV		
Caprifoliaceae	*Lonicera japonica* Thunb.	19									NN-IV		
Quadrat 37												118° ESE 208° SSW	75
Asclepiadaceae	*Vincetoxicum nigrum* (L.) Moench.	4			X	X	X				NN-IV		
Asteraceae	*Aster divaricatus* L.	22					X	X	X		N		
Asteraceae	*Erigeron annuus* (L.) Pers.	3			X	X	X				N		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	10	X	X	X						NN-IV		
Caprifoliaceae	*Lonicera japonica* Thunb.	9		X	X	X					NN-IV		
Commelinaceae	*Commelina communis* L.	6		X	X	X	X				NN		
Onagraceae	*Circaea lutetiana* L.	6			X	X	X				N		
Polygonaceae	*Polygonum virginianum* L.	4			X	X	X				N		
Rosaceae	*Rubus flagellaris* Willd.	2		X	X						N		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	9			X	X					N		

Table 3.29 Herbaceous taxa in 18 2 X 2 m^2 quadrats for the West Ridge/Slopes Forest in Inwood Hill Park (n=1245).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 38												26° NNE 116° ESE	86
Asteraceae	*Artemisia vulgaris* L.	8					X	X	X		NN-IV		
Asteraceae	*Aster divaricatus* L.	9				X	X	X	X		N		
Asteraceae	*Erigeron annuus* (L.) Pers.	2			X	X	X				N		
Asteraceae	*Solidago juncea* Aiton	5				X	X	X	X		N		
Balsaminaceae	*Impatiens capensis* Meerb.	9		X	X	X	X				N		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	13		X	X	X					NN-IV		
Caprifoliaceae	*Lonicera japonica* Thunb.	11		X	X	X					NN-IV		
Lamiaceae	*Prunella vulgaris* L.	4			X	X	X	X			NN		
Onagraceae	*Circaea lutetiana* L.	6			X	X	X				N		
Rosaceae	*Rubus phoenicolasius* Maxim.	5			X	X					NN-IV		
Urticaceae	*Bòehmeria cylindrica* (L.) Sw.	1				X	X	X			N		
Urticaceae	*Pilea pumila var. pumila* (L.) A. Gray	3				X	X				N		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	10				X	X				N		

Table 3.29 Herbaceous taxa in18 2 X 2 m^2 quadrats for the West Ridge/Slopes Forest in Inwood Hill Park (n=1245).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 39												192° SSW 282° WNW	66
Asteraceae	*Artemisia vulgaris* L.	13					X	X	X		NN-IV		
Asteraceae	*Eupatorium purpureum* L.	3					X	X			N		
Asteraceae	*Helianthus divaricatus* L.	11				X	X	X			N		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	9	X	X	X						NN-IV		
Liliaceae	*Allium vineale* L.	3			X	X					NN		
Phytolaccaceae	*Phytolacca americana* L.	4				X	X	X			N		
Polygonaceae	*Polygonum cespitosum* Blume	7			X	X	X	X			NN		
Polygonaceae	*Rumex crispus* L.	4			X	X					NN		
Rubiaceae	*Galium aparine* L.	12		X	X						N		
Quadrat 40												324° NW 54° NE	68
Apocynaceae	*Vinca minor* L.	32		X	X						NN-IV		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	12	X	X	X						NN-IV		
Caprifoliaceae	*Lonicera japonica* Thunb.	7		X	X	X					NN-IV		
Rubiaceae	*Galium aparine* L.	8		X	X						NN		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	9				X	X				N		

Table 3.29 Herbaceous taxa in 18 2 X 2 m^2 quadrats for the West Ridge/Slopes Forest in Inwood Hill Park (n=1245).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 41												140° SE 230° SW	67
Apocynaceae	*Vinca minor* L.	27		X	X						NN-IV		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	13	X	X	X						NN-IV		
Caprifoliaceae	*Lonicera japonica* Thunb.	14		X	X	X					NN-IV		
Commelinaceae	*Commelina communis* L.	6		X	X	X	X				NN		
Liliaceae	*Allium vineale* L.	3			X	X					NN		
Rosaceae	*Rubus phoenicolasius* Maxim.	4			X	X					NN-IV		
Quadrat 43												125° SE 215° SW	62
Balsaminaceae	*Impatiens capensis* Meerb.	8		X	X	X	X				N		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	11	X	X	X						NN-IV		
Liliaceae	*Allium canadense* L.	6		X	X						N		
Rosaceae	*Geum canadense* Jacq.	3		X	X						N		
Onagraceae	*Circaea lutetiana* L.	22			X	X	X				N		
Violaceae	*Viola sororia* L.	3		X	X	X					N		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	9			X	X					N		

Table 3.30 Herbaceous native (n=65), nonnative (n=19), invasive (n=13) species in 45 m^2 quadrats in Inwood Hill Park (n=2842).

Genus	Species	Family	Common Name	N	NN	NN-IV	TOTAL
1. *Aegopodium*	*podagraria* L.	Apiaceae	Goutweed			NN-IV	29
2. *Alliaria*	*petiolata* (Bieb.) Cavara & Grande	Brassicaceae	Garlic Mustard			NN-IV	341
3. *Allium*	*canadense* L.	Liliaceae	Wild Garlic	N			6
	vineale L.	Liliaceae	Field Garlic		NN		20
4. *Ambrosia*	*artemisifolia* L.	Asteraceae	Common Ragweed			NN-IV	14
	trifida L.	Asteraceae	Great Ragweed			NN-IV	7
5. *Apios*	*americana* Medikus.	Fabaceae	Groundnut	N			3
6. *Arctium*	*minus* Schk.	Asteraceae	Common Burdock			NN-IV	2
7. *Arisaema*	*triphyllum* (L.) Schott	Araceae	Jack-in-the-Pulpit	N			4
8. *Arrhenatherum*	*elatius* (L.) J. & C. Presl.	Poaceae	Tall Oats Grass			NN-IV	2
9. *Artemisia*	*vulgaris* L.	Asteraceae	Mugwort			NN-IV	56
10. *Aster*	*cordifolius* L.	Asteraceae	Heart-leaved Aster	N			25
	divaricatus L.	Asteraceae	White Wood Aster	N			407
	novae-angliae L.	Asteraceae	New England Aster	N			3
11. *Bidens*	*bipinnata* L.	Asteraceae	Spanish Needles	N			1
12. *Boehmeria*	*cylindrica* (L.) Sw.	Urticaceae	False Nettle	N			1
13. *Cardamine*	*concatenata* (Michx.) O. Schwartz	Brassicaceae	Cut-leaved Toothwort	N			6
14. *Carex*	*laxifolia* Lam.	Cyperaceae	Loosely-flowered Sedge	N			17
	pensylvanica Lam.	Cyperaceae	Pennsylvania Sedge	N			4
	vulpinoidea Michx.	Cyperaceae	Fox Carex	N			5
15. *Chimaphila*	*maculata* (L.) Pursh.	Pyrolaceae	Spotted Wintergreen	N			11
16. *Circaea*	*lutetiana* L.	Onagraceae	Enchanter's Nightshade	N			119
17 *Claytonia*	*virginica* L.	Portulacaceae	Spring Beauty	N			6
18. *Commelina*	*communis* L.	Commelinaceae	Asiatic Dayflower		NN		30
19. *Convallaria*	*majalis* L.	Liliaceae	Lily of the Valley		NN		19

Table 3.30 Herbaceous native (n=65), nonnative (n=19), invasive (n=13) species in 45 m^2 quadrats in Inwood Hill Park (n=2842).

Genus	Species	Family	Common Name	N	NN	NN-IV	TOTAL
20. *Cuscuta*	*gronovii* Willd.	Cuscutaceae	Dodder	N			4
21. *Dactylis*	*glomerata* L.	Poaceae	Orchard Grass		NN		15
22. *Danthonia*	*spicata* (L.) F. Beauv.	Poaceae	Poverty Grass	N			48
23. *Deschampsia*	*flexuosa* (L.) Trin.	Poaceae	Hair Grass		NN		3
24. *Desmodium*	*paniculatum* (L.) DC.	Fabaceae	Panicled Tick Trefoil	N			17
25. *Dicentra*	*cucullaria* (L.) Bernh.	Fumariaceae	Dutchman's Breeches	N			38
26. *Epipactis*	*helleborine* (L.) Cranz.	Orchidaceae	Helleborine		NN		2
27. *Erigeron*	*annuus* (L.) Pers.	Asteraceae	Annual Fleabane	N			5
	philadelphicus L.	Asteraceae	Philadelphia Daisy	N			2
28. *Eupatorium*	*purpureum* L.	Asteraceae	Sweet-scented joe-pye weed	N			14
	rugosum Houttuyn.	Asteraceae	White Snakeroot	N			57
29. *Festuca*	*ovata* L.	Poaceae	Sheep Fescue		NN		4
30. *Galium*	*aparine* L.	Rubiaceae	Cleavers	N			53
31. *Geranium*	*maculatum* L.	Geraniaceae	Wild Geranium	N			4
	robertianum L.	Geraniaceae	Herb Robert		NN		8
32. *Geum*	*canadense* Jacq.	Rosaceae	White Avens	N			17
33. *Hedera*	*helix* L.	Araliaceae	English Ivy			NN-IV	9
34. *Helianthus*	*divaricatus* L.	Asteraceae	Woodland Sunflower	N			31
35. *Hemerocallis*	*fulva* (L.) L.	Liliaceae	Day Lilly			NN-IV	43
36. *Hesperus*	*matronalis* L.	Brassicaceae	Dame's Rocket		NN		10
37. *Hieracium*	*venosum* L.	Asteraceae	Rattlesnake Weed	N			3
	paniculatum L.	Asteraceae	Panicled Hawkweed	N			8
38. *Impatiens*	*capensis* Meerb.	Balsaminaceae	Jewelweed	N			125
39. *Juncus*	*tenuis* Willd.	Juncaceae	Path Rush	N			33

Table 3.30 Herbaceous native (n=65), nonnative (n=19), invasive (n=13) species in 45 m^2 quadrats in Inwood Hill Park (n=2842).

Genus	Species	Family	Common Name	N	NN	NN-IV	TOTAL
40. *Leonurus*	*cardiaca* L.	Lamiaceae	Motherwort		NN		26
41. *Lonicera*	*japonica* Thunb.	Caprifoliaceae	Japanese Honeysuckle			NN-IV	112
42. *Luzula*	*multiflora* (Retz.) Lejune	Juncaceae	Wood Rush	N			13
43. *Maianthemum*	*canadense* Desf.	Liliaceae	Canada Mayflower	N			59
44. *Menispermum*	*canadense* L.	Menispermaceae	Moonseed	N			2
45. *Monotropa*	*uniflora* L.	Monotropaceae	Indian Pipe	N			29
46. *Oenothera*	*biennis* L.	Onagraceae	Evening Primrose	N			2
47. *Orobanche*	*uniflora* L.	Orobanchaceae	One-flowered Cancerroot	N			1
48. *Oxalis*	*stricta* L.	Oxalidaceae	Yellow Wood Sorrel		NN		15
49. *Pachysandra*	*terminalis* Sieb. & Zucc.	Buxaceae	Pachysandra		NN		9
50. *Panicum*	*virgatum* L.	Poaceae	Switch Grass	N			7
51. *Parthenocissus*	*quinquefolia* (L.) Planch.	Vitaceae	Virginia Creeper	N			189
52. *Phytolacca*	*americana* L.	Phytolaccaceae	Pokeweed	N			10
53. *Pilea*	*pumila* (L.) A. Gray	Urticaceae	Clearweed	N			5
54. *Plantago*	*lanceolata* L.	Plantaginaceae	English Plantain		NN		5
	major L.	Plantaginaceae	Common Plantain		NN		7
55. *Poa*	*annua* L.	Poaceae	Low Speargrass	N			3
	pratensis L.	Poaceae	Kentucky Blue Grass		NN		10
56. *Podophyllum*	*peltatum* L.	Berberidaceae	Mayapple	N			6
57. *Polygonatum*	*biflorum* (Walt.) Elliott	Liliaceae	Solomon's Seal	N			44
58. *Polygonum*	*cespitosum* Blume	Polygonaceae	Smartweed		NN		37
	virginianum L.	Polygonaceae	Jumpseed	N			99
59. *Prunella*	*vulgaris* L.	Lamiaceae	Self-Heal		NN		4

Table 3.30 Herbaceous native (n=65), nonnative (n=19), invasive (n=13) species in 45 m^2 quadrats in Inwood Hill Park (n=2842).

Genus	Species	Family	Common Name	N	NN	NN-IV	TOTAL
60. *Rubus*	*flagellaris* Willd.	Rosaceae	Dewberry	N			33
	hispidus L.	Rosaceae	Swamp Dewberry	N			1
	phoenicolasius Maxim.	Rosaceae	Wineberry			NN-IV	20
61. *Rumex*	*crispus* L.	Polygonaceae	Curled Dock		NN		4
62. *Sanguinaria*	*canadensis* L.	Papaveraceae	Blood Root	N			12
63. *Schizachyrium*	*scoparium* (Michx.) Nash	Poaceae	Little Bluestem Grass	N			11
64. *Silene*	*vulgaris* (Moench.) Garke.	Caryophyllaceae	Common Bladderwort			NN-IV	6
65. *Sisyrinchium*	*angustifolium* Miller	Iridaceae	Blue-eyed Grass	N			3
66. *Smilacina*	*racemosa* (L.) Desf.	Liliaceae	False Solomon's Seal	N			94
67. *Smilax*	*rotundifolia* L.	Smilacaceae	Catbriar	N			4
68. *Solidago*	*bicolor* L.	Asteraceae	Silverrod	N			24
	caesia L.	Asteraceae	Blue-Stem Goldenrod	N			58
	canadensis L.	Asteraceae	Canada Goldenrod	N			5
	juncea Aiton	Asteraceae	Early Goldenrod	N			50
69. *Tragopogon*	*pratensis* L.	Asteraceae	Goat's Beard	N			2
70. *Trillium*	*cernuum* L.	Liliaceae	Nodding Trillium	N			3
71. *Uvularia*	*perfoliata* L.	Liliaceae	Bellwort	N			2
72. *Verbena*	*hastata* L.	Verbenaceae	Blue Vervain	N			2
	urticifolia L.	Verbenaceae	White Vervain	N			5
73. *Vernonia*	*novaboracensis* (L.) Michx.	Asteraceae	Ironweed	N			4
74. *Vinca*	*minor* L.	Apocynaceae	Periwinkle		NN		59
75. *Vincetoxicum*	*nigrum* (L.) Moench.	Asclepiadaceae	Black Swallow-wort			NN-IV	4
76. *Viola*	*rotundifolia* L.	Violaceae	Round-leaved Violet	N			6
	sororia L.	Violaceae	Common Blue Violet	N			45
TOTAL	96	41		65	19	13	2842

Table 3.31 Inwood Hill Park Salt Marsh Community of Plants in 5 2 X 4 m^2 Quadrats 46-50: 58 Genera, 64 Species, 27 Families.

Genera	Species	Family	Common Name	H-S-T-V	N-NN-IV
1. *Acer*	*negundo* L.	Aceraceae	Box Elder	T	N
2. *Acnida*	*cannabina* (L.) Sauer	Amaranthaceae	Salt-marsh Water Hemp	H	N
3. *Alliaria*	*petiolata* (Bieb.) Cavara & Grande	Brassicaceae	Garlic Mustard	H	NN-IV
4. *Amaranthus*	*retroflexus* L.	Amaranthaceae	Rough Pigweed	H	N
5. *Amorpha*	*fruticosa* L.	Fabaceae	False Indigo	S	NN
6. *Arctium*	*minus* Schk.	Asteraceae	Common Burdock	H	NN
7. *Artemisia*	*vulgaris* L.	Asteraceae	Mugwort	H	NN-IV
8. *Asclepias*	*syriaca* L.	Asclepidaceae	Milkweed	H	N
9. *Aster*	*tenuifolius* L.	Asteraceae	Salt-marsh Aster	H	N
10. *Atriplex*	*patula* L.	Chenopodiaceae	Orach	H	NN
11. *Baccharis*	*halimifolia* L.	Asteraceae	Groundsel tree	S	N
12. *Calystegia*	*sepium* (L.) R. Br.	Convovulaceae	Hedge bindweed	V	N-IV
13. *Capsella*	*bursa-pastoris* (L.) Medikus	Brassicaceae	Shepherd's Purse	H	NN
14. *Carex*	*vulpinoidea* Michx.	Cyperaceae	Fox Carex	H	N
15. *Celastrus*	*orbiculatus* Thunb.	Celastraceae	Oriental Bittersweet	V	NN-IV
16. *Centaurea*	*maculosa* Lam.	Asteraceae	Spotted Knapweed	H	NN-IV
17. *Chenopodium*	*album* L.	Chenopodiaceae	Lamb's Quarters	H	NN
18. *Cichorium*	*intybus* L.	Asteraceae	Chickory	H	NN
19. *Clematis*	*virginiana* L.	Ranunculaceae	Virgin's Bower	V	N
20. *Commelina*	*communis* L.	Commelinaceae	Asiatic Dayflower	H	NN
21. *Cyperus*	*strigosus* L.	Cyperaceae	Umbrella Sedge	H	N
22. *Dactylis*	*glomerata* L.	Poaceae	Orchard Grass	H	NN

Table 3.31 Inwood Hill Park Salt Marsh Community of Plants in 5 2 X 4 m^2 Quadrats 46-50: 58 Genera, 64 Species, 27 Families.

Genera	Species	Family	Common Name	H-S-T-V	N-NN-IV
23. *Digitaria*	*sanguinalis* (L.) Scop.	Poaceae	Crab Grass	H	NN
24. *Eleusine*	*indica* (L.) Gaertn.	Poaceae	Goose Grass	H	NN
25. *Elymus*	*virginicus* L.	Poaceae	Wild Rye	H	NN
26. *Erigeron*	*annuus* L.	Asteraceae	Daisy Fleabane	H	N
27. *Galinsoga*	*ciliata* Ruiz & Pavon	Asteraceae	Gallant Soldier	H	NN
28. *Galium*	*aparine* L.	Rubiaceae	Cleavers	H	N
29. *Hibiscus*	*moscheutos* L.	Malvaceae	Rose-Mallow	S	N
30. *Iva*	*frutescens* L.	Asteraceae	Marsh Elder	S	N
31. *Lamium*	*purpureum* L.	Lamiaceae	Dead purple nettle	H	NN
32. *Lolium*	*perenne* L.	Poaceae	English Rye Grass	H	NN
33. *Lonicera*	*japonica* Thunb.	Caprifoliaceae	Japanese Honeysuckle	V	NN-IV
34. *Malva*	*neglecta* Wallr.	Malvaceae	Common Mallow	H	NN-IV
35. *Matricaria*	*matricarioides* (Less.) Porter	Asteraceae	Pineapple Weed	H	N
36. *Mellilotus*	*alba* Medikus	Fabaceae	White Sweet Clover	H	NN
Mellilotus	*officinale* (L.) Pallas	Fabaceae	Yellow Sweet Clover	H	NN
37. *Oenothera*	*biennis* L.	Onagraceae	Evening Primrose	H	N
38. *Oxalis*	*stricta* L.	Oxalidaceae	Yellow Wood Sorrel	H	NN
39. *Parthenocissus*	*quinquefolia* (L.) Planch.	Vitaceae	Virginia Creeper	V	N
40. *Plantago*	*lanceolata* L.	Plantaginaceae	English Plantain	H	NN
Plantago	*major* L.	Plantaginaceae	Common Plantain	H	NN
41. *Poa*	*annua* L.	Poaceae	Low Speargrass	H	N
42. *Rosa*	*multiflora* Thunb.	Rosaceae	Multiflora Rose	S	NN-IV

Table 3.31 Inwood Hill Park Salt Marsh Community of Plants in 5 2 X 4 m^2 Quadrats 46-50: 58 Genera, 64 Species, 27 Families.

Genera	Species	Family	Common Name	H-S-T-V	N-NN-IV
43. *Rumex*	*crispus* L.	Polygonaceae	Curled Dock	H	NN
Rumex	*obtusifolius* L.	Polygonaceae	Broad-leaved Dock	H	NN
Rumex	*pallidus* Bigelow	Polygonaceae	Sea-beach Dock	H	N
44. *Saponaria*	*officinalis* L.	Caryophyllaceae	Bouncing Bet	H	NN-IV
45. *Scirpus*	*robustus* Pursh.	Cyperaceae	Saltmarsh Bulrush	H	N
46. *Sedum*	*ternatum* Michx.	Crassulaceae	Wild Stonecrop	H	NN
47. *Senecio*	*vulgaris* L.	Asteraceae	Common Groundsel	H	NN
48. *Setaria*	*glauca* (L.) P. Beauv.	Poaceae	Yellow Foxtail Grass	H	NN
49. *Silene*	*vulgaris* (Moench.) Garke	Caryophyllaceae	Bladder Campion	H	NN-IV
50. *Solanum*	*dulcamara* L.	Solanaceae	Purple Nightshade	H	NN
51. *Solidago*	*sempervirens* L.	Asteraceae	Seaside Goldenrod	H	N
52. *Sonchus*	*oleraceus* L.	Asteraceae	Sow Thistle	H	NN
53. *Spartina*	*cynosuroides* (L.) Roth	Poaceae	Salt Reed Grass	H	N
54. *Stellaria*	*media* (L.) Villars	Caryophyllaceae	Chickweed	H	NN
55. *Taraxacum*	*officinale* Weber	Asteraceae	Dandelion	H	NN-IV
56. *Trifolium*	*pratense* L.	Fabaceae	Red Clover	H	NN
Trifolium	*repens* L.	Fabaceae	White Clover	H	NN
57. *Viola*	*sororia* L.	Violaceae	Common Blue Violet	H	N
58. *Vitis*	*labrusca*	Vitaceae	Fox Grape	V	N
Vitis	*riparia*	Vitaceae	River Grape	V	N
TOTAL	64	27			

Table 3.32 Inwood Hill Park Salt Marsh Community of Plants: 2 X 4 m^2 quadrat 46 (n=114).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 46												278° W 8° N	114
Asteraceae	*Artemisia vulgaris* L.	7			X	X	X	X	X		NN-IV		
Asteraceae	*Cichorium intybus* L.	2			X	X	X	X			NN		
Asteraceae	*Galinsoga ciliata* Ruiz & Pavon	3			X	X	X				NN		
Asteraceae	*Iva frutescens* L.	3					X	X	X		N		
Asteraceae	*Matricaria matricarioides* (Less.) Porter	6		X	X	X	X	X			N		
Asteraceae	*Senecio vulgaris* L.	3	X	X	X	X					NN		
Asteraceae	*Solidago sempervirens* L.	5					X	X	X	X	N		
Asteraceae	*Sonchus oleraceus* L.	2		X	X	X	X				NN		
Asteraceae	*Taraxacum officinale* Weber.	6	X	X	X	X	X				NN-IV		
Brassicaceae	*Capsella bursa-pastoris* (L.) Medikus.	3		X	X	X					NN		
Caryophyllaceae	*Stellaria media* (L.) Villars.	4		X	X	X					NN		
Chenopodiaceae	*Chenopodium album* L.	6					X	X	X	X	NN		
Commelinaceae	*Commelina communis* L.	2			X	X	X	X			NN		
Fabaceae	*Mellilotus alba* Medikus.	4			X	X	X				NN		
Fabaceae	*Mellilotus officinale* (L.) Pallas.	1			X	X	X				NN		
Fabaceae	*Trifolium pratense* L.	7		X	X	X	X	X	X		NN		
Fabaceae	*Trifolium repens* L.	4		X	X	X	X	X	X		NN		
Malvaceae	*Malva neglecta* Wallr.	3			X	X	X	X			NN-IV		
Plantaginaceae	*Plantago lanceolata* L.	2		X	X	X					NN		
Plantaginaceae	*Plantago major* L.	6			X	X	X	X			NN		

Table 3.32 Inwood Hill Park Salt Marsh Community of Plants: 2 X 4 m^2 quadrat 46 (n=114).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 46												278° W 8° N	
Poaceae	*Dactylis glomerata* L.	7			X	X	X				NN		
Poaceae	*Digitaria sanguinalis* (L.) Scop.	1			X	X	X	X			NN		
Poaceae	*Eleusine indica* (L.) Gaertn.	2				X	X	X			NN		
Poaceae	*Elymus virginicus* L.	1			X	X	X	X			NN		
Poaceae	*Lolium perenne* L.	2		X	X	X	X				NN		
Poaceae	*Poa annua* L.	9			X	X					N		
Poaceae	*Spartina cynosuroides* (L.) Roth.	4					X	X	X		N		
Polygonaceae	*Rumex crispus* L.	4			X	X	X				NN		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planchon.	5			X	X					N		
		114											

Table 3.32 Inwood Hill Park Salt Marsh Community of Plants: 2 X 4 m^2 quadrat 47 (n=117).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 47												202° SSW 292° WNW	117
Asteraceae	*Artemisia vulgaris* L.	6				X	X	X	X		NN-IV		
Asteraceae	*Centaurea maculosa* Lam.	2			X	X	X	X			NN-IV		
Asteraceae	*Galinsoga ciliata* Ruiz & Pavon	4			X	X	X	X			N		
Asteraceae	*Iva frutescens* L.	3						X	X	X	N		
Asteraceae	*Matricaria matricarioides* (Less.) Porter	6		X	X	X	X				N		
Asteraceae	*Solidago sempervirens* L.	5						X	X	X	N		
Asteraceae	*Taraxacum officinale* Weber	7	X	X	X	X	X				NN-IV		
Brassicaceae	*Capsella bursa-pastoris* (L.) Medikus	4		X	X	X					NN		
Caryophyllaceae	*Stellaria media* (L.) Villars	9		X	X	X					NN		
Celastraceae	*Celastrus orbiculatus* Thunb.	6		X	X						NN-IV		
Crassulaceae	*Sedum ternatum* Michx.	4		X	X						NN		
Cyperaceae	*Carex vulpinoidea* Michx.	2			X	X	X				N		
Fabaceae	*Trifolium pratense* L.	7		X	X	X	X	X	X		NN		
Fabaceae	*Trifolium repens* L.	6		X	X	X	X	X	X		NN		
Oxalidaceae	*Oxalis stricta* L.	2			X	X	X				NN		
Plantaginaceae	*Plantago lanceolata* L.	4		X	X	X					NN		
Plantaginaceae	*Plantango major* L.	8		X	X	X					NN		
Poaceae	*Dactylis glomerata* L.	7		X	X	X	X				NN		
Poaceae	*Eleusine indica* (L.) Gaertn.	3			X	X	X				NN		
Poaceae	*Poa annua* L.	6		X	X	X					N		
Polygonaceae	*Rumex crispus* L.	9			X	X					NN		
Vitaceae	*Parthenocissus quinquefolia* (L.) Pallas	7			X	X					N		
		117											

Table 3.32 Inwood Hill Park Salt Marsh Community of Plants: 2 X 4 m^2 quadrat 48 (n=90).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 48												24° NNE 114° ESE	90
Asclepidaceae	*Asclepias syriaca* L.	2			X	X					N		
Asteraceae	*Aster tenuifolius* L.	1					X	X	X		N		
Asteraceae	*Erigeron annuus* L.	1			X	X					N		
Asteraceae	*Iva frutescens* L.	4						X	X	X	N		
Asteraceae	*Solidago sempervirens* L.	6					X	X	X	X	N		
Asteraceae	*Taraxacum officinale* Weber	5	X	X	X						NN-IV		
Brassicaceae	*Alliaria petiolata* (Bieb.) Cavara & Grande	8		X	X	X					NN-IV		
Caprifoliaceae	*Lonicera japonica* Thunb.	4				X	X	X			NN-IV		
Caryophyllaceae	*Saponaria officinalis* L	4			X	X	X				NN-IV		
Caryophyllaceae	*Silene vulgaris* (Moench.) Garke.	7			X	X	X				NN-IV		
Celastraceae	*Celastrus orbiculatus* Thunb.	5		X	X						NN-IV		
Commelinaceae	*Commelina communis* L.	2			X	X	X	X			NN		
Convovulaceae	*Calystegia sepium* (L.) R. Br.	5			X	X					N-IV		
Cyperaceae	*Cyperus strigosus* L.	1			X	X					N		
Cyperaceae	*Carex vulpinoidea* Michx.	2			X	X	X				N		
Fabaceae	*Amorpha fruticosa* L.	2		X	X						NN		
Fabaceae	*Trifolium pratense* L.	5		X	X	X	X	X			NN		
Fabaceae	*Trifolium repens* L.	3		X	X	X	X	X			NN		

Table 3.32 Inwood Hill Park Salt Marsh Community of Plants: 2 X 4 m^2 quadrat 48 (n=90).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Plantaginaceae	*Plantago major* L.	5		X	X	X					NN		
Poaceae	*Dactylis glomerata* L.	6		X	X	X	X				NN		
Polygonaceae	*Rumex crispus* L.	4			X	X					NN		
Polygonaceae	*Rumex obtusifolius* L.	1			X	X					NN		
Rubiaceae	*Galium aparine* L.	3			X	X					N		
Solanaceae	*Solanum dulcamara* L.	2			X	X	X	X			NN		
Vitaceae	*Vitis labrusca* L.	1			X	X					N		
Vitaceae	*Vitis riparia* L.	1			X	X					N		
		90											

Table 3.32 Inwood Hill Park Salt Marsh Community of Plants: 2 X 4 m^2 quadrat 49 (n=78).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 49												46° NE 136° SE	78
Amaranthaceae	*Acnida cannabina* (L.) Sauer	3						X	X	X	N		
Asteraceae	*Arctium minus* Schk.	1			X	X					NN-IV		
Asteraceae	*Baccharis halimifolia* L.	4						X	X	X	N		
Asteraceae	*Iva frutescens* L.	4						X	X	X	N		
Asteraceae	*Solidago sempervirens* L.	8						X	X	X	N		
Chenopodiaceae	*Atriplex patula* L.	12			X	X					NN		
Convovulaceae	*Calystegia sepium* (L.) R. Br.	3			X	X					N-IV		
Cyperaceae	*Carex strigosus* L.	3			X	X					N		
Cyperaceae	*Scirpus robustus* Pursh.	3				X	X	X			N		
Fabaceae	*Amorpha fruticosa* L.	2		X	X						NN		
Fabaceae	*Trifolium pratense* L.	7			X	X	X	X			NN		
Lamiaceae	*Lamium purpureum* L.	4	X	X	X	X					NN		
Malvaceae	*Hibiscus moscheutos* L.	1					X	X			N		
Onagraceae	*Oenothera biennis* L.	2				X	X	X			N		
Poaceae	*Dactylis glomerata* L.	6			X	X	X				NN		
Poaceae	*Setaria glauca* (L.) P. Beauv.	2			X	X	X				NN		
Poaceae	*Spartina cynosuroides* (L.) Roth	8					X	X	X		N		
Polygonaceae	*Rumex crispus* L.	3			X	X					NN		
Polygonaceae	*Rumex pallidus* Bigelow	1			X	X					N		
Violaceae	*Viola sororia* Willd.	1		X	X	X					N		
		78											

Table 3.32 Inwood Hill Park Salt Marsh Community of Plants: 2 X 4 m^2 quadrat 50 (n=98).

Family	Genus and Species	No	Months of Blooming								N-NN-IV	Location	Total
			A	M	J	J	A	S	O	N			
Quadrat 50												62° ENE 152° SSE	98
Aceraceae	*Acer negundo var. negundo* L.	1	X	X							N		
Amaranthanceae	*Acnida cannabina* (L.) Sauer	2					X	X	X		N		
Amaranthanceae	*Amaranthus retroflexus* L.	6					X	X	X		N		
Asteraceae	*Baccharis halimifolia* L.	4						X	X	X	N		
Asteraceae	*Iva frutescens* L.	5						X	X	X	N		
Asteraceae	*Solidago sempervirens* L.	9						X	X	X	N		
Asteraceae	*Taraxacum officinale* Weber	7	X	X	X	X					NN		
Caryophyllaceae	*Silene vulgaris* (Moench.) Garke.	5			X	X	X				NN		
Celastraceae	*Celastrus orbiculatus* Thunb.	3		X	X						NN-IV		
Chenopodiaceae	*Atriplex patula* L.	7			X	X	X				NN		
Convovulaceae	*Calystegia sepium* (L.) R. Br.	3			X	X					N-IV		
Cyperaceae	*Carex vulpinoidea* Michx.	3			X	X	X				N		
Fabaceae	*Amorpha fruticosa* L.	1		X	X						NN		
Fabaceae	*Trifolium pratense* L	6		X	X	X	X	X			NN		
Fabaceae	*Trifolium repens* L.	7		X	X	X	X	X			NN		
Malvaceae	*Hibiscus moscheutos* L.	2				X	X	X			N		
Poaceae	*Dactylis glomerata* L.	5			X	X	X				NN		
Poaceae	*Spartina cynosuroides* (L.) Roth	6					X	X	X		N		
Polygonaceae	*Rumex crispus* L.	3			X	X					NN		
Polygonaceae	*Rumex obtusifolius* L.	2			X	X					NN		
Ranunculaceae	*Clematis virginiana* L.	6				X	X	X			N		
Rosaceae	*Rosa multiflora* Thunb.	3			X	X	X				NN-IV		
Solanaceae	*Solanum dulcamara* L.	2			X	X	X	X			NN		
		98											

IV. Chapter 4. Discussion

Comparisons with Previous Research in New York City

The 45 quadrats within the forested portion of Inwood Hill Park in northern Manhattan contain an interesting diversity of trees, shrubs, and vines measured from the cut-point ≥ of 2.00 - 171.20 cm DBH. This low cut-point accounted for many trees that would have been excluded had the cut-point been ≥7.00 cm DBH measurement or higher, and closely adheres to the cut-point that was used by Loeb (1984, 1986), Yost et al. (1991), and Glaeser (2004). Seventy-seven species resulted from sampling 4070 stems, and of these, 68 species were identified within the 2 .0 > 7.0 cm DBH range (n=3722). Glaeser (2004) also observed that using the cut-point ≥of 2.00 cm DBH instead of the 7.06 cm DBH used by earlier workers who had documented New York City flora, resulted in identifying 22 species within the DBH range of 2.0 > 7.06 cm alone, which increased the number of tree species by nine.

Of these 77 species found in Inwood Hill Park, 49 were native to the temperate northeast, 10 were nonnative, 17 were nonnative-invasive, and 1 species was considered native-invasive (Table 3.1). Seventeen species were arboreal, twenty-six were shrubs, and seven were vines. Trees, shrubs, and vines were counted as number of stems and not as individual plants to record basal area (BA) occupied by each stem. Herbaceous taxa, found in 2 X 2 m^2 quadrats nested within each of the larger 45 10 X 10 m^2 quadrats, represented 96 species of which 65 were native, 20 were nonnative, and 12 were nonnative-invasive (Table 3.25, 3.30).

In contrast, Loeb (1986) identified 21 arboreal species and 35 species of herbs and shrubs in 12 contiguous 10 X 50 m^2 quadrats spaced at 6 m intervals along a transect traversing Inwood Hill Park. Herbs and shrubs were sampled in 2 X 4 m^2 quadrats spaced at 6 m intervals along the edge of the 10 X 50 m^2 quadrats. Of the 21 arboreal species, 17 were native, 1 species was nonnative, and 3 were nonnative-invasive.

Among all woody taxa in the Valley-Clove forest, Loeb (1986) observed that the two most important arboreal species were *Liriodendron tulipifera* and *Acer saccharum*, and among non-arboreal shrub species, *Lindera benzoin*. This current census revealed non-arboreal *Lindera benzoin* (n=572) ranking first in ecological dominance (IV = 87.77%). Among arboreal taxa, *Liriodendron tulipifera* (n=20) ranked second in dominance (IV = 72.81%). It is the dominant taxon among all tree species in the Valley-Clove. *Quercus rubra* (n=n=9) (IV = 27.99%) ranked third, followed by *Fraxinus americana* (n=7) (IV = 10.54%) in fourth place. *Tilia americana* (n=6) (IV = 8.59%) placed sixth, with *Acer saccharum* (n=9) (IV = 8.11%) in seventh place (Table 3.9).

The frequency distribution in the Valley-Clove (n=790) (Figure 3.3) for stem diameters (2.0 – 122.60 cm DBH) was typical for a mature stand that contains an abundance of smaller stems (n=742) (2.0 – 9.50 cm DBH) (Figure 3.16a), in contrast to several larger stems (n=40) (30.20 – 122.60 cm DBH) (Figure 3.16b), such as *Acer saccharum*, *Liriodendron tulipifera*, and *Quercus rubra*, which form the canopy. Graves' (1930) observations of the Valley-Clove (Shorakapkok Glen) includes these species as dominants as does Loeb (1986). Within a DBH range of 42.0 - 62.0 cm, there is an absence of *Liriodendron tulipifera*. This is evidence of very few saplings mixed in with fully mature trees and nearly negligible mid-size trees (n=8) (Figure 3.16b). This skewed phenomenon of stem diameter distribution at the early stages of growth is widely accepted as a general trend (Hara 1988). NRG has been planting many *Liriodendron* *tulipifera* saplings (< 10 cm DBH), but not all survive as some of the root balls were not placed deeply enough in the soils, and drought conditions were severe at the time of this census. It rarely does well in very wet or very dry situations. There are very few sub-canopy (understory) trees in the Valley-Clove such as *Cornus florida*, as most have probably succumbed to the anthracnose virus. NRG has also been replanting this native species but few have survived, whether through lack of maintenance or the virus, remains unclear.

Historically, Inwood Hill had at least one *Liriodendron tulipifera* that had attained an age of 280 years before it was felled in 1938. It stood at the edge of the ancient Spuyten Duyvil Creek which is now buried. *Liriodendron tulipifera* has an average life span of approximately 100 to 300 years. However, low levels of soil nutrients, most frequently nitrogen, have occasionally been linked to slow rates of growth for *Liriodendron tulipifera*. Also, naturally occurring levels of phosphorous and potassium can limit growth, but physical properties far overshadow chemical properties in determining distribution and growth (Della-Bianca and Olson 1961; Phillips 1966; Ike and Huppuch 1968).

Another factor that can be damaging to *Liriodendron tulipifera* are vines, especially *Vitis* spp. (Smith and Lamson 1975), which are abundant throughout the Park. Although *Liriodendron tulipifera* is classified as intolerant of shade, it can overcome much competition from any of its associates (excepting white pine) by producing numerous seedlings and sprouts that grow very rapidly (Olson 1969). However, gray and black squirrels, and white-footed mice, which are abundant in this isolated Park, eat many of the seeds before they have a chance to sprout.

Lindera benzoin forms nearly a microecosystem within the Valley-Clove where temperatures in winter can be as much as 5 - 7° F higher than on the ridges. The dense shrub layer stands of *Lindera benzoin* that Graves (1930) described earlier, and later Loeb (1986), as being dominant, are still very much in evidence today (Figure 3.14). However, *Rosa multiflora* has started to invade parts of the Clove, and *Rubus phoenicolasius* has become a problem species as well. Soil erosion problems continue to plague the Clove, but mitigation efforts by the NRG to restore and clean the drainage ditches as well as the planting of many native species has helped stop erosion. The removal of some of the more aggressive invasives has begun although disturbance of the seed bank tends to facilitate their spread.

The Valley holds much moisture from water drainage off the two ridges which also protect it from high winds. The cobbled drainage ditches traverse the Valley-Clove and empty into the 2 ha lagoon. One specimen of *Clethra alnifolia* (Clethraceae) was reported to have been found by a drainage ditch in the Valley-Clove (Tim Wenskus, Forestry Manager, NRG, personal communication).

Among families in the Valley-Clove, the Lauraceae placed first in distribution with a relative frequency of 72.65% as displayed in the seventh interval bar (Figure 3.22), and was represented by two species, primarily non-arborescent *Lindera benzoin* (n=572), and arborescent *Sassafras albidum* (n=2). In terms of relative dominance, as an extrapolation of the basal area, the Lauraceae ranked first with a family importance value (FIV) of 90.18% and 100% quadrat representation among all woody taxa of the Valley-Clove forest (Tables 3.17, 3.18).

The Valley-Clove had 23 woody natives, 1 non-native, and 5 nonnative-invasive species, the most important being *Rosa multiflora* (Table 3.2).

Among herbaceous taxa, the top species was nonnative-invasive *Alliaria petiolata* (n=133), representing 18.97% of the sampled taxa followed by native *Impatiens capensis* (n=108) (15.4%) (Tables 3.26, 3.30).

The soils of the Valley-Clove remain moist even in the hotter, summer months supporting a large population of *Impatiens capensis* which is quite abundant throughout the Clove. The moisture provides enough turgor pressure to cause the mature fruit to explode (dehise) by the slightest jarring of the plant, or by touch, shooting seeds several feet from the parent plant. This method of seed dispersal has thus facilitated its spread throughout the Valley-Clove.

Native *Arisaema triphyllum* (n=4), found in quadrats #3 and 5, made a rare appearance in Spring, 2003. Soils for *Arisaema triphyllum* must be moist with a pH of 6.1 – 6.5, mildly acidic to neutral, with enough nitrogen to support the plant's reproductive cycle.

Another plant observed was *Aegopodium podagraria* (n=29) (4.13%), a member of the Apiaceae family found only in quadrat #2, is considered to be a nonnative, and in some cases, an aggressive invasive species. The plant has been spreading rapidly in the Valley-Clove forest, particularly at the foot of the West Ridge, east-facing slope which extends into the Clove. The plant is collected annually by a number of Koreans though collection of plants in New York City parks is not permitted. They purportedly use it for medicinal purposes. However, the removal of the plants has disturbed the seed bank in large patches and has facilitated their spread. This has had the effect of displacing the native species and allowing other invasives, such as *Alliaria petiolata*, to colonize. The seedlings generally need recently disturbed soils and rather bright light. This rhizomatous perennial has a vigorous growth habit, spreading mainly by vegetative means. Patches where the plant has colonized, tend to increase in size through an extension of its rhizome system. When established, the plants are highly competitive in shaded environments, which the Valley-Clove provides. It appears to do best in moist soils in light to moderate shade, but is also highly shade-tolerant and very capable of invading closed-canopy forests (Alien Plant Working Group 2005).

The frequency distribution for the East Ridge (n=707) (Figure 3.5) for stem diameters (2.0 – 87.7 cm DBH) was similar to the Valley-Clove with many small stems (n=658) (2.0 – 9.50 cm DBH) (Figure 3.17a), representing 93.06% of the sampled population. There were fewer mid-size (n=20) (11.90 – 29.90 cm DBH) (Figure 3.17b), and fewer large-size class trees (n=29) (31.50 – 87.70 cm DBH) (Figure 3.17c), which represented 2.83% and 4.1% (respectively) out of the 707 stems.

Viburnum acerifolium (n=368), like its cohort *Lindera benzoin* in the Valley-Clove, was the ecologically most dominant species (IV = 62.11%) among shrubs. At 52.05%, it ranked first in density and frequency (8.64%) and was represented in 7 out of 8 quadrats (Figure 3.4). The second ecologically dominant taxon was *Quercus rubra* (n=16) (IV = 57.05%), followed by *Q. prinus* (n=8) (IV = 22.60%), and *Q. alba* (n=7) (IV = 16.64) among tree species. *Quercus rubra* had a density of 2.26% with frequency of 8.64%, the same as *Viburnum acerifolium.* However, it was first in relative dominance (46.15%) with a mean DBH of > 52.56 cm compared with *Viburnum acerifolium* (1.42%). *Acer rubrum* (n=47) had the greatest number of stems on the East Ridge compared with the other three geographic locations. There were many more trees in this family 15 years ago, particularly *Acer platanoides* and *A. pseudoplatanus*, both considered to be serious invasive species. However, a concentrated effort was begun by the Natural Resources Group (NRG, NYC Parks Dept.) to remove these trees, thus reducing the abundance of this family. NRG has established a planting program to replace these invasive species with natives such as *Acer rubrum*. Hence, there are many small size stems in this family. *Acer rubrum* ranked fifth in dominance (IV =16.55%) followed by *Prunus serotina* (n=31) (IV = 13.58%), and *Sassafras albidum* (n=17) (IV =11.95%).

The East Ridge borders the Ridge Top east and has suffered considerable vandalism and many fires. These fires have spread through parts of the East Ridge and have stimulated the growth of many stands of *Sassafras albidum*, *Prunus serotina*, and *Viburnum acerifolium*, with *Alliaria petiolata* as an herbaceous ground cover. The *Sassafras* stands are so dense with poles that they are only separated by less than a half meter with DBHs of less than < 3.00 cm. The area just south of quadrat #22 and before quadrat #16 (Figure 2.1 Map), has the greatest density of *Sassafras* stands in the entire Park. The dense stands are mainly concentrated on sites that have been largely denuded of other vegetation by frequent fires. Loeb (1986) has mentioned these stands near the tennis courts on the west-facing slope of the East Ridge. The persistence of *Sassafras* on these sites seems to be attributed to root sprouting (suckering) and allelopathy. It is also a fire-adapted species and very resilient to disturbances and post-fire regeneration. It is a seral stage, shade-intolerant, and gap- phase regenerator as a pioneer species (Dirr 1983).

In the case of *Viburnum acerifolium,* which is very shade-tolerant, it seems to regenerate very rapidly after fire and spreads by a suckering habit (Dirr 1983), hence the abundance of stems on the East Ridge.

While it is very susceptible to fire injury, *Prunus serotina* can typically regenerate from the root crown or stump. *Prunus serotina* has two advantages: (1) it produces copious seeds which are stored in the soil and, (2) the seed's stony endocarp and the soil provide some insulation from fire (Hare 1961). Some of the soil-stored seeds presumably survive at least light fires and contribute to postfire seedling establishment although this has not been documented (Marquis 1975). Birds also may distribute some seed into burned areas. Like *Sassafras albidum*, *Prunus serotina* is a seral-stage, shade-intolerant, and gap-phase species. Its postfire regeneration strategy is that of a survivor species with on-site surviving root crowns or caudex (Curtis 1959; Auclair and Cottam 1971; Marquis 1990).

Prunus serotina (n=31*)* had a very high frequency (8.64%), on par with the three top *Quercus* spp., *Q. rubra*, *Q. prinus*, and *Q. alba* on the East Ridge. However, the number of stems for *Prunus serotina* (n=31) do not include the large number of seedlings present as they were below the cut-point of ≤ 2.0 cm DBH (Table 3.10). *Prunus serotina* had a mean DBH of > 3.94 cm and was represented in 7 out of 8 quadrats.

Sassafras albidum (n=17) (IV =11.95%) ranked seventh in ecological dominance after *Prunus serotina* with a density of 2.41% and frequency of 8.64%, the same as *Prunus serotina*. The same circumstances exist for *Sassafras albidum* as for *Prunus serotina*, with many *Sassafras* poles under < 2.0 cm DBH (Table 3.10). *Sassafras albidum* was represented in 7 out of 8 quadrats.

Among the families in the East Ridge forest, the Adoxaceae (n=376) placed first in frequency distribution (53.18%) as displayed in the the second interval bar (Figure

3.23). It was represented by two shrub species in the genus *Viburnum*: *V. acerifolium* (n=368) and *V. dentatum* (n=8), both of which ranged within a DBH of 2.0 - 3.0 cm. While the Valley-Clove is dominated by *Lindera benzoin*, the East Ridge is dominated primarily by *Viburnum acerifolium*, in the small diameter size class (Figure 3.4). In terms of relative dominance, as an extrapolation of the basal area, the Adoxaceae ranked second in family importance values (FIV = 65.92%) among all woody taxa in the East Ridge forest with 88% quadrat representation (Tables 3,19, 3,20).

Placing second was Rosaceae (n=80), with a frequency distribution of 11.31%. Rosaceae was represented three species, primarily arborescent *Prunus serotina* (n=31), non-arborescent *Rosa multiflora* (n=46), and *Rubus allegheniensis* (n=3). Both *Rosa multiflora* and *Rubus allegeheniensis* stems fell into the small diameter size-class ranging within a DBH of 2.0 - 3.0 cm. *Prunus serotina* had 30 stems within a DBH range of 2.50 - 6.60 cm, also the small diameter size-class, with 1 stem (11.40 cm DBH) falling into the mid-size class. In terms of relative dominance, as an extrapolation of the basal area, the Rosaceae ranked fourth with a family importance value (FIV) of 23.34% among all woody taxa in the East Ridge forest and 88% quadrat representation.

The East Ridge had 25 woody natives, 2 native-invasive (*Catalpa bignonioides*), and 8 nonnative-invasive species, the most important being *Rosa multiflora* (Table 3.3). The native shrub, *Vaccinium corymbosum* (n=4), was found in quadrat #8, and thought to have been extirpated by Graves (1930). The Ericaceae family is poorly represented in Inwood Hill Park, but recently, the NRG has been planting native species of Low-bush blueberry (*Vaccinium angustifolium*) which serves as erosion control and has, thus far, acclimated well in the acidic soils of the ridges.

Of note is non-native *Pinus nigra* (n=1) (IV =7.91%), a singleton, which ranked eleventh in ecological dominance after *Lindera benzoin* (IV = 7.99%) with negligible density and frequency percents. However, in terms of relative dominance (6.53%), it ranked fourth after *Quercus alba*. One tree was found in quadrat #27 with a DBH of > 87.10 cm surrounded by *Rosa multiflora.* Five species of *Quercus* were represented in the East Ridge forest: *Quercus alba*, *Q. coccinea*, *Q. prinus*, *Q. rubra*, and *Q. velutina.*

Among herbaceous taxa, the top species was native species was *Aster divaricatus* (n=88), representing 22.11% of the sampled population, and found in 8 out of 8 quadrats. The top nonnative-invasive species was *Alliaria petiolata* (n=22), representing 5.52% of the sampled population, and found only in quadrat #27 (Tables 3.27, 3.30). Also present were two species of fern on the East Ridge, especially near quadrat #12, *Dennstaedtia punctilobula* and *Thelypteris noveboracensis* (Figure 3.4).

The frequency distribution for the Ridge Tops (east and west) (n=595) for stem diameters (2.0 - 100.2 cm DBH) (Figure 3.7), like the Valley-Clove and East Ridge forests, had many small stems (n=531) (2.0 – 9.70 cm DBH) (Figure 3.18a), representing 89.24% out of the entire 595 stems sampled for the Ridge Tops. Among the small stems most frequently encountered was *Prunus serotina* (n=75), with a relative frequency of 14.12% in this DBH range, followed by *Viburnum acerifolium* (n=70) (13.18%), and *Celastrus orbiculatus* (n=63) (11.86%).

In the mid-size diameter class, there were just 32 stems (10.40 – 29.40 cm DBH) (Figure 3.18b) representing 5.37% of the sampled population. The species most frequently encountered was *Quercus rubra* (n=10), with a relative frequency of 31.25% within this DBH range, followed by *Prunus serotina* (n=5) (15.62%), *Fraxinus* *americana* (n=4) (12.50%), and *Quercus coccinea* (n=4) (12.50%).

In the large-size diameter class, the number of stems (n=32) (30.50- 100.20 cm DBH) (Figure 3.18c) was the same as the mid-size class, and with the same percent representation. Of these stems, the most frequently encountered species was *Quercus rubra* (n=20), with a relative frequency of 62.50% within this DBH range. Next were *Quercus velutina* (n=4) (12.50%), *Liriodendron tulipifera* (n=2) (3.12%), and *Quercus coccinea* (n=2) (3.12%).

The top ecologically dominant species for the Ridge Tops was *Quercus rubra* (n=30) with an IV of 72.30% and relative dominance of 59.2%. Its percent density was 5% with a frequency of 8%. *Quercus rubra* was represented in 8 out of 8 quadrats, comparable with the East Ridge where it appeared in 7 out of 8 quadrats. The largest tree was measured at > 100.2 cm DBH in quadrat #21. The mean DBH for *Quercus rubra* was 44.3 cm, and the mean stem density for the 8 quadrats was 3.75%. Next was *Prunus serotina* (n=80) (IV = 24.08%). At 13.06%, it ranked first in density, ahead of *Quercus rubra*, but shared the same rate of frequency (8%) with *Q. rubra* (Table 3.11).

Among shrubs and vines, *Viburnum acerifolium* had the highest relative density (11.77%) followed by *Celastrus orbiculatus* (10.59%), and *Lonicera maackii* (5.55%). *Viburnum acerifolium* had the highest relative dominance (0.24%) as an extrapolation of the basal area followed by *Celastrus orbiculatus* (0.22%) and *Lonicera maackii* (0.21%). The high values gave *Viburnum acerifolium* an importance value (IV) of 14.30% as the dominant taxon among shrubs, ranking fifth, with *Celastrus orbiculatus* (IV = 14.25%), ranking sixth in dominance among vines within this same interval range (Table 3.11). The greatest concentration of stems (n=33) for *Celastrus orbiculatus* was found in quadrat #20, an area that has burned twice in the last 10 years. The canopy here is open with many small diameter stems not higher than 10 > 25 ft. The DBHs of Oriental bittersweet are all in the range of 2.0 – 2.30 cm indicating rapid growth with many lateral roots. Mean stem density per 8 quadrats was 7.88%.

Among the families on the Ridge Top (east and west) forests, the Fagaceae (n=44) ranked first, in terms of relative dominance as an extrapolation of the basal area, with an FIV of 92.29% (Tables 3.21, 3.22). Five species of *Quercus* were represented on the Ridge Tops (east and west) forest: *Q. alba* (n=1), *Q. coccinea* (n=6), *Q. prinus* (n=3), *Q. rubra* (n=30), and *Q. velutina* (n=4) (Figure 3.6). Ranking second in ecological dominance was Rosaceae (n=115) (FIV = 32.72%). In relative density (19.50%), the Rosaceae ranked first, and in relative frequency (10.60%), it shared the top spot with the Fagaceae. However, in relative dominance (2.6%), it ranked very low indicating many small stems as an extrapolation of the basal area, which gave it an FIV of 32.72%. Most of these stems consisted of *Prunus serotina* (n=80) with the largest tree measured at 27.7 cm DBH found in quadrat #20. The mean stem density for *Prunus serotina* was 10.0%.

The Ridge Tops, especially the east top, (as mentioned in descriptions of the East Ridge) have been subjected to many fires as well. Quadrat #20, which has been burned at least two times, (as mentioned above) has ample representation of *Sassafras albidum* (n=24) and *Prunus serotina* (n=20). Of note, three invasives, *Celastrus orbiculatus* (n=33), *Rosa multiflora* (n=15), and *Lonicera maackii* (n=8) spread very rapidly into the denuded areas along with *Lonicera japonica*. Interestingly, *Acer saccharum* (n=10) was also present, but the stems are all within 3.0 - 4.0 cm DBH, indicating fairly recent growth.

The Ridge Tops had 25 woody natives, 2 native-invasive (*Catalpa bignonioides*), 5 nonnative, and 9 nonnative-invasive species, the most important being nonnative-invasives *Celastrus orbiculatus* (n=63), *Lonicera maackii* (n=20, and *Rosa multiflora* (n=19) (Table 3.4).

Among herbaceous taxa, the top dominant was native *Aster divaricatus* (n=80) representing 16.06% of the sampled population, with a mean stem density per quadrat of 10%, and appearing in 6 out of 8 quadrats. The Asteraceae was the top herbaceous family on the Ridge Tops, forest representing 17 species. Next was native *Danthonia spicata* (n=40) (8.03%) in quadrats #10 and 15, both quadrats being in an open meadow-type environment on the Ridge Top east (Figure 3.6).The top nonnative-invasive species was *Alliaria petiolata* (n=32), representing 6.42% of the sampled population (Tables 3.28, 3.30).

The frequency distribution for the West Ridge (n=1978) for stem diameters (2.0 – 171.20 cm DBH) (Figure 3.9), like the three other geographic locations, had an abundance of small diameter size stems (n=1834) (2.00 – 9.70 cm DBH) (Figure 3.19a). These stems represented 92.72% of the sampled population out of the entire 1978 stems for the West Ridge. Out of the overall small-size stem category (n=3765), the West Ridge represented 48.71% of the sampled taxa in 18 quadrats. Within this DBH range, the species most frequently encountered was *Lonicera maackii* (n=227), with a relative frequency of 12.37%, followed by *Viburnum acerifolium* (n=168) (9.16%), *Prunus serotina* (n=166), (9.05%), *Lindera benzoin* (n=159) (8.67%), *Viburnum dentatum* (n=113) (6.16%), *Cornus foemina* (n=111) (6.05%), *Celastrus orbiculatus* (n=106) (5.78%), and *Rosa multiflora* (n=81) (4.41%) in order of most abundant species.

There were fewer mid-size trees (n=67) (10.20 – 29.60 cm DBH) (Figure 3.19b) in contrast to large-size class trees (n=77) (30.40 – 171.20 cm DBH) (Figure 3.19c), representing 3.38% and 3.89% (respectively) of the sampled population. Out of the overall mid-size class (n=127) category, the West Ridge represented 52.8%, and the large-size class (n=178) category represented 43.25%. These percentages indicate more mature canopy trees, but fewer mid-size trees that would eventually replace mature trees (Figure 3.8). Also, the abundance of small stems for the West Ridge indicates a more successional forest in a transitional stage of growth.

Within the mid-size diameter class, the most frequently encountered species was *Robinia pseudoacacia* (n=19) with a relative frequency of 28.35%. Following were *Quercus rubra* (n=12) (17.91%), *Carya cordiformis* (n=4) (5.97%), *Pinus strobus* (n=4) (5.97%), *Celtis occidentalis* (n=3) (4.47%), *Prunus serotina* (n=3) (4.47%), *Quercus velutina* (n=3) (4.47%), *Sassafras albidum* (n=3) (4.47%), *Acer rubrum* (n=2) (2.98%), *Carya tomentosa* (n=2) (2.98%), and *Liriodendron tulipifera* (n=2) (2.98%) within this interval range (Figure 3.19b).

Within the large-size diameter class, the most frequently encountered species was *Quercus rubra* (n=42) with a relative frequency of 54.54%. Following were *Quercus velutina* (n=8) (10.39%), *Q. prinus* (n=5) (6.49%), *Aesculus hippocastanum* (n=4) (5.19%), *Robinia pseudoacacia* (n=4) (5.19%), *Carya cordiformis* (n=3) (3.89%), and *Liriodendron tulipifera* (n=2) (2.59%) within this interval range (Figure 3.19c).

Among trees in the West Ridge forest, *Prunus serotina* (n=169) had the greatest relative density of 8.54% and a relative frequency of 6.99%. However, *Quercus rubra* (n=66) with a relative density of 3.34% and frequency of 6.11%, had a greater relative dominance of 41.21% in contrast to *Prunus serotina* (1.09%) as an extrapolation of the basal area, which gave it an importance value (IV) of 50.66%. *Prunus serotina*, in contrast, as an extrapolation of the basal area based on relative dominance, had an importance value (IV) of 16.62%, considerably less than *Quercus rubra*, which is the top ecologically dominant tree in the large-size hierarchy (Table 3.12). *Prunus serotina* had a greater abundance in the small size stem category (n=166) as opposed to *Quercus rubra* (n=12), indicating perhaps the composition of the future forest of Inwood Hill, as there are many canopy gaps on the West Ridge where *Prunus serotina* is very abundant. There are very few specimens of *Quercus velutina* (n=19) (IV = 7.06%) left in Inwood Park and very little regeneration of new stems (Table 3.6). Most stems were singletons and doubletons. Figure 3.10 shows the sparse population of this member of the Fagaceae in contrast to *Quercus rubra* (n=121).

Light intensity appears to be critical to the survival and growth of *Quercus velutina* seedlings which need open, forested areas in order to thrive (Sander 1979). Both ridges of Inwood Hill have many open areas (gaps in canopy) but few seedlings and saplings were found in this census. It does not produce seeds until about age 20 and reaches optimum production at 40 to75 years, with crops of acorns about every 2-3 years (Brinkman 1965). The acorns are a favored food for squirrels, mice and voles, turkeys, and other birds. Inwood Hill has a large population of both squirrels and white-footed mice, fewer of voles, and recently, a small group of wild turkey has inhabited the Park Pheasants had been in abundance but NRG has removed much of their habitat at the top of the West Ridge and they have migrated to other areas outside the Park.

Among the families for the West Ridge forest (n=1978), the Fagaceae (n=103) ranked first, in terms of relative dominance as an extrapolation of the basal area, which gave it a family importance value (FIV) of 82.17% followed by Rosaceae (n=379) (FIV = 30.67%). The Adoxaceae (n=299) placed third (FIV = 20.61%) with Lauraceae (n=201) (FIV = 18.45%) placing fourth, and Caprifoliaceae (n=227) (FIV = 17.64%) in fifth place (Tables 3.23, 3.24). The Caprifoliaceae was represented by only one species, *Lonicera maackii*, which is the top nonnative-invasive species on the West Ridge and Slopes forest.

For the north-facing slope forest of the West Ridge, Loeb (1986) observed three dominant arboreal native species, *Liriodendron tulipifera*, *Quercus prinus*, and *Q. rubra*, followed by *Acer rubrum and Prunus serotina*, the latter species having the highest reproduction. In this census, quadrats # 28, 33, 34, and 35, fall within the West Ridge forest, north-facing slope, and also quadrat #45 in the Ridge Top (west) forest (Tables 3.4, 3.5). Out of the five quadrats, five arboreal species were present that matched Loeb's observations: *Liriodendron tulipifera* (n=1), *Quercus prinus* (n=4), *Q. rubra* (n=49), *Acer rubrum* (n=21), and *Prunus serotina* (n=92). In the case of *Liriodendron tulipifera*, only one specimen was found within these the five quadrats. However, the abundant numbers for *Prunus serotina* attest to the high rate of reproduction that Loeb (1986) had noted.

The West Ridge had 40 woody natives, 6 nonnatives, and 16 nonnative-invasive species, the most important being *Lonicera maackii* (n=227), and *Rosa multiflora* (n=81) (Table 3.5). Quadrat #43 had the greatest density of stems (n=186) of the sampled taxa.

Among herbaceous taxa, the top dominant species was *Aster divaricatus* (n=195), representing 15.66% of the sampled taxa. *Aster divaricatus* was found in 11 out of 18 quadrats with a mean stem density of 10.83% per quadrat. Next was nonnative-invasive

Alliaria petiolata (n=154), representing 12.36% of the sampled taxa. This species was found in 14 out of 18 quadrats with a mean stem density per quadrat of 8.55%.

It is on the West Ridge that wealthy landowners had numerous estates, c. 1860's into the 1900's. The landscape gardeners, employed by the wealthy, planted many of the "newly introduced" ornamentals, such as the Asiatic honeysuckles and knotweed: *Lonicera japonica*, *L. maackii*, *L. tatarica, and Polygonum cuspidatum.* Others were *Ampelopsis brevipedunculata, Celastrus orbiculatus*, *Hedera helix*, *Rosa multiflora*, *Rubus phoenicolasius, Vinca minor*, *Wisteria floribunda* and *W. sinensis*. European beeches were introduced to the landscape, and later, cultivars such as the copper beech (*Fagus sylvatica* var. *sylvatica*) in quadrat #37. Other introductions to the Park included *Acer platanoides, and A. pseudoplatanus*, *Broussonetia papyrifera, Gingko biloba*, *Pinus nigra*, and *Robinia pseudoacacia*.

Many of these species have become the invasives of today, posing serious threats to the remaining native species as they compete for light, space and nutrients. For example, the southwestern portion of the Park is now completely dominated by *Robinia pseudoacacia* near to quadrat #43. In another area on the West Ridge not far from quadrat #43, a small population of surviving Eastern hemlock (*Tsuga canadensis*) is precariously hanging on as encroaching *Robinia pseudoacacia* and *Maclura pomifera* (Osage orange) threaten to overtop them. NRG has begun work to thin and clear this deciduous overstory.

Like the other geographic locations, the West Ridge has suffered numerous fires as evidenced by the blackened trunks of larger trees, and gaps in the canopy, created by tree falls. These areas have many young seedlings and saplings of *Prunus serotina* regenerating, especially quadrats #28 (n=18), 31 (n=14), 34 (n=19), 36 (n=25), 38 (n=11), 41 (n=31), and 43 (n=12). *Prunus serotina* was found in 16 out of 18 quadrats of the sampled taxa.

Large areas of the West Ridge are in transitional stages of growth and interspersed with many invasive species, especially those that are close to the Westside Highway. It has been theorized that forest disturbances (of any type and scale) result in gaps that are heterogenous thereby placing a stand in “transition.” The recovery from disturbance often results in a mosaic of patches at different stages of a forest cycle. The trees found within gaps may consist of either pioneer or climax (non-pioneer) species or both, adding to stand diversity. The abundance of *Prunus serotina, Sassafras albidum, Fraxinus americana*, *Carya* spp., *Celtis occidentalis*, and *Acer* spp. mixed in with *Morus* spp., *Maclura pomifera*, *Paulownia tomentosa*, *Pyrus* spp*.*, *Ailanthus altissima*, *Robinia pseudoacacia*, *Rhus* spp., and a few mature, dominant canopy trees such as *Quercus* spp. and *Liriodendron tulipifera* seems to attest to the validity of the theory. Numerous studies have related forest composition to the size and frequency of those disturbances (Brokaw and Schneider 1989; Whitmore 1989; Veblen 1989). Plant communities in general respond to disturbances differently, i.e. soil compaction and composition, fires, vandalism, or just the trampling of too many people walking or biking off the pathways through the woods.

The most northerly end of the West Ridge slopes (north-facing and west-facing sides) is the exception where invasive species are minimum. Native species such as *Kalmia latifolia* are growing and expanding their niche on the west-facing slope just past the shadow of the Henry Hudson Bridge (Figure 2.1 Map). However, the soils directly beneath the Henry Hudson Bridge have suffered due to the extensive use of de-icing salts on the overhead bridge in winter and many trees are dying as a result. The foliage here is sparse. Plants are injured by salts that are deposited by drift on dormant stems and buds of deciduous trees and on stems, buds, and leaves of evergreens, or by excess amounts of salts that leach into the root zone. The resultant plant injury from soil salts may be caused by differences in osmotic potentials between the plant and the soil solution by a specific ion effect usually related to Na or Cl ions, or a combination of the two (Dirr 1976).

In a survey conducted at Wave Hill, Bronx, NY, Yost et al. (1991) found that the most important arborescent species were *Robinia pseudoacacia*, *Quercus rubra*, and *Acer platanoides*, and the most important non-arborescent species were *Ampelopsis brevipedunculata*, *Lonicera maackii*, and *Alliaria petiolata*, all considered to be serious nonnative, invasive species with the exception of *Quercus rubra*. The researchers (1991) found 276 species comprised of 50 trees, 35 shrubs, 20 vines and 171 herb species. Of the total number of species, 132 (48%) were not native to New York with nonnative tree species comprising 44% of the 50 trees recorded. This high percentage (48%) and importance of non-native species is related to Wave Hill's urban location and land-use history of anthropogenic disturbances (Yost et al. 1991).

In contrast to the Wave Hill survey, this census of the vascular flora in Inwood Hill Park revealed that the most important arborescent species was *Quercus rubra* (n=121) (IV = 48.69%) followed by *Liriodendron tulipifera* (n=34) (IV = 25.55%), and *Prunus serotina* (n=286) (IV = 15.15%). Among non-arborescent shrub taxa, the most important native species was *Lindera benzoin* (n=760) (IV = 23.75%) followed by *Viburnum acerifolium* (n=618) (IV = 19.07%), nonnative, invasives *Lonicera maackii* (n=269) (IV = 9.78%) and *Celastrus orbiculatus* (n=181) (IV = 7.87%), the dominant taxon among vines (Table 3.6) Among herbaceous taxa, the dominant species was native *Aster divaricatus* (n=401), representing 14.3% out of a total of 2842 individuals, while nonnative-invasive *Alliaria petiolata* was recorded at an astounding 341 plants (12%) (Table 3.30).

The Impact of Invasive Species on the Plant Communities of Inwood Hill Park

In understanding the mechanism and dynamics of an urban woodland community, how different communities respond to forest disturbances such as tree-fall gaps, and how these communities add to the diversity of flora, has been a hotly debated topic among many forest ecologists (Hibbs 1979; Shugart 1984; Sipe and Bazzaz 1995; Hubbell 1999; Vandermeer et al. 2000). In temperate woodlands, such as Inwood Hill Park, by what mechanism do these plant communities respond in relation to disturbances and how do they maintain their structure and composition after the disturbances have occurred? Disturbances such as fires and vandalism occur on a regular basis in Inwood Hill Park. These disturbances affect community structure and dynamics in different ways at various hierarchical levels and spacial scales (McCarthy and Facelli 1990). Disturbances may be frequent and severe at one extreme, or minor and rare at the other end of the spectrum. Severe forest disturbances can be large, such as the high intensity brush fire that was set at the northern end of the Inwood Hill directly beneath the Henry Hudson Bridge in the late summer of 2001 during the height of the drought. Recent fires are evident in several of the study plots, as they are elsewhere in urban parks throughout the five boroughs as documented by Loeb (2001)

Minor or rare disturbances can be described as the occasional tree-fall (Martin 1999). It is in the process of renewal, of regrowth and regeneration, such as the replacement of new and different taxa, that results in the recovery of a plant community in an urban woodland. The seed bank may have been disturbed, and gaps may have opened in the canopy, allowing a fuller amount of sunlight into a previously shaded area. This factor may favor some species to be released from suppression that would otherwise not thrive in low light conditions. It is also the process of differential recruitment and mortality in gaps of different sizes, by shade-tolerant and shade-intolerant species, that can lead to changes in landscape diversity (Brokaw and Schneider 1989).

In Inwood Hill Park, disturbances such as tree-falls by mature trees are always present but are of low intensity and rare occurrences. In one instance, a very mature *Quercus rubra*, with a DBH of 62.70 cm, was felled in 2000 in the Valley-Clove because of carpenter ants that had eaten the tree’s heartwood from the crown down to just 7 feet above ground. As it fell, it knocked the crown off of an adjacent *Fagus grandifolia* which has subsequently resprouted. (Anthony Emmerich, Manager, Urban Forest and Education Project (UFEP), personal communication).

Decomposing tree stumps, decaying logs (especially of ash), and an abundance of young tree saplings are common throughout the forest of Inwood Hill Park, providing evidence of a mature woodland in transition as was documented by Loeb’s (1986) descriptions of the several plant communities of Inwood.

As noted earlier in the Chapter, urban forest disturbances that are created by fires, vandalism, and human use and abuse, result in gaps that are heterogeneous whereby placing a stand in “transition.” Recovery from such disturbances often results in a mosaic of patches at different stages of the forest cycle. Trees found within the gaps may consist of either pioneer or climax (non-pioneer) species, or both, adding to stand diversity

(Brokaw and Schneider 1989; Whitmore 1989; Veblen 1989). Where gaps exist, many species that are invasive colonize very rapidly, as was noted in the descriptions of the four geographic locations, thereby creating plant communities of a differing composition than had existed before. The frequency and rate of these disturbances facilitate movement of not only native, and invasive, pioneer tree species, but of herbaceous plants such as shade-tolerant, *Alliaria petiolata*, with its prolific seed dispersal and ability to protect its space, possibly through allelopathy (Baskin and Baskin 1992; Prati and Bossdorf 2004). The seeds can remain viable in the soil for up to four or five years. Not only is it an invader of forest edges and disturbed areas, but it can also invade a closed-canopy forest understory where it apparently suppresses native understory plants, including the seedlings of dominant canopy trees (Nuzzo 1999, 2000; Blossey et al. 2001). It can aggressively out-compete native species in understory forests, such as in the Valley-Clove. The overwintering rosettes of this plant resume growth in early spring when many native forest wild flowers are also active. In the Valley-Clove, it is competing with *Aster divaricatus*, *Dicentra cucullaria*, *Eupatorium rugosum*, *Sanguinaria canadensis*, *Viola* spp., and others. As a result, *Alliaria petiolata* competes with these native understory species for sunlight at a critical time before the trees leaf out.

The mechanism underlying this unusual capacity to enter and proliferate within intact North American forest communities has not yet been established. However, in recent greenhouse experiments, Stinson et al. (2006) found that garlic mustard's (*Alliaria petiolata*) impact on native understory flora may indeed involve not only competitive or allelopathic effects on native plants, but also suppression of mycorrhizal relationships. It has been hypothesized that *Alliaria petiolata* interferes with plant-AMF (arbuscular mycorrhizal fungi) interactions in its invaded range (Roberts and Anderson 2001). Members of the Brassicaceae, including *Alliaria petiolata*, produce various combinations of glucosinolate products, organic chemicals with known anti-herbivore, anti-pathogenic and allelopathic properties. The phytochemicals may also prevent this non-mycorrhizal plant family from associating with arbuscular mycorrhizal fungi which many other plant families have relationships (Stinson et al. 2006). In various experiments, Stinson et al. (2006) found that dominant native hardwood trees species of northeastern temperate forests, *Acer saccharum*, *A. rubrum*, and *Fraxinus americana*, showed significantly less AMF colonization of roots and slower growth rates when grown in soil that had been invaded by garlic mustard (*Alliaria petiolata*). AMF colonization was almost undetectable in soil that had been invaded by garlic mustard (*A. petiolata*.) The reductions were similar to those observed when seedlings were grown in sterilized soil from both garlic mustard-invaded and garlic mustard-free sites. Stinson et al. (2006) have suggested that the mechanism by which garlic mustard suppresses the growth of native tree species is "microbially-mediated," and "not the result of soil differences or direct allelopathy."

Stinson et al. (2006) have postulated that phytochemicals may be released into soils as root exudates as a result of damaged root tissue, or in the form of leaf litter. High densities of garlic mustard in the field seemed to be correlated with low inoculum potential of AMF spores and impair AMF colonization. However, it is unclear which phytochemicals being produced by garlic mustard have the observed antifungal properties.Whether and how they interact with other soil microbes, and whether these antifungal effects extend to other functionally important forest soil fungi, such as ectomycorrhizal fungi, and saprophytic fungi, remains to be more fully investigated. *Alliaria petiolata* is the top invasive among herbaceous taxa in all of Inwood Park.

Disturbances of the seed bank, and to a lesser extent, birds and other animals are another factor in the spread of invasive species, such as *Aegopodium podagraria* and *Rosa multiflora* in the Valley-Clove forest, and *Celastrus orbiculatus*, *Lonicera japonica*, and *L. maackii* in the West Ridge forest. It is on the West Ridge of Inwood Hill, that several large estates once commanded magnificent views of the Hudson River, and bequeathed as their inheritance, numerous gardens filled with oriental and exotic, non-native species that altered the original composition of these native plant communities. *Acer platanoides* and *A. pseudoplatanus*, *Alliaria petiolata*, *Ampelopsis brevipedunculata*, *Celastrus orbiculatus*, *Hedera helix*, *Lonicera japonica*, *L. maackii, Polygonum cuspidatum, Robinia pseudoacacia, Rosa multiflora, Rubus phoenicolasius,* and both species of *Wisteria*, *W. floribunda* and *W. sinensis,* have the greatest frequency distributions in the West Ridge forest, extending from Dyckman Street on the southwest, to the northeast along the west-facing slope of the West Ridge to the Henry Hudson Bridge.

The ability of these nonindigenous species to alter population, community, and ecosystem structure and function, is well documented (Elton1958; Mooney and Drake 1986; Vitousek et al. 1987; Drake et al. 1989). Urbanization modifies the extent and type of vegetation on a landscape through losses from deforestation and fragmentation and gains from reforestation and afforestation (Godron and Forman 1983; Sharpe et al. 1986; Zipperer et al. 1990). With deforestation and fragmentation, there are bound to be reductions of native flora and fauna including keystone species (Murphy 1988; Peter and

Lovejoy 1990), as well as increases in non-native species (Zipperer et al. 1997). Three prime examples exist today of this kind of deforestation and fragmentation in urban parks in New York City: 1) building the Westside Highway through Inwood Hill Park, 2) the division of Van Cortlandt Park in the Bronx by creating the Major Deegan Highway and, 3) the multi-sectioning of Forest Park in Queens by creating several corridors of transportation, the Interboro Parkway (now Jackie Robinson Parkway) to the north, Myrtle Avenue to the southwest, and Metropolitan Avenue to the east.

In a recent study of the woody taxa of Forest Park, Queens County, Glaeser (2004) found 158 stems of *Phellodendron amurense* (Amur cork tree) representing 20.8% of all the trees in a 0.5 ha plot. Amur cork tree was ranked for ecological dominance with other taxa in the study plot by species importance values (IV), and of the top ten of twenty-two overall taxa identified by woodland census, *P. amurense* ranked third in ecological dominance with an IV of 33.34% (Glaeser 2004). *P. amurense* was first introduced to the United States by the horticultural industry for street trees, or ornamental shade trees in parks, arboreta, botanical gardens, and cemeteries from its native forest habitats in northern China, Manchuria, and Japan (Rehder 1940).

The NYC Department of Transportation planted *P. amurense* along the Interboro Parkway (now Jackie Robinson Parkway) in 1935 (NYC DPR 1990) and as a result, it became the “seed source” for the gradual movement of this species into the woods of Forest Park where it appears to have established self-sustaining populations (Glaeser 2004). No ecological or scientific studies have been done to date to assess this relatively recent invader of the forests of New York City (Glaeser 2004).

In a recent 2002 report on noteworthy plants in the New York portion of the

Torrey range, *P. amurense* was cited as invasive in two known locations - the grounds of the New York Botanical Garden and in Forest Park (Lamont and Young 2002). In my study of the woody taxa of Inwood Hill Park, 3 stems were found of *P. amurense* confined to the westface of the West Ridge (quadrat #36) on the south side of the Westside Highway. I have also observed *Phellodendron amurense* in Fort Tryon Park (an adjacent park to Inwood Hill Park), Van Cortlandt Park in the Bronx, and on the New Jersey side of the Hudson River in the Palisades.

By way of comparison, *P. amurense* ranked 70th out of seventy-seven species in ecological dominance with an IV of 0.305% in Inwood Hill Park. However, the non-arborescent shrub, *Lonicera maackii* (Amur honeysuckle), first introduced to America in the late 1700s from eastern Asia for possible ornamental use, ranked 6th in ecological dominance with an astounding 269 stems with an IV of 9.78%. The shrub is listed on the top twenty invasive species for New York State (New York State Ad Hoc Invasive Plant Group 1998), and also for New York City (Invasive Plant Council of NYC 2004).

These factors, and many others, have had negative impacts on urban forest plant composition and community structure. Very little is known about these and other ecological impacts on urban systems such as water pollution, changes in air temperature, evapotranspiration rates, and albedo (Zipperer et al.1997). What is known is that a change in the disturbance regimen of an urban habitat can initiate many plant invasions (Hobbs and Huenneke 1992; Woods 1997).

Viewed in the long term, most species are invaders. However, the term “invader” is usually applied to species that have moved around in the past few hundred years, and especially in the past 150 years, as a result of human activity (Orians 1986). However, not all “invaders” become invasive. The success of an invasion is affected not only by the characteristics of the invader, but also by the characteristics of the site being invaded. Disturbance increases plant invasions by providing suitable microsites for germination and seedling establishment and by increasing light and nutrient availability that enhance seedling survival and growth (Orians 1986; Hobbs and Huenneke 1992). Salinity and other soil conditions also regulate survival and growth of natives and nonnatives as well as temperature, rainfall, fire, competition, and predation (Berger 1993). Characteristics of an ideal plant colonizer were described by Lewontin (1965) as having “effective dispersal, high somatic plasticity, and high interspecfic competitive ability,” as well as other factors such as “high seed production, strong vegetative reproduction, self-compatibility, and agamospermy.”

The dominant vine in Inwood Park, *Celastrus orbiculatus*, a deciduous twining woody vine, was first introduced in 1860's as an ornamental from eastern Asia. It has become naturalized in northeastern United States and was reported as being present in every county of Massachusetts (Sorrie and Somers 1999). *Celastrus orbiculatus* infests forest edges and woodlands, early successional fields and hedgerows, coastal areas and salt marsh edges, particularly those suffering from some form of land disturbance, as was noted in the plant communities of Inwood. While it prefers sunny sites, its tolerance for shade allows *Celastrus orbiculatus* to invade forested areas. It produces abundant fruits that are high in carbohydrates, but low in fats, and is readily dispersed by birds. Pollen and seed viability are significantly greater in *Celastrus orbiculatus* than in *C. scandens*, and *C. orbiculatus* was shown to have the highest germination under low light conditions. These and other factors are favoring the rapid spread of *Celastrus orbiculatus* and the decrease of its native counterpart, *C. scandens* (Dreyer et al. 1987). Celastrus orbiculatus has invaded all parts of Inwood Hill Park, especially at the southern perimeter of the Park. *Celastrus orbiculatus* (n=181) ranked ninth in ecological dominance with an IV of 9.2% and was among the twelve top taxa (Table 3.8). Nonnative-invasive *Lonicera maackii* (n=269) ranked sixth in ecological dominance among the twelve top taxa with an IV of 9.78%. It has invaded many parts of the West Ridge and both Ridge Tops, particularly where canopy gaps exist.

A fundamental question was raised by researchers concerning the anticipated relative growth of *Lonicera maackii* and *Lindera benzoin* (a native species found predominately in the Valley-Clove and West Ridge forests), if disturbance of the forest canopy suddenly increases light availability. In a study of comparative responses of *Lonicera maackii* (Amur honeysuckle) and *Lindera benzoin* (Spicebush) to increased light, Luken et al. (1997) found that stem growth of *L. maackii* equals or exceeds that of *L. benzoin* across a full range of tested light conditions. The magnitude of *Lonicera maackii*'s advantage depends on the degree to which light is enhanced, and this in turn, depends on the type of disturbance present. When anthropogenic disturbances such as fires create canopy gaps, or lead to increased degrees of forest fragmentation, the light regimen may change from shade to direct light. Under these circumstances, Luken et al. (1997) found that *Lonicera maackii* had a threefold advantage in stem growth over *Lindera benzoin*. Growth of *Lonicera maackii* and *Lindera benzoin* after a light-enhancing event depends on the ability of these species to increase photosynthetic rates, to acclimate, or to express new phenotypes. Measurement of branch architecture and whole-plant allocation patterns suggested clear species differences in potential for leaf display and height gain. In the case of *Lindera benzoin*, responses to increased light were slow growth of branches, thus supporting relatively less leaf mass, and capturing less energy (Luken et al. 1997). However, a species may allocate a relatively greater amount of captured energy to belowground structures at the expense of stem growth (Cipollini et al. 1993). In contrast, *Lonicera maackii* under increased light, had rapid branch growth, supporting relatively more leaf mass, with allocation plasticity relatively high. In addition, Lukens et al. (1997) found that *L. maackii* growing under shaded conditions allocated relatively less energy to belowground structures and relatively more energy to above-ground stems. Based on their research, Lukens et al. (1997) have suggested that this "light-seeking" response may be of fundamental importance in allowing broad-niched or shade intolerant woody plants to improve the light environment of terminal leaves to overgrow other more slow-growing species. The ability of *Lonicera maackii* to establish seedlings in forest edges and interiors, coupled with continuous activity of adventitious buds on the bases of parent plants (Luken 1988), provides a potentially potent combination for long-term domination of site, but this typically occurs as only a result of clonal growth (Luken and Goessling 1995).

Another rapid invader in Inwood Park is *Rosa multiflora*. First introduced to the East Coast from Japan in the1860's as a rootstock for ornamental roses, it has become an ecological threat throughout most of the United States with its tenacious and unstoppable growth habit. The arching cane tips produce new plants on contact with the soil, and it is estimated that one *Rosa multiflora* shrub can produce upwards of a million seeds per year (PCA Alien Plant Working Group 2005). The fruits are readily sought after by birds, the primary dispersers of its seed. *Rosa multiflora* is a serious threat in Inwood Park, particularly at the southern and western portions of the park. A total of 186 stems were recorded with DBHs that were 2.00 cm and above. The encroachment of this shrub into the Valley-Clove forest is particularly troubling as this area is prime habitat for not only migratory birds, but year round resident birds.

While the problem of invasive nonnative species is on a global scale (Drake et. al.1989), some of these species have been planted and used extensively in the past throughout the urban-to-rural gradients across the landscape (Harrington et al. 2003). Opening up of forest canopies through management activities, or natural disturbance that increases light availability, often favors growth and survival of invasive species (Luken et al. 1997; Horvitz et al. 1998; Knapp 1998)). Although natural disturbance has sometimes been implicated in the establishment of invasive species in natural areas (Horvitz et al. 1998), increasing fragmentation of the landscape, especially at the suburban-rural interface, seems to be responsible for the establishment and spread of a great number of invasive species.

The species that were planted as ornamentals in the 1850's through the 1900's in Inwood, and now considered to be serious invasives, are well established, threatening the native species. Fragmentation of the forest by the building the Westside Highway and the Henry Hudson Memorial Bridge, opened the forest edges to further invasion of non-desirable species, such as *Acer platanoides*, *A. pseudoplatanus*, *Ailanthus altissima*, *Alliaria petiolata*, *Ampelopsis brevipedunculata*, *Celastrus orbiculatus*, *Lonicera japonica, Morus alba, Phellodendron amurense, Rosa multiflora*, *and Rubus phoenicolasius*, to name a few. While disturbance facilitates invasion, it is not a prerequisite. Certain shade intolerant species (i.e. *Celastrus orbiculatus*) have been able to establish in the forest understories of Inwood with direct consequences for natural area management.

Along with a need to understand and mitigate the impacts of these invasive species already in the landscape, there is also a need to stop the introduction of species known to be invasive to prevent the introduction of new species that may have the potential to be invasive. Several methods for predicting which species could become invasive have been proposed (Mack 1996). One approach relies on identifying key ecological and life history characteristics common to many invasive plant species (Newsome and Noble 1986; Rejmanek and Richardson 1996). It is also important to look at current geographic distributions of species. Plants with a wide geographic native range are more likely to become invasive when they are introduced elsewhere because of their ability to tolerate a wide range of conditions (Goodwin et al. 1999).

In a recent study assessing whether native or nonnative, and invasive species are spreading or declining, Clemants and Moore (2005) observed a striking pattern for the New York metropolitan region's two native *Chimaphila* species, which are not being impacted by non-native congeners. Based on a value index, which provides a specific measure on the expansion, contraction, or stabilization of these species, Clemants and Moore (2005) found that *Chimaphila umbellata,* which had a raw count of 39 specimens collected during the years 1901-1950, and 8 specimens collected during 1951-2000, had a change index of -2.51. *Chimaphila maculata*, on the other hand, had a raw count of 107 specimens collected during 1901-1950, and 59 specimens collected during 1951-2000, had a change index of -0.29. No studies have been done as yet to better assess why *Chimaphila umbellata* is declining at a greater rate than *C. maculata*. However, some botanists (Lamont and Young 2004) have hypothesized that there may be a leaf chemistry difference between the two species as *C. umbellata* may be more significantly affected by deer browsing than *C. maculata*. *Chimaphila maculata* is present in Inwood (quadrat #12), however, no specimens of *C. umbellata* were found during this current census.

In the same study, two cogeneric species, nonnative-invasive *Celastrus orbiculatus*, had a raw count of 8 during the period 1901-1950. In the period 1951-2000, the raw count increased to 71, with a change index of +3.24. In contrast, *Celastrus scandens*, a native species, had a raw count of 81 during the period 1901-1950, but declined significantly with a raw count of 30 from 1951 to 2000, resulting in a change index of -1.15 (Clemants and Moore 2005). The wide disparity in the indices is indicative of a dramatic decline for the American bittersweet, *Celastrus scandens*, while nonnative-invasive *C. orbiculatus*, has had a dramatic increase (Steward, Clemants, and Moore 2003). *Celastrus scandens* is present in Inwood Park, but was not found in any of the 45 quadrats during this census. Nonnative-invasive *Lonicera maackii* was not included in this study, as it had a recent introduction (lack of any pre-1950 records) (Clemants and Moore 2005), but it is spreading rapidly in the region. Among shrubs, *Lonicera maackii* is the top woody invasive species in Inwood Park. Clemants and Moore (2005) have reported significant increases in nonnative honeysuckles, such as nonnatives *Lonicera japonica* and *L. morrowii*, while native species are undergoing significant decline. Native species *Lonicera dioica* (present in Inwood Park) and *L. sempervirens*, both had negative change indices of -2.87 and -1.93 respectively, while *Lonicera japonica* and *L. morrowii*, both present within Inwood Park, had positive change indices of + 1.60 and + 1.73

respectively.

Along with biological control of invasive species through use of herbicides in Inwood Park, the problem of fires has also continued to plague NRG managers. In recent studies at several National Parks, investigators compared forests with infestations of invasive species to nearby or contiguous stands that lack invasive species (Dibble et al. 2002). The purpose of the study was to compare these infestations to nearby uninvaded stands because of fuel loads, fire return intervals, understory plant diversity, wildlife habitat, and tree regeneration, all of which may be altered when invasive species are especially abundant. Since relatively little is known about the interactions between fire and some of the most problematic invasive species in the Northeast, the researchers measured fuel depths and load by size class, duff depth, basal area for the stand as a whole, percent cover by vegetation stratum, abundance of all vascular plants by species, woody seedling abundance, soil pH, and litter load (Dibble et al. 2002). The focus was on exotic and invasive species such as *Berberis thunbergii*, *Celastrus orbiculatus*, *Lonicera japonica*, *L. maackii*, *L. morrowii*, and *Microstegium vimineum*, and *Robinia pseudoacacia*, which can form dense populations in forested habitats. These invasive species are all present within Inwood Park.

Out of the 11 sites set up in various National Parks, the investigators found significantly greater mass of nonwoody litter in three uninvaded pitch pine stands than in the nearby invaded pine sites and in all other forest types combined. In 8 of the 11 sites, duff depth from 227 Brown planar intercepts on 109 plots was greater in uninvaded forests. What this has suggested is that bare soil in invaded stands might provide a niche for seeds of invasive plants and be less conducive to germination of seeds of native species which often require humus in which to stratify over winter. Dibble et al. (2002) also noted that it would be more difficult to burn invaded habitats where surface fuels are sparse, and response to fire differs by species. However, in some cases application of fire could be effective as a control of invasive plants.

At 8 of 11 sites, Dibble et al. (2002) found that 1-hr fuels were at least slightly more abundant in invaded stands than in uninvaded, and this factor may be be due to the increased shrub density in invaded stands as many of these invasives are shrubs.

In 10 of the 11 sites, graminoid cover was more abundant in invaded stands, and some of these differences are prominent. The graminoids in the invaded stands tended to be invasive exotic grasses, especially *Poa nemoralis*, *Anthoxanthum odoratum*, and especially of *Microstegium vimineum*, the latter two species found in Inwood Park. Especially troubling is the spread of *Microstegium vimineum* in Inwood, as the thick patches of fine fuels are in the interior portions of the West Ridge forest.

Dibble et al. (2002) found distinct differences in the fuels of invaded versus uninvaded forest conditions. Their results showed that Pitch pine stands invaded by black locust are vulnerable to loss of the fire-adapted plant community, and litter and duff layers are greatly reduced under locust. Stands invaded by grasses have continuity of fine fuels that have suggested that these stands might burn more frequently, as fine fuel recovery is quicker following a fire. Where invasive exotic shrubs dominate, there are generally more 1-hr fuels, less litter and duff, more bare ground, and abundant seedlings of some invasive species (e.g., one square meter can have up to 137 smooth buckthorn seedlings, or 343 Norway maple seedlings) (Dibble et al. 2002).

Urban Forest Management: Functions and Practices

The results of this research and the review of the literature suggest that invasive species are likely to persist and that fire regimes may be permanent without intervention. Whether treatments should include fire, herbicide, or cutting depends on, among other things, vegetation type, invasive plant of interest, management goals, proximity to water (i.e. hydrants), recreational use by the public, and presence of rare plants and animals. If burning is considered as an alternative to herbicides for NRG Park managers, fuels may require pretreatment to increase the flammability (Dibble et al. 2002) of some invaded stands. The planting of native species that are less prone to fire in areas of Inwood Park where fires have occurred in the past, can also be considered as an option. In addition to the above, NGR Resource Managers need to include in their management goals for Inwood Hill Park, education of the public as another means of reducing unwanted fires and vandalism.

Urban vegetation has many different functions that provide a wide range of service (Dwyer et al. 1992). All urban forest designs and plans need to consider the specific morphology, natural factors, and human influences. By understanding land-use vegetation structure and composition in context with local conditions, NRG Managers can identify potential opportunities and limitations to enhancing urban forest functions.

Areas such as Inwood Hill Park offer potential space for trees, but the natural environment, (such as lack of water), current land uses, (such as baseball fields), management practices (such as mowing), and/or limited management/maintenance budgets may preclude tree planting and maintenance. While some of these limitations can be overcome by education and increased funding (for example, see Chapter 2, Lila-Wallace Reader's Digest Fund provided to UFEP), it is important to provide a suitable maintenance program in areas undergoing restoration and reforestation. Large areas on the West Ridge undergoing herbicidal treatment to reduce invasive species were left unattended for nearly three years after treatment was completed. In my observations of these areas during this census, nonnative-invasive species such as *Ailanthus altissima*, *Alliaria petiolata*, *Artemisia vulgaris, Celastrus orbiculatus*, *Lonicera japonica*, *L. maackii*, *Microstegium vimineum*, and *Rubus phoenicolasius* have colonized.

Watering of newly planted trees must also be maintained. I have observed many new saplings and seedlings that have died as a result of lack of water. Trained NRG personnel need to oversee volunteers who are involved with the planting process. Urban forest managers need to decide which functions are important, for example, local air quality improvements, reduced energy usage, improved esthetics, and/or management of natural areas. Managers need to develop plans that will provide a vegetation structure for these functions. While designs to improve esthetics, air quality, or transpirational cooling are highly laudable, they may not be conducive to recreational activities. Inwood Park has an abundant wildlife habitat in the forested portion, which NRG managers also need to take into consideration. The recent introduction of the Bald Eagle (*Haliaeetus leucocephalus*) into the forest five years ago has brought an upswing in the number of visitors to the Park. As a result, there is more foot traffic in vulnerable areas that have undergone recent plantings. Daily supplies of fresh salmon for the newly arrived hatchings (installed seasonally) are trucked up to the top of the West Ridge, further increasing stress on exposed roots along the narrowly paved pathways. These conflicts of park usage still remain today and are another factor to consider in establishing and maintaining natural areas in densely populated urban areas.

Urban forest structure is a key determinant of function (Nowak 1994). By understanding forest structure, its composition and diversity, such as in Inwood Hill Park, NRG managers can better evaluate and assess potential changes (e.g. species shifts) in urban forest structure.

<u>V. Chapter 5. Conclusion</u>

Community disturbances of various types and degrees are apparent throughout Inwood Hill Park as was discussed in Chapter 4. The process of gap-phase regeneration is the outcome of such disturbances. The theory of forest dynamics indicates that within the gap-phase of a forest cycle, there are likely to be different taxa present than those found within the non-gap, or non-disturbance sites. Woodland regeneration is a complex process and involves a combination of factors that include: the types of disturbance, the influence of biotic and abiotic factors, the recruitment of pioneer trees in canopy gaps, and the impact of nonnative and invasive species, all of which may determine the future composition and diversity of the plant community. Frequent disturbances from tree falls and tree deaths, brush fires, vandalism, and human trampling may be responsible for the abundance of tree, shrub, and vine species associated with disturbed sites, such as *Prunus serotina*, *Robinia pseudoacacia, Sassafras albidum*, *Lonicera maackii*, *Rosa multiflora*, *Ampelopsis brevipedunculata, and Celastrus orbiculatus*. Trees adapt to disturbance rapidly and fill newly opened canopy space by advance regeneration (i.e. growth release of long-suppressed trees such as *Acer* spp.), by clonal spread (such as *Sassafras albidum* and *Robinia pseudoacacia*), or by abundant seed production (such as *Prunus serotina*). The probability of successful invasion of these species seems to be crucially dependent on the extent and type of disturbance, the number of nonnative and invasive propagules deposited on the community per year, and how long the community is exposed to the import of these propagules (Rejmanek 1989).

Other factors involve changes in arbuscular relationships that may be suppressing native species from colonizing (i.e. *Alliaria petiolata*) (Stinson et. al. 2006), increased light in canopy gaps, which favor the spread of species such as nonnative-invasive *Lonicera maackii,* to the detriment of the native species *Lindera benzoin* (Lukens et al.1997), and the ability of nonnative-invasive *Celastrus orbiculatus* to germinate seeds at a much higher rate of production under low light conditions than its native cogeneric, *C. scandens* (Dreyer et al. 1987).

Of the twelve dominant trees, shrubs, and vines, three arboreal species, *Prunus serotina*, *Sassafras albidum*, and *Fraxinus americana* share characteristics associated with pioneers in disturbed sites. The characteristics of the pioneer class are plants that produce copious amounts of small, well-dispersed seeds, have seeds that can only germinate in full sun, and are short-lived (Whitmore 1989). Among shrubs and vines, *Lonicera maackii*, *Rosa multiflora*, and *Celastrus orbiculatus* have these same pioneer characteristics. These species are of special interest because of their high rates of density and frequency within the study plots.

In comparing diameter size classes, the high preponderance of small stems (n=3765) in the small diameter size-class (2.0 - 9.70 cm DBH), which represented 93% of the total population sampled, indicates a forest composition consisting primarily of saplings, shrubs, and vines. Among trees in this size-class, *Prunus serotina* (n=276) was the most abundant sapling followed by *Sassafras albidum* (n=96), and *Fraxinus americana* (n=93). Among shrubs, *Lindera benzoin* (n=760) was the most abundant species, followed by *Viburnum acerifolium* (n=618), *Lonicera maackii* (n=269), *Viburnum dentatum* (n=190), and *Rosa multiflora* (n=186). Among vines, *Celastrus orbiculatus* (n=181) was the most abundant species.

In the mid-size class diameter (10.20 - 29.90 cm DBH) (n=127), there are considerably fewer stems, which represented just 3% of the overall taxa sampled. Of these, *Quercus rubra* (n=25) had the greatest abundance and was the dominant taxon within this size-class. Following were *Robinia pseudoacacia* (n=19), and *Prunus serotina* (n=9). There was a dearth of mid-size trees especially of *Acer* spp., *Betula lenta*, *Carya* spp., *Liriodendron tulipifera*, *Quercus alba*, Q. *coccinea*, *Q. prinus*, and *Q. velutina*. Most were doubletons (n=2) or singletons (n=1). This is another indicator of a more successional forest as there are fewer trees approaching maturity that would constitute future canopy trees.

In the large-size class diameter (30.20 - 171.20 cm DBH) (n=178), fully mature canopy trees represented just 4% of the overall sampled population. Of these, *Quercus rubra* (n=82) was the most abundant and dominant taxon followed by *Liriodendron tulipifera* (n=23), *Quercus velutina* (n=14), *Q. prinus* (n=13), *Q. alba* (n=6), *Aesculus hippocastanum* (n=5), *Carya cordiformis* (n=5), *Robinia pseudoacacia* (n=4), *Acer saccharum* (n=3), *Fraxinus americana* (n=3), and *Quercus coccinea* (n=3). The remaining species were doubletons (n=2) or singletons (n=1). These mature canopy trees (n=178) represent the last vestiges of the remaining secondary forest of Inwood Hill Park and are mostly confined to two geographic locations, the Valley-Clove forest, and the most northerly portion of the West Ridge forest.

I believe that the past disturbances within the quadrats of the study area, as discussed in Chapter 4, have promoted a distribution of trees more typical of a pioneer rather than a canopy forest. These disturbances of the plant communities may have implications for the future composition and diversity of the forest. Without intervention on the part of NRG managers, invasive species will continue to displace natives.

Permanent vine communities may be established where there are canopy gaps, such as those seen at Wave Hill in the Bronx (Yost et al. 1991), choking out the herbaceous layer. The low representation of saplings and poles of climax (non-pioneer) species will continue to be evident. The reduced numbers of canopy species as indicated by the statistics presented in Chapter 3, will significantly impact on the overall ecology of Inwood Hill Park. The loss of an emerging canopy, usually provided by climax species, will restrict the full range of microclimate influences needed to maintain a rich, and abundant herbaceous and arborescent community. Furthermore, this may lead to a loss or reduction of vegetative cover as habitat that may well have an impact on other important forest organisms.

Fires and vandalism need to be continually addressed by NRG managers of the natural area of Inwood Hill, and contingency plans implemented to thwart their reoccurrence. Other factors that need management attention is the availability of a water source, such as workable hydrants in locations where there is limiting road access for fire-fighting equipment.

As it stands today, the composition of Inwood Hill Park has changed dramatically since Graves (1930) first described it, and later Loeb (1986), who defined the seven distinct plant communities within the confines of this 196 acre Park.

VI. Chapter 6. Geology of Inwood Hill Park in Northern Manhattan

Physiography and Geology of Inwood Hill

Physically, Inwood Hill is part of the New England Province, essentially a northward extension of the larger Appalachian Mountains or Highlands region. The Province is a plateau-like upland that gradually rises inland from the coast and is surmounted by mountain ranges or individual peaks. The principal mountain ranges are the Green, Taconic, and White, while the Berkshire Hills and Hoosac Mountains are southern extensions of the Green Mountains and are of lesser elevation. South and west of the Berkshires and Hoosac Mountains, the physiographic distinction between them and the Taconic Mountains is difficult. The Province sends out two arms or prongs southeastward from New England that serve to connect it with the Appalachian provinces: the *Manhattan Prong*, which terminates at the tip of Manhattan Island, and the *Reading Prong*, which extends beyond the Hudson and Delaware Rivers to Reading, Pennsylvania (Figure 6.1 Map of the New England Physiographic Province and Manhattan Prong).

The *Manhattan Prong*, also known as the *Manhattan Hills*, is a landscape of rolling hills and valleys with elevations generally less than 100 meters (328 feet) above sea level, but ranging from sea level to nearly 274 meters (900 feet) above sea level. The highest point in Manhattan is Fort Tryon Park at about 80 meters (262 feet). Inwood Hill Park is the terminus of Manhattan at about 70 meters (230 feet) and lies just north of Fort Tryon at 40 ° 52' 15" N, 74 ° 55' 45" W. It is separated from Fort Tryon by the Dyckman Street fault valley which cuts across upper Manhattan in a northwest-southeast direction as it bisects the Fort Washington Ridge (Schuberth 1968) (Figure 6.2).

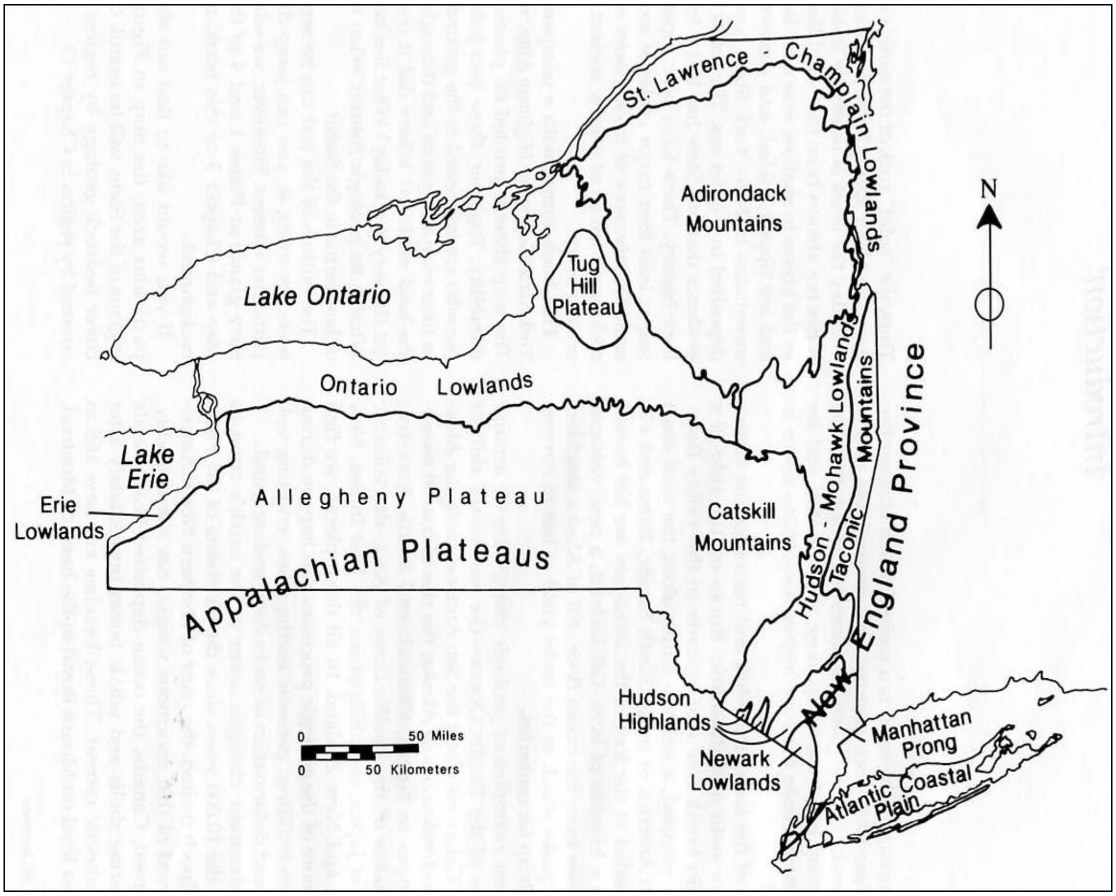


Figure 6.1 Map of New York State showing New England Physiographic Province and the Manhattan Prong. Adapted from Geology of New York: A Simplified Account, Educational Leaflet No. 28, p. 4. New York State Museum/Geological Survey 1991.

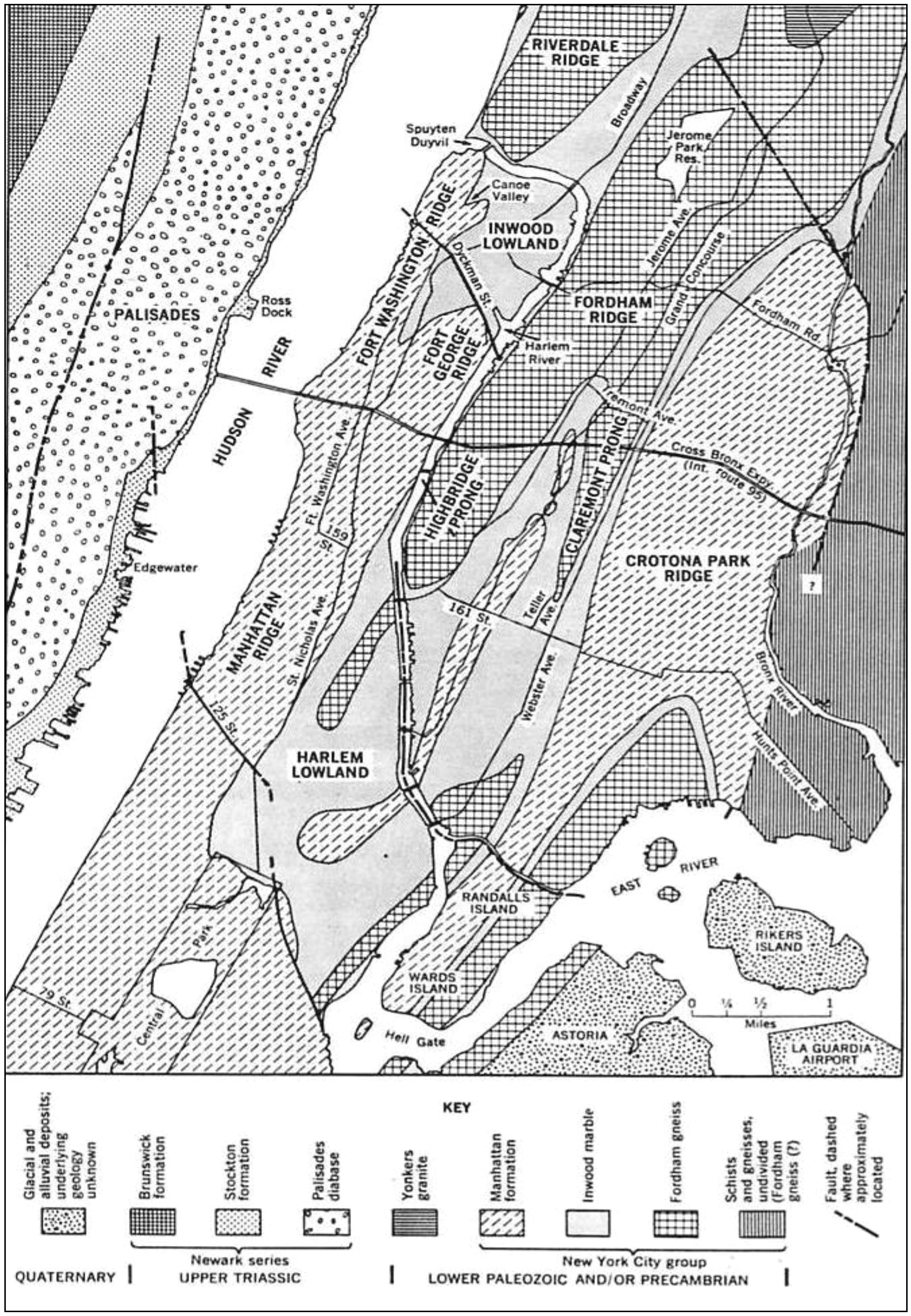


Figure 6.2 Geologic map of the northern part of Manhattan showing arrangement and distribution of rock formations in geologic cross-section in northern New York City. The Inwood Lowland appears in the upper center and is separated by the Dyckman Street fault valley on the south, and Spuyten Duyvil (Harlem Ship Canal) on the northern end. Adapted from Schuberth, 1968 p. 75.

The bedrock of the *Manhattan Prong* underlies much of southwestern Connecticut, Westchester County, New York, and New York City, and ends at the southern tip of Manhattan. The valleys are principally marble and more easily erodible than the schists and gneisses of this unit's higher elevations. The hills are primarily erosion-resistant and tightly folded metamorphic rocks, mostly gneisses and schists with some local deposits of quarzite, overlain with glacial till and coastal plain deposits; they represent vestiges of ancient, worn-down mountain ranges such as are seen in Central Park and Inwood Hill Park. Three distinct metamorphic rock formations make up the Manhattan Prong, known collectively as the New York City Group: the highly folded and contorted Fordham gneiss - the oldest and most widespread of the formations; the Inwood marble, derived from dolomitic limestone; and the younger Manhattan Formation, consisting largely of mica schist, overlying the marble and making up most of the outcrops on Manhattan Island. The soils are mostly acidic, shallow to deep, and rocky. Rivers of note in this geomorphic unit include the Harlem River, the lower Hudson River, the East River, and the Bronx River (Geology of New York: A Simplified Account Educational Leaflet No. 28, 1991). All of these are underlain by Inwood marble except for the Bronx River, which originally flowed through the marble valley, but changed course to its present flow through the mica schist (Merguerian and Sanders 1997).

Geological Significance of Inwood Hill

Geologically, Inwood Hill Park is considered to be part of the New York City Group. It was thought that these metamorphic rock types ranged in age from Precambrian (570 to 4500 mya) to Early Paleozoic (500 to 570 mya) and included sedimentary rock from 600 million years to the present (Schuberth 1968). In terms of sequence stratigraphy, the bedrock underlying Manhattan and the Bronx includes the lowest member, the Fordham Gneiss, followed by Lowerre Quartzite, Inwood Marble, and various schistose and gneissic rocks that were formerly included in a single formation thought to be younger than the Inwood Marble, the Manhattan Schist. Since Schuberth's (1968) time, various geologic researchers have assigned these rocks to different time frames and sequences of events based on petrology and mapping of these rocks and geologic structures, as well as electron-microprobe studies of mineral assemblages, whole-rock geochemical analyses, and radiometric age determinations (Baskerville 1992, 1994; Brock 1993; Brock and Brock 1998, 1999; Brock et al, 2001; Chesman 1997; Hall 1980; Merguerian 1983a, 1983b, 1985, 1996c; Merguerian and Sanders 1990, 1991, 1998) (Table 6.1 Geological Time Chart).

During on recent excavations at the New York Botanical Garden in early November 1997, when new construction was just underway at the Plant Study Center and LuEster T. Mertz Library, Merguerian and Sanders (1998) visited the site of the newly exposed bedrock. After extensive mapping, reconnaissance, photography, and sampling of the bedrock (which was later thin-sectioned and analyzed), the authors have proposed that the Lower Schistose Paleozoic rocks of New York City consist of "three" lithologically distinct amphibolite-grade rock sequences: Sauk; Tippecanoe; and Taconic. These three sequences were formerly deposited as "temporarily correlative lithotopes" in then a convergent-margin regime, which in turn, supplanted a former passive-margin regime. The three units, according to the authors, were originally lumped together as a single formation, the Manhattan Schist, and thought to be younger than the Cambro-Ordovician Inwood Marble formation - which in terms of stratigraphy, would belong to the Tippecanoe Sequence. At present, they are separated by ductile faults, the Saint Nicholas thrust (the basal Taconic thrust), and Cameron's Line, a major tectonic boundary in New England (Merguerian and Sanders 1998) (Figure 6.3).

Important changes occurred from a passive continental margin to a convergent margin during Cambrian to Early Ordovician time. In Late Neoproterozoic time (ca. 560 Ma), rifting and bimodal igneous activity and an extension of the lithosphere led to the opening of the Iapetus Ocean between North America and Amazonia. Deposition of the Manhattan Schist and Hartland terrane type strata were laid down over the ancestral supercontinent of North America (previously formed by Grenvillian collisions), and accompanied this episode of continental rifting (Brock and Brock 2001). After the Iapetus Ocean opened, new continental margins began to develop, and a marine incursion transformed much of eastern North America into shallow-water continental shelf environments. The climate was warm and a carbonate bank flourished in the New York City area. The sediments deposited at this time are now preserved as the Inwood Marble (Brock and Brock 2001). By Middle Ordovician time (450 Ma), the ocean separating North America from an exotic volcanic-arc terrane had closed, and subduction occurred eastwards towards this arc. The exotic terrane began to ride up over the North American crust, depressing it. In response, carbonaceous (graphitic) sediments were deposited in this trough. These sediments are now the metamorphosed products of "two contrasting paleogeographic-paleotectonic regimes separated by a surface of disconformity of regional extent," according to Merguerian and Sanders (1998). The authors have inferred that the lower part of this sequence includes these sediments deposited on an ancient passive continental margin persisting from early in the Cambrian period until the middle

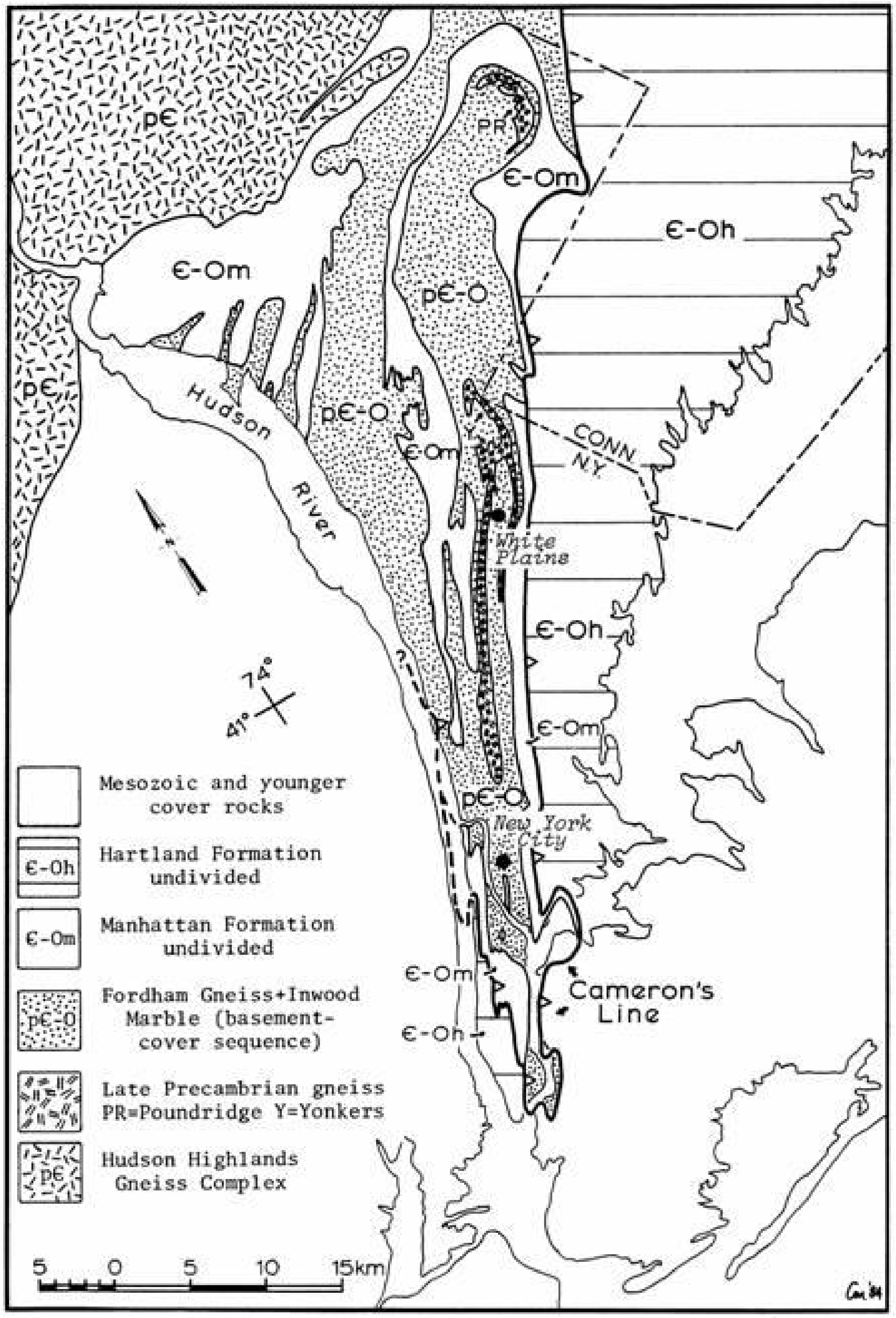


Figure 6.3 Simplified geological map of the Manhattan Prong showing distribution of metamorphosed equivalents of the Sauk and Tippecanoe (included in pЄ-Om and Є-Oh) sequences in the vicinity of New York City. Both Cameron's Line (**CL** – solid triangles) and the Saint Nicholas thrust (**SNT** – open triangles) are represented. Originally published in Mose and Merguerian, 1985, and adapted from Merguerian and Sanders, 1998.

of the Ordovician Period. It featured a carbonate-platform interior: "the Sauk Sequence," bordered by a continental-rise prism (accretionary) of fine-textured terrigenous sediment "the Taconic Sequence," and an oceanward volcanic realm. After exposure of the former carbonate shelf and rapid subsidence to form a foreland basin, the Sauk and Taconic sequences were "overlapped" by a thick body of terrigenous sediment: "the Tippecanoe Sequence," which filled the foreland basin. As a result, the deposits of these "disparate" sedimentologic realms were juxtaposed during the late middle Ordovician Taconic Orogeny (Merguerian 1983a, 1985, 1996; Merguerian and Baskerville 1987; Merguerian and Sanders 1991, 1993a, 1993b, 1996, 1998).

The first of the "overthrusts" toward the continent broke "inboard of the former shelf edge" and brought felsic continental basement rocks above the muds on the floor of the foreland basin where the Tippecanoe Sequence was accumulating. Later, according to Merguerian and Sanders (1998), the Taconic allochthons were emplaced bringing the "displaced terrigenous sediments" of the Taconic Sequence above the carbonates and clastics of the Sauk and Tippecanoe sequences. The two important ductile fault surfaces are connected with the Taconic Sequence: (1) the "Taconic basal thrust," which brought the continental-rise sediments up above the former shelf (the Saint Nicholas thrust (**SNT**) in New York City and, (2) Cameron's Line (**CL**), a "major dislocation" within the Taconic Sequence along which deep-ocean sediments were transported above the continental-rise sediments. Hence, the authors state that only a "small part" of the rocks assigned to the Manhattan Schist "represent" the metamorphosed clastics belonging to the Tippecanoe Sequence (Figure 6.4A, B).

The three distinctive mappable units of the "Manhattan Schist" represent

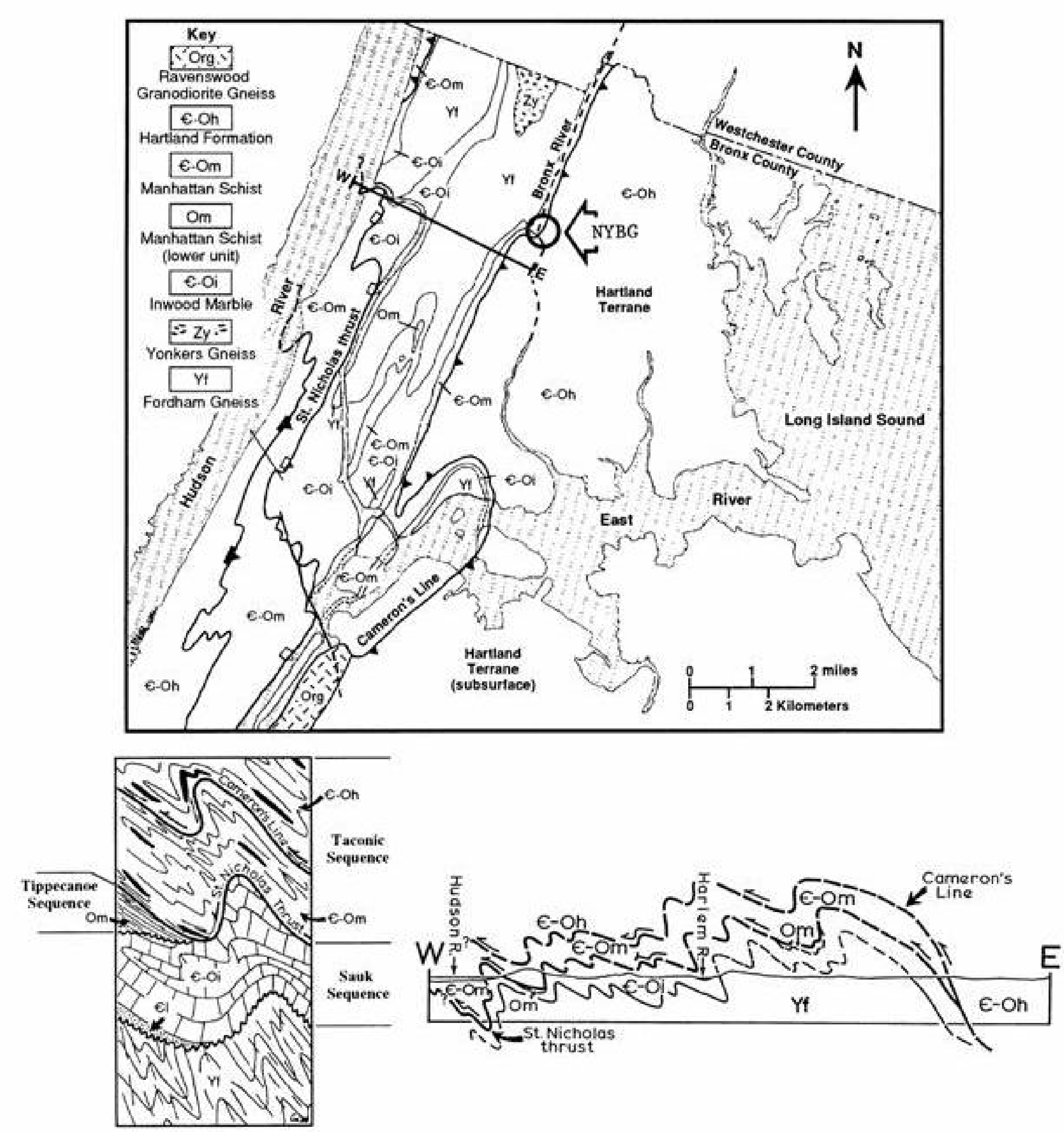


Figure 6.4A, B, C. Geologic map of the south end of the Manhattan Prong showing Cameron's Line, the Saint Nicholas Thrust, and bounding metamorphic units.The new excavation at the New York Botanical Garden is circled. Insets (B, C) show tectostratigraphic units of New York City as subdivided into the Sauk, Tippecanoe, and Taconic sequences. Geologic section (W-E) shows folded Taconian thrusts (**CL** and **SNT**). Adapted from Merguerian and Sanders 1998.

essentially coeval foreland-basin fill (Om = Tippecanoe Sequence), transitional slope/rise (Є-Om = Taconic Sequence), and deep-water (Є-Oh = Taconic Sequence), former sea floor lithotopes that were juxtaposed when the ancestral North American shelf edge was "telescoped" in response to closure of the proto-Atlantic (Iapetus) ocean during the Taconic orogeny. Detailed mapping and recognition of ductile faults within the Manhattan Formation has allowed a new interpretation of the previously "lumped together" Manhattan Schist (Merguerian 1983a, 1983b, 1985, 1996c; Merguerian and Baskerville 1987; Merguerian and Sanders 1991, 1993a, 1993b, 1996, 1998).

What Merguerian and Sanders (1998) have inferred is that regional correlation of the higher structural slices of the Manhattan Schist are "older," or may possibly overlap in age with the lower unit (Om) (Figure 6.5A, B). Structural evidence to define the contacts among the "three Manhattan schists" can be seen in Inwood Hill Park, Isham Park, Saint Nicholas Park, Mount Morris Park, and in Boro Hall Park as well as the new excavation in the New York Botanical Garden (Figure 6.4A). A ductile shear zone, the Saint Nicholas Thrust (open symbol in Figure 6.5A), truncates the base of the middle schist (Є-Om) and is exposed here in Inwood Hill and Isham Parks (Merguerian and Sanders 1998).

Metamorphic Rocks of Inwood and Isham Parks

Inwood Hill Park is bordered by Dyckman Street on the south, the Hudson River on the west, Harlem Ship Canal (Spuyten Dyvil) on the north, and Payson and Seaman Avenues on the east. This area of Manhattan is known as the Inwood section and is underlain by Inwood Marble (Inwood Lowland), which occupies the flat area northeast of Inwood Hill Park, extending eastward to Broadway between Isham and 214th Streets

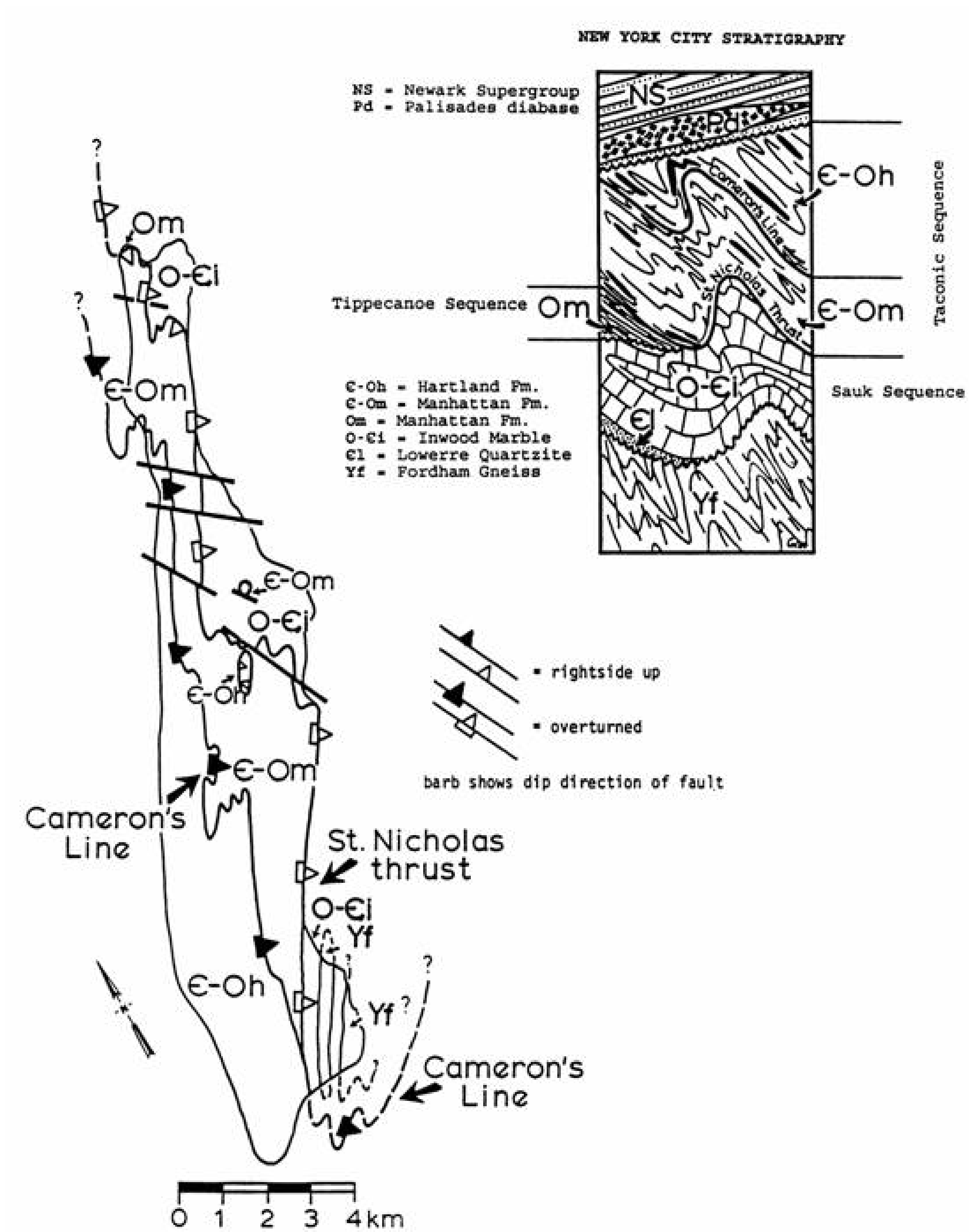


Figure 6.5A, B. Geologic Map of Manhattan Island showing new interpretation of the stratigraphy and structure of the Manhattan Schist and distribution of metamorphic rocks ranging from Proterozoic Y through Early Paleozoic in age. Originally published in Mose and Merguerian 1985, and adapted from Merguerian 1996c.

(Schuberth 1968) (Figure 6.2). The exception is nearby Isham Park (once a continuous tract of land with what is now Inwood Hill Park). Isham Park contains near continuous exposure of the Inwood Marble with several lithologies occurring: coarse-grained dolomitic marble, fine-grained calcite marble, foliated calc-schist, and marble containing siliceous layers and calc-silicate aggregates that stand in relief as knots on a weathered surface (Merguerian 1996c). These exposures can be seen at Isham Street and Seaman Avenue across from the Park, and represents the former carbonate shelf, the Sauk Sequence, preserved here as the Cambro-Ordovician Inwood Marble.

The soils of Inwood Hill are primarily acidic due to the schist with the exception of Inwood marble which underlays the schist. A full discussion of how these soils relate to the forest community is presented in Chapter 2 under Edaphic Conditions.

Entering Inwood Hill Park at Isham Street and Seaman Avenue, the first of two prominent ridges, the East Ridge, arises. It is composed of kyanite-garnet gneiss and schist of the middle schist unit (**Є**-Om), and is structurally separated from the Inwood Marble by the Saint Nicholas thrust but not exposed here (Merguerian and Sanders 1991). On the west side of East Ridge, a valley (Clove) separates the East and West ridges and is underlain by a plunging synform (syncline), exposing tan weathering, gray-white Inwood Marble. The West Ridge extends further north with massive, brown-weathering, blackish amphibolite of the middle schist unit cropping out along the northernmost path. The rocks exposed here (**Є**-Om) are massive muscovite-biotite-plagioclase-quartz-garnet-kyanite gneiss and schist with weathered kyanite and sillimanite nodules (Merguerian and Sanders (1991). Along the north-facing backslope of the Western Ridge, the contact between the middle (**Є**-Om) and lower (Om) schist units, the Saint Nicholas Thrust

(**SNT**), is exposed in a 20 meter zone from beneath the Henry Hudson Bridge abutment to the river level. Directly beneath the Henry Hudson Bridge is a steep dirt trail that leads down to the river where a coarse-grained, gray-white calcite marble is exposed at low tide. Near the schist-Inwood contact, the schistose rocks include layers of calcite marble, most probably metamorphosed Balmville, the basal limestone of the Tippecanoe Sequence (Fuller, Short, and Merguerian (2004); Merguerian and Sanders (1998). Unit Om is interpreted as being autochthonous (depositionally above the Inwood Marble but not originally deposited where the rocks are now found). Merguerian and Sanders (1998) have assigned it as Middle Ordovician age and consider it to be part of the Tippecanoe Sequence. Physically, above the marble exposure, Merguerian and Sanders (1996c) describe the lower schist unit as consisting of biotite-quartz-plagioclase and kyanite with abundant garnet porphyroblasts. Here, the lower schist unit contains mylonitic (ductile-fault zone) foliation composed of mm-scale ribboned and polygonized quartz with recrystallized reddish biotite. The thrust zone is structurally complex, consisting of intercalated lithologies of the lower and middle schist units together with mylonitic amphibolite (Merguerian and Sanders 1996c).

Beginning at roughly 10 to 15 km and continuing downward, the rocks in the thrust zone have been under great stress resulting in aseismic behavior to relieve strain by recrystallizing during flow. These unique metamorphic conditions prompted the development of highly strained (ribbonized) quartz, a condition that results in highly laminated (mylonitic) rocks usually associated with ductile faults. Differential forces, applied over long periods of time, caused the rocks to “fail by flowing,” defined as behaving in a ductile fashion (Merguerian 2002).

The significance of the geology of Inwood is the fact that it is seismically active as the Park is situated between several earthquake faults: the Dyckman Street fault on the southern end; the Hudson River on the west; and a major tectonic boundary, Cameron's Line and the Saint Nicholas thrust at the northern end (Figures 6.5 and 6.6). Merguerian (2002) has mapped many NW-trending faults in the Queens Tunnel. The protracted brittle faulting in the New York City area has developed a regional pattern consisting of three major, mutually intersecting fracture orientations: NW, NNW, and NNE. Together, they provide a nearly orthogonal pattern of crustal weakness, and brittle NNW-trending faults have proven to be the "youngest" geological episode recorded in the Queens Tunnel, according to Merguerian (2002). The slip along NNW-trending faults has produced "recent seismicity" in the Manhattan Prong. The epicenter of a small earthquake (~2.4 Richter, 40.777° N latitude and 73.954° W longitudinal at a depth of ~5-7 km.) localized in New York City on 17 January 2001 plots adjacent to the trace of the 125th Street (Manhattanville) fault (Figure 6.6) near 102nd Street and Park Avenue in Manhattan (Merguerian 2002). The fault traverses diagonally across Manhattan from Broadway and 125th Street southeastward to the Harlem Meer in Central Park at 108th Street, passing through the epicenter across 96th Street and the east shore of Manhattan. From there, the Manhattanville fault passes across the East River and onwards to the subsurface of Long Island City. Later in the same year on 27 October, another similar earthquake (~2.6 Richter, 40.76° N latitude and 73.98° W longitude at a depth of only 1 km.) struck New York City with an epicenter near 55th Street and Eighth Avenue. These events are significant because they mark the first recorded on-land earthquakes to occur within the confines of New York City (Merguerian (2002). This supports the contention of Merguerian and Sanders (1997), that the NW-trending faults in New York City, (the Manhattanville) 125th Street, Dyckman Street, Mosholu (Van Cortlandt Park) faults, and many others (Figure 6.6) hold the greatest potential for "urban seismic risk." Seismic activity along the NW-trending Dobbs Ferry fault in late October 1985 produced two small (~4.0 Richter) tremors and many aftershocks. Larger earthquakes in and around the vicinity of New York City were recorded in 1884 (~5.0-5.5), 1783 (~4.9), and 1737 (~5.2). In the Bronx, field evidence suggests that the right-lateral offset along the NW-trending Mosholu fault (Van Cortlandt Park) was a post-glacial phenomenon with demonstrable offset of surface drainage (Mergurian 1996a, b; Merguerian and Sanders 1996, 1997). Very clearly, a pattern of seismic slip along NNW-trending faults has begun to establish itself in the New York City area.

In summary, the Saint Nicholas Thrust (Taconic frontal thrust) separates lower-plate Tippecanoe (Om) and Sauk (Є-Oi) (Figures 6A, C) rocks of upper-plate gneiss, schist, and amphibolite of the Cambro-Ordovician slope- and rise (Manhattan Formation Є-Om). The structurally higher ductile fault, mapped as Cameron's Line, juxtaposes muscovite-rich schist and gneiss, amphibolite, serpentinite, and a coticule of former deep-water realm (Hartland Terrane Є-Oh) with Є-Om rocks. (Coticules are garnet-rich quartzites which have chemically distinct lithologies of controversial origin usually occurring in schists, amphibolites, and quartzites as thin layers of Paleozoic age formations and associated with orogenic belts such as the Appalachians (Merguerian and Sanders 1998). Combined together as the Manhattan Schist Formation by past workers, the subunits Є-Om and Є-Oh, are considered to be metamorphosed sheared facies of the Taconic sequence. During Ordovician Taconic-arc continental suturing, the Saint

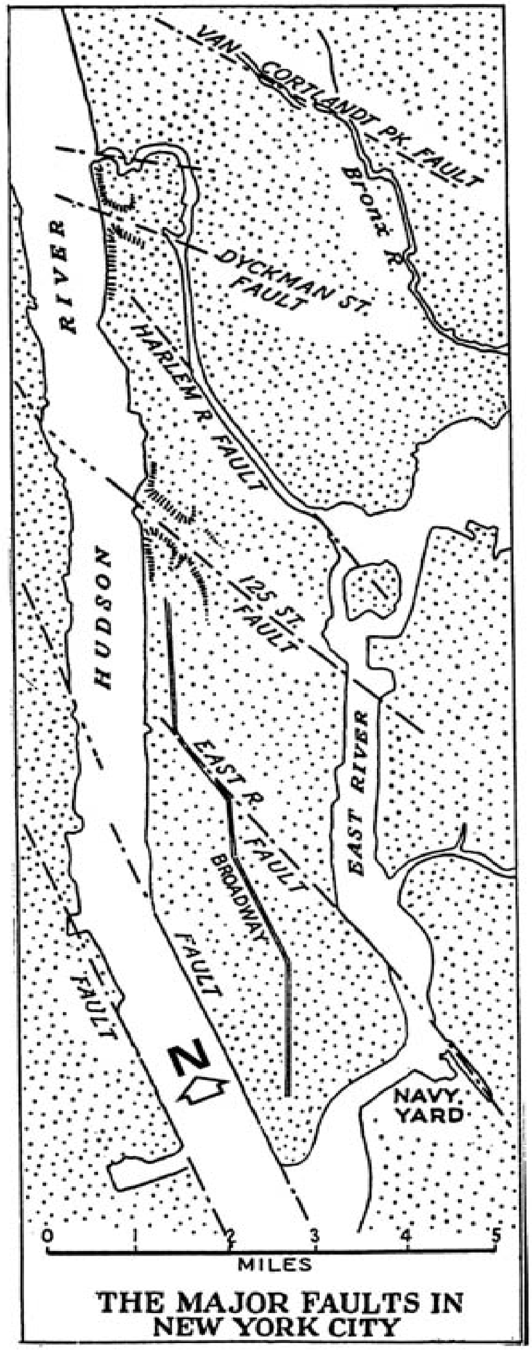


Figure 6.6 Map of major faults drawn by Lobeck. 1939.

Nicholas Thrust (beneath Inwood Hill Park) and Cameron's Line juxtaposed former shelf-, rise-, and deep-water facies in a continentward- facing subduction complex (Merguerian 1986, 1996c; Merguerian and Sanders 1991b, 1991g, 1993d).Various metamorphic rocks found in Inwood Hill and Isham Parks, as well as in the New York City area, were formerly deposited across a Cambro-Ordovician shelf edge of the embryonic North America. The former shelf, Sauk Sequence, is preserved as the Cambro-Ordovician marble (**Є**-Oi) that is locally interlayed with autochtonous (detached sheets of rock) calcite-marble (Balmville Limestone) bearing Middle Ordovician Manhattan Schist (Om) of the Tippecanoe Sequence. At the western edge of the New York Botanical Garden and the Bronx Zoo, the fault contact of the Hutchinson-Hartland Terrane with the Manhattan Prong (Figures 6.3, 6.4C) is exposed. Mapped by Merguerian and Sanders (1998) from New York City into western Connecticut, this zone of highly sheared metamorphic rocks known as mylonites (ductile-fault zones) are developed along Cameron's Line (major tectonic plate suture boundary), and also appear in Inwood Hill Park's northern end. The shear zone (suture) separates rocks of oceanic parentage to the east (deep-water mafic amphibolites) from rocks of continental affinities to the west, and marks an important geologic boundary for the Appalachian mountain belt through southeastern New York into New England.

Table 6.1 Geological Time Chart

ERA		Selected Major Geologic Events from Southeastern New York and Vicinity
Periods	**Years**	
(Epochs)	**(Ma)**	
CENOZOIC		
Holocene	**0.1**	Rising sea forms Husdon Estuary, Long Island Sound, Great South Bay, other bays and harbors on
		Long Island. Barrier islands form and migrate as sea level rises.
Pleistocene	**1.6**	Melting of last glaciers forms large lakes. Drainage from Great Lakes overflows into Mohawk River
		and Hudson Valley. Protracted continental glaciation with five (?) glaciers flowing from NW and NE
		to form moraine ridges and superposed glacial drift deposits in NJ, NY, CT, and LI.
Pliocene	**6.2**	Regional uplift, tilting and erosion of Cretaceous coastal plain strata; sea level drops.
Miocene	**26.2**	Sediment fans spread E and SE from Appalachians to extend coastal plain and push back sea. Last
		widespread marine unit appears in coastal plain strata.
MESOZOIC	**65**	
Cretaceous		Passive eastern margin of North American plate subsides and sediments of coastal plain strata
		accumulate to 18,000 ft. thickness. **[Passive-margin sequence II]**.
Jurassic	**190**	Baltimore Canyon Trough forms and fills with 8,000 feet of sediment as Atlantic Ocean starts to open.
		Newark Basins deformed, arched, and eroded.
	200	Continued sediment filling of subsiding Newark basins along mafic igneous activity both intrusive and
Triassic		extrusive. Newark basins form and fill with red river flood plain and channel sediments.
PALEOZOIC	**245**	
Permian		Extensive pre-Newark erosion surface formed.
	260	**Appalachian Orogeny** (Terminal Stage). Folding, overthrusting, and metamorphism of Rhode Island coal
		basins; granites intruded.
Carboniferous	**320**	Faulting, folding, and retrograde metamorphism in New York City area. Southeastern NY undergoes
		period of uplift and erosion.

Adapted from Merguerian and Sanders 1991.Geology of Manhattan and the Bronx. New York Academy of Sciences.

Table 6.1 Geological Time Chart

Devonian	**365**	**Acadian Orogeny.** Intrusive activity and metamorphism in New England infrastructure. Faulting,
		folding, and metamorphism in New York City area. Peekskill Granite and Acadian granites intruded in
		New York and New England. Deep burial of sedimentary strata of Appalachian Basin.
Silurian		Uplift, erosion and planation surface forms across Appalachian orogeny.
Ordovician	**440**	**Taconic Orogeny.** Arc-continent collision. Intense deep-seated deformation and granulite-grade
		metamorphism in infrastructure. Overthrusts from ocean toward continent in supercrustal (external)
		parts of orogen. Taconian deep-water strata thrust above shallow-water strata. Ultramafic rocks
		(oceanic lithosphere) sliced off and transported above deposits of continental shelf.
	450	Brookfield Series, Cortlandt Complex, Hodges Complex, and related rocks intrude across Taconian
		suture zone (**Cameron's Line** and related shear zones).
		Bathymetric reversal and development of deep-water **Tippecanoe Sequence** above beveled **Sauk** platform.
Cambrian	**510**	Shallow-water clastics and carbonates accumulate in west basin (**Sauk Sequence**; protoliths of
		Lowerre Quartzite, Inwood Marble, and part of the Manhattan Schist Formation = Walloomsic).
		Deep-water terrigenous silts form to the east. (**Taconic Sequence**; (Cambrian) protoliths of Hartland
		Formation and parts of Manhattan Schist Formation). **[Passive-margin sequence I].**
PROTEROZOIC	**544**	Period of uplift and erosion followed by subsidence of margin.
Z		Rifting with rift sediments, volcanism, and intrusive activity.
		Ned Mountain, Pound Ridge, and Yonkers gneiss protoliths.
Y	**~1000**	**Grenville Orogeny.** Sediments and volcanics deposited, compressive deformation, intrusive activity, and
		granulite facies metamorphism. (Fordham Gneiss, Hudson Highlands and related rocks including Queens
		Tunnel Complex in New York City).
ARCHEAN	**2600**	No record in New York City area. Some elements of western Adirondacks form.
	4400	Oldest crustal rocks from western Australia.
	4600	Solar system, Earth and Moon form.

Adapted from Merguerian and Sanders 1991.Geology of Manhattan and the Bronx. New York Academy of Sciences.

VII. Chapter 7. History of Inwood Hill Park in Northern Manhattan

Historical Background of Inwood Hill: Native Americans and the Arrival of the European Settlers

The PaleoIndian period (10,000-8,000 B.C.) is the time humans first came to the southeastern New York region and corresponds with the end of the Wisconsin glacier (Funk 1972, 1976; Ritchie 1980). The Archaic (8,000-1,700 B.C.) refers to a time prior to the introduction of horticulture and pottery manufacture and is divided into Early, Middle, and Late periods. The Transitional period (1,700-100 B.C.) witnessed a gradual change in Archaic lifestyles with the development of "Woodland" period traits. The Woodland Period (100 B.C.-1,600 A.D.), which is characterized by use of pottery and reliance on horticulture, is divided into Early, Middle, and Late periods.

Little is known about the cultural activities during the PaleoIndian period although it is generally accepted that the region was first inhabited by humans approximately 8,000 B.C. (Funk 1972, 1976; Ritchie 1980). Population was very sparse. Sea levels were lower during this period and the subsequent Early Archaic period due to sea water being trapped in the remaining glacial ice. Local forests consisted primarily of spruce and firs with small amounts of oak and other deciduous species (Snow 1980). Many faunal species, now extinct or no longer native to the area, were present (Hartnagel 1922). However, a number of different sites, where various activities had been occurring, were identified based on the recovery of a variety of stone tools, and other artifacts, and their environmental setting (Funk 1976). Most evidence for PaleoIndian sites, however, comes from scattered finds of Clovis Fluted points, a diagnostic PaleoIndian artifact (Funk 1976: 205). A small number of undisturbed PaleoIndian sites have been recorded in the southeastern New York area (Funk 1976). In particular, the number of sites found in the region of Staten Island: Port Socony North and South sites; Cutting site; Kreischerville; and Charleston Beach (Grossman and Boesch 1996).

During the Archaic period (8,000-1,700 B.C.), the environment changed from a pine-dominated forest to an increasingly deciduous character by 2,000 B.C. (Salwen 1975). Archaic cultures were adapted to life in the forests with individuals eating a varied diet based on seasonal exploitation of various animal and plant species (Funk and Ritchie 1973). However, in the lower Hudson Valley and Long Island area, oysters became the major part of the diet, at least seasonally, during this period (Brennan 1977).

Most Early Woodland sites in southeastern New York are located along the Hudson River or its major tributaries, or along the East River-Long Island Sound Shore (Funk 1976). During Early Woodland times (100 B.C.-200 A.D.), the use of fired clay ceramic was gradually replaced by the use of soapstone vessels. Diet included a continuation of hunting, gathering, and fishing of the Archaic period but was supplemented by an increase in shellfish collecting. It has been suggested that this indicated a trend towards more permanent villages with individuals living in the same place year round (Funk 1976; Snow 1980).

The Middle Woodland period (1-900 A.D.) witnessed a gradual change to a more sedentary lifestyle. There has been speculation that domestication of various plants occurred during this period (Ritchie and Funk 1973). By Late Woodland times (900-1,600 A.D.), horticulture was the primary subsistence base and permanent villages existed. However, some archaeologists disagree whether Native American cultivation of corn (*Zea mays*), an indication of agriculture-based permanent settlements, occurred before the arrival of the Europeans (Loeb 1998). Fossil pollen evidence of prehistoric corn (*Zea mays*) and hickory (Carya spp.) plantings have been found in Mishow Marsh, Hunter Island, Bronx County, NY, and dated to between 1075 and 1275 A.D. (Loeb 1998).

By the latter part of the Late Woodland period, Native American cultures began to resemble those groups that were encountered by seventeenth century Europeans. At this time, Native Americans of the lower Hudson Valley region were part of a widespread Algonquian cultural and linguistic stock. Specifically, they were a group of Munsee speakers who migrated into southeastern New York and southwestern Connecticut during Late Woodland times (Goddard 1978a, 1978b; Salwen 1978; Solomon 1982). Their descendants were known collectively as the Wappinger. The Wappinger occupied present-day Westchester, Putnum, Dutchess, the Bronx and New York Counties, and southwestern Connecticut.

About 700-800 A.D., the roving bands of human beings who had hunted and intermittently farmed the area began to develop tribal groupings identified by the people who were to arrive centuries later. The basic precondition for the creation of a larger grouping began to appear: small settled communities and villages (Ultan 1993)

By the time the early Europeans arrived on the North American continent, generally known as the Contact period (A.D. 1600 ca - 1750), the area now known as Inwood had a long history of human activity. In what was to become Manhattan and the nearby Bronx, two or perhaps three tribes appeared: the Weckquaesgeeks, a branch of the Wappinger tribe (headquartered in what is now Dobbs Ferry) who occupied the area just north of Manhattan; in the western section were the Rechgawawancs (Manhattans) who occupied most of the island later named for them, and who were part of the larger group of Weckquaesgeeks. On the eastern shore, extending from Hell Gate to Norwalk in Connecticut, might have been the Siwanoys (Ultan 1993). The tribes had grown out of village bands, and it was still the local village that was the important unit to the people then. In addition, all tribes in the area shared the same general cultural aspects and had similar ways of doing things. They all spoke variations of the basic Algonquin language. It is believed that the tribes inhabiting the area also shared a common heritage. The Lenape were a family of tribes that included the Rechgawawancs (Manhattans). The tribes in the area always addressed the Lenapes as "grandfathers," rather than the usual "brothers," used for other tribes, presumably because of their ancient origin. It is supposed that the other tribes evolved by splitting off from the Lenape grouping (Ultan 1993).

European contact with Manhattan and the nearby Bronx first occurred over 400 years ago. In 1609, Henry Hudson, probably the first European to see the shoreline, sought cover from a storm for his vessel, the Halve Maen, in Spuyten Duyvil Creek (Hermalyn and Ultan 1995). Living in the area (now known as Inwood) were the Rechgawawancs whose Sachem was named "Rechgawac," or "Rechewac," that contained the caves in which the Rechgawawane lived. It is the oldest dwelling of mankind on Manhattan Island (Bolton 1932) (Figure 7.1 Map of Indian Sites in Inwood). The Rechgawawane controlled the part of Manhattan from its northern end down to 59th Street. Here, the territory was controlled by the Carnarsee of Kings County. The Rechgawawane also controlled Morrisania as far as the Bronx River (Bolton 1924). In 1629, they sold Jonas Bronck, a Swedish sea captain from the Netherlands, the southern

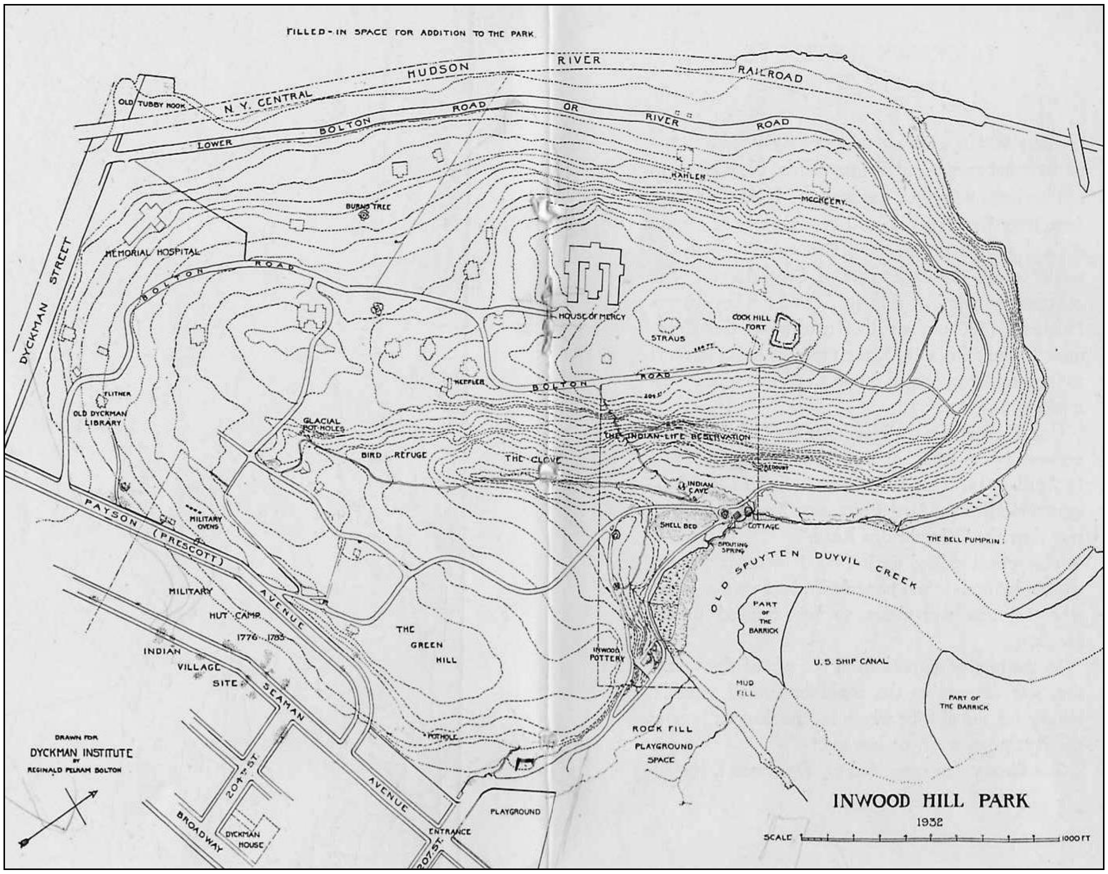


Figure 7.1 Map of Inwood Hill in1932 showing Indian middens and caves where the Rechgawawane (Manhattan Indians) lived. Adapted from Bolton 1932. Dyckman Institute.

portion of the Bronx, extending east to the Bronx River (Bolton 1924).

The Rechgawawancs had numerous fishing stations along the rivers, one of the largest being the Dyckman tract that extended from Fort George to Inwood Hill and Marble Hill. The remains of their fishing and hunting expeditions have been unearthed along the east side of Seaman Avenue from Academy Street to the Creek in the pits that were found there (Bolton 1924) (Figure 7.2). The pits were filled with oyster shells, burials, and extensive deposits of carbonized debris indicating a long and continuous occupation (Bolton 1924). At Seaman Avenue and Isham Street, a planting-ground was evidently cultivated. Human internments that have been found along the Seaman Avenue village-site are the only aboriginal burials discovered on the island of Manhattan (Bolton 1924). Some of these remains were evidently from a very remote period as the skeletons were extremely dry and of much greater age than those of nearby early settlers buried in the sandy soils (Bolton 1924).

The extent, depth, and character of the shell heaps at Dyckman Street, at Cold Spring hollow (Shorakapkok Glen), and at Seaman Avenue, point to a settlement spread out over a considerable space of time (Bolton 1924). The ceremonial pits at 212th Street, and certain remains of aboriginal feasting (fish bones, and oyster shells in firepits), were found at a level below the graves of the slaves of the early Colonial settlers who were buried there (Bolton 1924). These remains are probably an indication that the period of occupancy was at least as remote as the Late Woodland period. The tools and weapons discovered are all of the Neolithic order in various degrees of finish and polish. It is only at Dyckman Street that objects of the earlier Paleolithic character have been found, such as crudely chipped and unfinished stones (Bolton 1924).

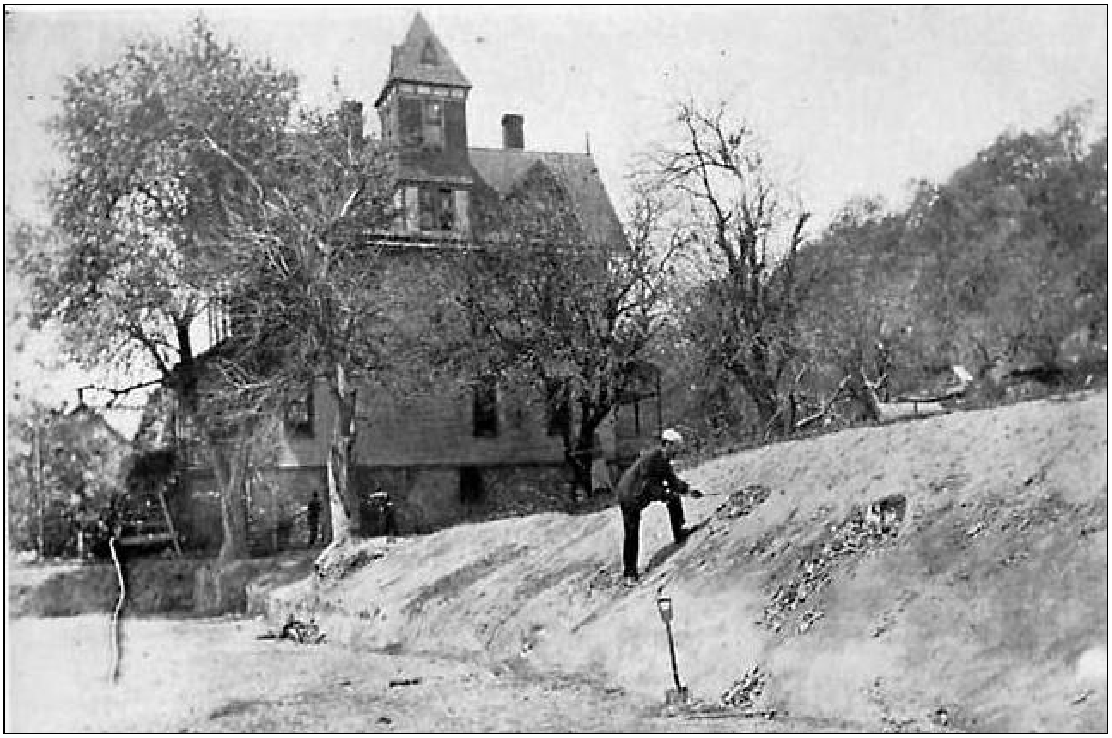


Figure 7.2 The Indian Village Site on Seaman Avenue. Reginald. P. Bolton exposing food-pits filled with shells which mark the position of the Indian lodges. Aboriginal remains dating to the Late Woodland Period were found nearby. Adapted from Bolton 1924. Dyckman Institute.

At Shorakapkok Glen, the most extensive native depositions of discarded shells, flints, broken pottery and other debris were found near the old Tulip tree (Figure 7.3). These were Indian middens which were explored and preserved by the Heye Foundation at the Museum of the American Indian (Bolton 1924).

After the Dutch occupied and bought several large tracts of land from the Weckquaesgeeks, they timbered the land, cutting large swaths along the original Indian pathways that later became Amsterdam Avenue and Kings Way, now Broadway (Bolton 1924). In 1625, Peter Minuit may have purchased Manhattan Island somewhere near Cold Spring hollow, in the area known as Shorakapkok Glen. The Dutch had many wars with the Weckquaesgeeks as they colonized the land and built their farms and apple orchards. By 1644, the Weckquaesgeeks had been driven from their fishing and hunting grounds (Bolton 1924). Spuyten Duyvil Creek lowland was divided among the freeholders of Niew Haarlem in 1677, the largest tract going to Jan Dyckman and Jan Nagel. Colonel Stephen Van Cortlandt, acting for the town of Niew Haarlem, made a treaty with the last of the Weckquaesgeeks in 1688, but the money was not paid until 1715. The last Indian claims to the northern portion of Manhattan were ended, and the land divided between the Nagels, who owned the northern portion and included what is now Kingsbridge, and the Dyckmans, who owned the southeast plot that included all of Inwood as far as the Harlem River.

In 1744, the woodlands of the hill north of Tubby Hook were divided between the Nagel and Dyckman heirs in six lots (Bolton 1924). (Tubby Hook was originally named for a Dutch settler named Ubrecht; the name was altered by the English and became “T’Ubby,” then Tubby, and finally called Inwood.) After the Revolutionary War ended,

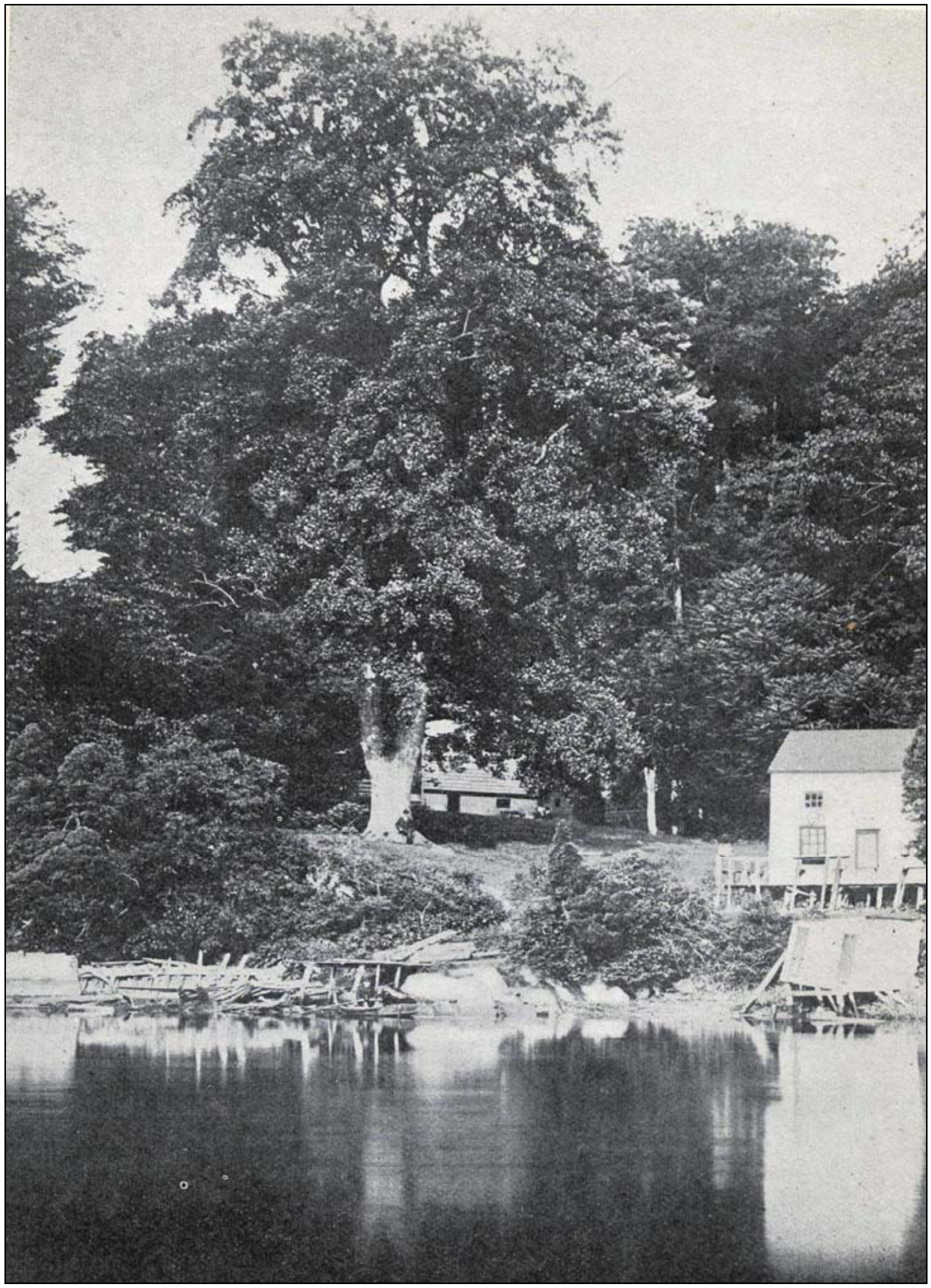


Figure 7.3 The Great Tulip tree at the edge of Spuyten Duyvil Creek where Indian middens were explored by the Heye Foundation. The tree was the last living link with the Rechgawawane Indians and assessed to be 280 years old when it was felled in the hurricane of 1938. The tree was 165 feet high with a 6 ½ foot girth. Abraham Seeley's cottage is at far right, and the Indian Museum, containing many Indian artifacts, is behind the tulip tree. Adapted from Bolton 1924. Dyckman Institute.

Dyckman's youngest son, William Dyckman, built a farmstead at what is now Broadway and West 204th Street. His heirs continued to live on the farmstead until 1916 when the property was deeded to New York City. The building still stands today but the large orchards that were planted there were destroyed by the British during the Revolutionary War (Bolton 1924).

Revolutionary War Activities in Inwood Hill Park

After the British were forced out of the Boston area during the American Revolution, they attacked the New York City area, routing General George Washington from Long Island through the Bronx to White Plains, Westchester County. The Americans still retained a stronghold on the northern tip of Manhattan Island, namely, Fort Washington. Included in this defense system was Cock Hill Fort (General George Washington may have shortened the name of Shorakapkok to Cock Hill) at the top of Inwood Hill (Bolton 1924) (Figure 7.1). The Americans were forced to surrender this entire area with the taking of Fort Washington. Hessian troops were stationed in huts from 1776 to 1783 in part of Inwood (along what is now Payson Avenue) until after the end of the American Revolution (Bolton 1924). The timber of Inwood was removed during the war and the old Indian paths widened to carry horse-drawn carts and cannon. Both the British and the Americans practiced slash-and-burn policies which had a profound effect on the forests of northern Manhattan.

As the forests receded, land acquisition expanded for the later development of the many estates that dotted the picturesque landscape of Fort Washington and Inwood (Bolton 1924; Clayton 1992) (Figure 7.4, 7.5 Valentine Seaman Mansion, Seaman-Drake Arch). Many of the estates had gardeners and landscapers, such as those of the Seaman-

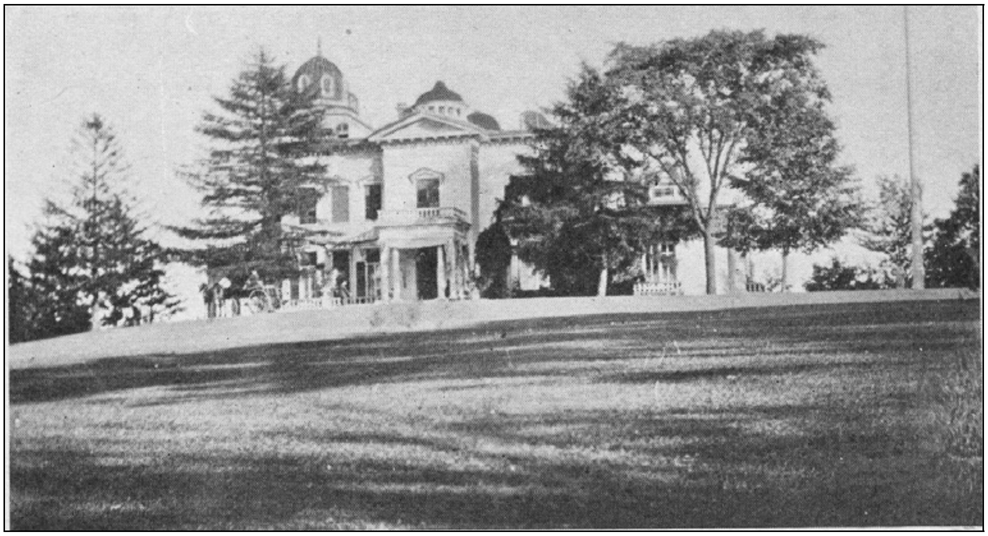


Figure 7.4 Valentine Seaman Mansion (shown above). Built in 1851 and later owned by the Seaman-Drake heirs, was located west of Broadway at 217th Street. The mansion commanded a spectacular view of the Palisades and Spuyten Duyvil Creek. Adapted from Bolton 1924. Dyckman Institute.

Figure 7.5 The Archway entrance of the Seaman-Drake estate (shown below) at West 215th Street in 1920. Built in 1855, the Romanesque arch was constructed as a gateway to the hilltop estate and still exists today although in a great state of disrepair. The mansion and arch were constructed of Inwood Marble quarried from Bolton's Quarry located in Marble Hill (part of Manhattan then), now the Kingsbridge Section of the Bronx. Bronx County Historical Society.

Drake, and Isham families. In 1864, William Bradley Isham, a leather merchant, purchased 24 acres of land between 211th Street and Isham Street, north to 218th Street and built a large country estate. The land was cleared of trees, greenhouses and stables built, and formal gardens created. A *Gingko biloba* tree was planted on the estate around this time. The tree still stands today at the entranceway to Isham Park at 212th Street and Broadway. Its estimated age has been put at 140 years. A sandstone mile-marker is inset within the stone wall at the entranceway of the park that was used during the colonial and Federalist period. It designated the distance of 13 miles to and from Lower Manhattan and also served as the carriageway to the hilltop estate (Washington Heights and Inwood Report 1995).

Within Inwood Hill, a number of country retreats had been established for some of the notables of the community and the rest of New York's social elite in the 19th century. In 1847, the New York and Hudson River Railroad opened and a station built at Tubby Hook located at the foot of Dyckman Street. The station made the area more desirable for the wealthy to come to northern Manhattan. One such notable who had a summer estate in Inwood was that of Isidor Straus, a philanthropist and director at Macy's, and Abraham and Straus. Straus and his wife, Ida, died at sea on the maiden voyage of the HMS Titanic on April 15, 1912. The foundations of their home on Bolton Road in Inwood are all that remain today (Bolton 1924) (Figure 7.6).

Other notables were the Lords of Lord and Taylor who owned about 300 acres of land with two mansions on the western escarpment (West Ridge) of Cock Hill facing the Hudson River. The mansions were destroyed by fire in the latter part of the 19th century but some of the foundations still remain (Washington Heights and Inwood Report 1995).

Figure 7.6 The Straus residence on Bolton Road in Inwood Hill Park prior to being demolished. The foundations of the house remain today covered with *Vinca minor*. Adapted from Bolton 1924. Dyckman Institute.

During the time of the Revolutionary War, when the Americans had built Fort Cock Hill at the top of Inwood Hill, a house built prior to the Revolutionary War near to the Fort had become a legend. It was reputed to be the home of the “smuggler of Inwood” (NY Times 1924).The house had a series of underground tunnels that led down to the Hudson River, and numerous stairways that led nowhere. Prior to the acquisition of properties by the City of New York, Jesse R. Grant, son of Ulysses S. Grant, occupied the mansion. Grant was thought to be the smuggler because of the elaborate network of tunnels that ran underground from the mansion. According to the New York Times (1924), Grant admitted to the existence of the tunnels but that they were “most likely drainage tunnels” carrying run-off down to the Hudson, and “probably dug by the man who had built the house about 175 years earlier.” The legend, however, still persists, and the tunnels are still in evidence today on the west ridge of Inwood although the house was demolished by the City of New York in the early 1920s.

Land north of 110th Street was considerably cheaper during the 19th century and was mostly woodlands. Institutions such as the House of Mercy and the Jewish Memorial Hospital, built in 1888, also had their roots in Inwood. The buildings were demolished in the 1920s after the City of New York began acquiring the land for the future park.

Building of the United States Ship Canal

Beginning in the early 1900's, as Inwood Hill was in the process of being acquired by the City of New York, the Harlem Ship Canal, a project which was “one hundred and twelve years in the making,” was getting ready to open (Hermalyn 1993). The longevity of the endeavor, despite the ravages of nature, war, political and legal problems, economic disasters and private opposition (including the Torrey Botanical Club membership amongst others), is testimony to the tenacity of the idea.

The problem, according to Hermalyn (1993), was that while "Manhattan (on mid 19th century New York City Maps) was an island, the stream on its northern boundary was not fully navigable." To promote more efficient commercial shipping to the Harlem River, East River and Long Island Sound, with the resultant wharves and docks for new industries, a canal seemed a natural course (Hermalyn 1993). Spuyten Duyvil Creek (before the Ship Canal was built), wound around the knob of Marble Hill with Bolton's Canal as the only connection between the Harlem River and an opening to the Hudson River (Figure 7.7 United States Ship Canal).

In 1888, a proposal was offered by the Army Corps of Engineers under the leadership of Lt. Colonel McFarland to "dredge a 400 foot wide channel ranging from 15 to 18 feet deep in the Harlem River," and to "cut through rock in Dyckman's Meadows to provide a straight channel for Spuyten Duyvil Creek." (Hermalyn 1993). Winding around the knob of Marble Hill, the Spuyten Duyvil Creek connected with two streams that emptied into it on either side of Kingsbridge. On the east was a small brook, while the Mosholu (Tippett's Brook) on west, received the main supply of water coming from the Van Cortlandt lake and millpond (Bolton 1924) (Figure 7.8). However, an obstacle stood in the way of straightening the canal as the cut through the Dyckman Meadows involved cutting through a valuable peninsula (The Barrick) where the Johnson Iron Foundry was located. The high property value forced the Army Corps of Engineers to avoid the Foundry by leaving in the "bell-shaped" bend to its south (Hermalyn 1993). The canal, by July 1893, extended from the mouth of the Spuyten Duyvil Creek to the site called the "Bell Pumpkin Meadow" near the Hudson River (Hermalyn 1993). It was in this

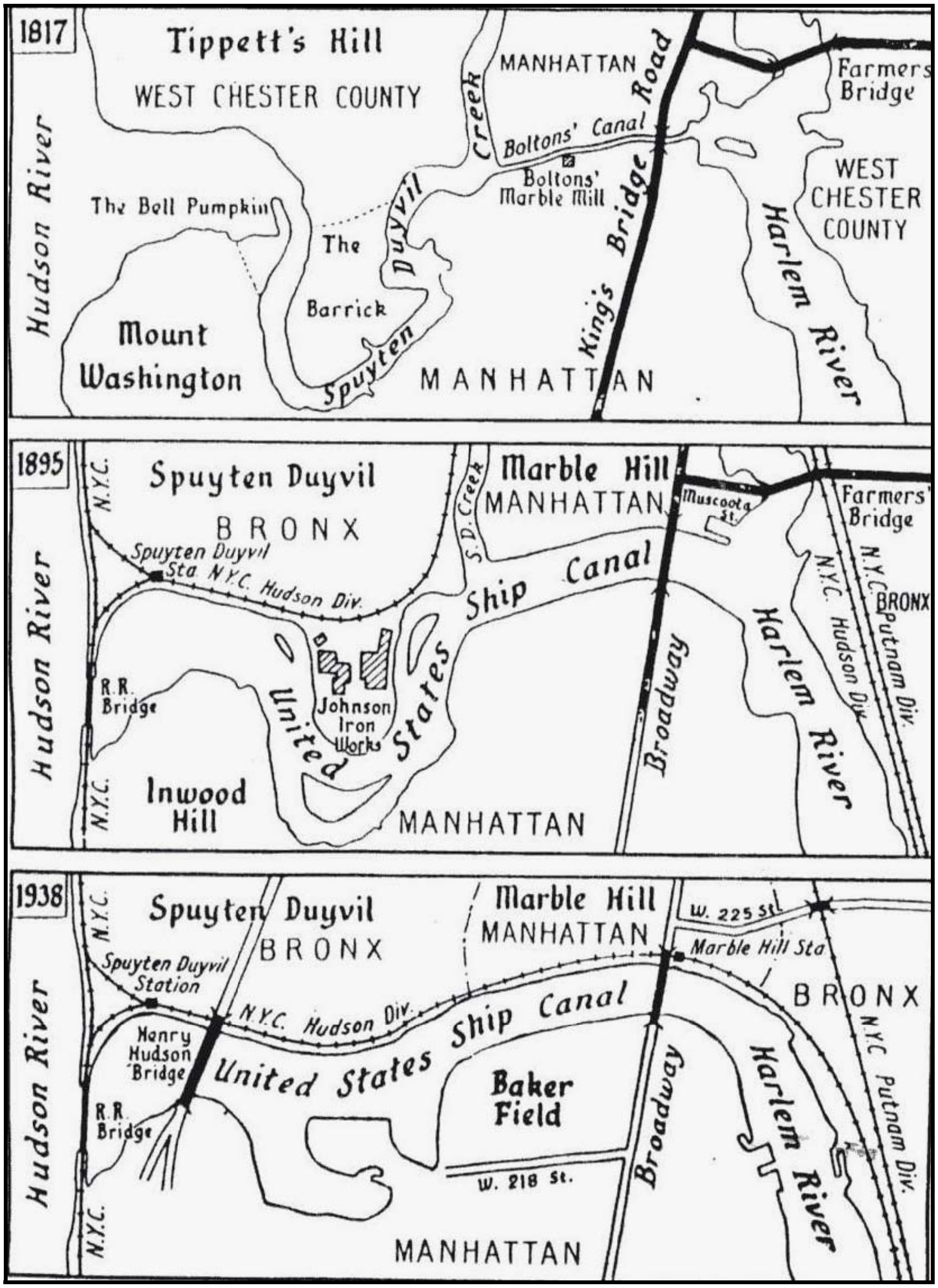


Figure 7.7 The United States Ship Canal through the years. Adapted from Hermalyn 1993. The Bronx County Historical Society, Bronx, NY.

Figure 7.8 The Mosholu, or Tippetts Brook, below Spuyten Duyvil Hill in 1906. Shown are the marshy areas most probably filled with rushes, sedges, and cattails which supported a large population of muskrats and bird life. An Indian path to Nipnichsen (Marble Hill) is visible in the foreground. The building of the Harlem Ship Canal drained the area and it was paved over. Adapted from Bolton 1922. Dyckman Institute.

area (at the foot of the West Ridge) that a rather extensive stand of Blue Cohosh thrived in Inwood (Torrey Botanical Field Trip, member correspondence, 1936).

By 1895, the United States Ship Canal was fully navigable, though not complete. In 1904, passage of Chapter 615 of the Laws of 1904 of the State of New York authorized the filling up of one-half of Spuyten Duyvil Creek in the City of New York (Hermalyn (1993). The bend in Spuyten Duyvil around the Johnson Foundry had proved to be treacherous for navigation. However, by this time the northern loop of the creek had been so deprived of the scouring action of the tides that it became a mere shadow of itself. Most of the salt marsh was destroyed as were many plants including the stand of Blue Cohosh, which never fully recovered and is now extirpated.

By 1923, the Johnson Iron Works were closed by a decision of the State Supreme Court, and the peninsula was to be released to the State by July 1st, for "wrecking or or whatever method of disposal was decided upon by public authorities." (Hermalyn 1993). Removal of the Foundry began and dredging commenced until the channel of the canal was straightened (Figures 7.9, 7.10). By 1938, the canal was completed as was construction of the new Henry Hudson Memorial Bridge spanning the United States Ship Canal. The Bridge ran from the northern tip of Inwood Hill Park and connected with mainland Bronx (Hermalyn 1993).

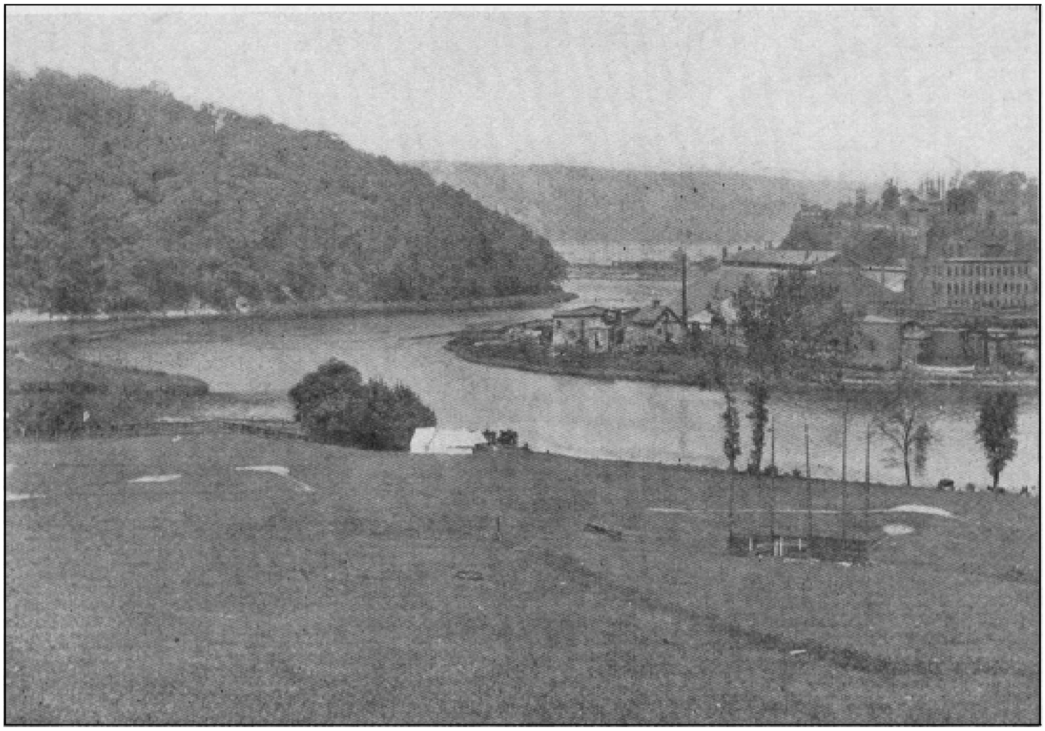


Figure 7.9 The Indian Shorakapkok, now the United States Ship Canal. At left is Inwood Hill Park. The Johnson Ironworks Foundry is right prior to its removal. The site was subsequently filled in with dredging to create a meadow and ball fields, and the Spuyten Duyvil Creek partially buried and rerouted Adapted from Bolton 1924. Dyckman Institute

Figure 7 10 Dredging Spuyten Duyvil for the straightening of the United States Ship Canal. The Barrick, where the Johnson Ironworks once stood, has been removed. Manhattan (at far right) has been truncated from Marble Hill (at far left) exposing the Fordham gneiss (near left). Looking ahead (east), the ridge in the distance is Kingsbridge Heights. The future Henry Hudson Memorial Bridge will connect Manhattan with the Bronx mainland. The Canal was completed in 1938. Photo courtesy of the Bronx County Historical Society.

Inwood Hill Park Acquisition

During the building of the Harlem Ship Canal in 1876, the Commissioners of the Streets, affluent Fort Washington residents appointed by the New York State Legislature, hired Frederick Law Olmsted and Calvert Vaux (who were designing Central Park at the time) to devise a street layout that would discourage street traffic and thus prevent the poorer classes from moving into Fort Washington (Clayton 1992). In 1876, Olmsted and James R Cropes suggested to the newly formed Department of Parks that Inwood be developed as a “residential area” (including the Washington Heights area), as they “envisioned” Inwood as a residential neighborhood for “fairly comfortable people” (WPA 1992 edition). Eventually, authority for laying out the streets was transferred to the Commissioners of Central Park and Andrew H. Green directed the project (Clayton 1992).

In 1895, the acquisition of Inwood Hill was proposed by Andrew H. Green who had worked to acquire Central Park. Green was appointed Commissioner of Central Park in 1857 and had a deep commitment to the beautification of New York City. He grew to be an eminent supporter of landscape gardening and was Calvin Vaux’s nemesis in implementing their design of Central Park (Clayton 1992). His life was dedicated to improving the city dweller’s quality of life through the development of parks and cultural institutions. In 1895, he made a public plea for establishing Inwood Hill as a park.
In 1901, the American Scenic and Historic Preservation Society was founded in New York. It had developed out of the state-level Trustees of Scenic and Historic Places and Objects which had been founded in 1895 by Andrew H. Green, (who presided over the Commissioners of the State Reservation at Niagara for fifteen years) and was modeled

after Britain's National Trust. The new organization advocated protection of both scenic places and historic sites throughout the nation, demonstrating (like the American Antiquities Act of 1906) the relationship between movements for natural and cultural preservation in turn-of-the-century America.

Parks Department: The Changing Landscape and Philosophies

Before the 1890's, the idea of recreation in New York City was "quiet contemplation of nature in a pastoral setting," and active use was discouraged. Much of the philosophy about parks and gardens had come from those who worked in the field of horticultural landscaping and design for the very wealthy (Stevenson 1977). Andrew Jackson Downing liked to write about the beauties of native landscapes of America (Schack 1936). Downing believed that every wealthy person should have a country residence and such a residence should naturally blend in with an unobtrusive, man-made garden. In turn, the garden should blend in with the larger natural order (Stevenson (1977). In their report for 1860, the Board of Park Commissioners for Central Park wrote of its "oaks, chestnuts, walnuts, tulips, maples, hemlocks, cedars, elms and other indigenous trees, forming forests and groves of great extent and beauty," that extended north to Fort Washington and Inwood Hill (Schack 1936). The report also mentions a tulip tree in Inwood as dating back some 250 years. It was against this natural background that dozens of imposing estates were laid out in the 1850's: the Dyckmans, Van Nests, and Van Cortlandts, all of whom had holdings there since the colonial days (Schack 1936). Their estates reflected the dominance of the "natural type" landscape design which had received strong impetus with the publication in 1841 of Andrew Jackson Downing's *Treatise on the Theory and Practice of Landscape Gardening*

Schack (1936). In the years following, Olmsted, Vaux, Weidenmann, and others developed it to its highest point.

It was Frederick Law Olmsted who believed that parks were of great benefit to city workers as they had a chance to "recuperate" in the parks. According to Olmsted, writes Stevenson (1977), "the great advantage which a town finds in a park, lies in the addition to the health, strength and morality which comes from it to its people." To police the park grounds, Olmsted did not want to rely on the Police Department. Instead, he wanted his own trained organization of "park keepers." These keepers were to be trained by Olmsted so that they would be devoted to the aims of the park, be able to interpret these aims to the public visitors, and to enforce the public law within the borders of the park (Stevenson 1977).

At that time, there were very few parks per resident of New York City. When Jacob Riis published *How the Other Half Lives* in 1890, documenting the miserable conditions of people living in the city's tenements, it exposed the appalling living conditions of poor children. Children of the poor had no room in which to run and play as had children of the more fortunate. Pressure mounted upon the Parks Commission to take up Riis' suggestion that park space be increased. In 1898, the Department of Parks created a commission to acquire land for small parks to benefit the tenement people.

In January of 1910, Mayor William J. Gaynor appointed Charles B. Stover as Manhattan Park Commissioner (Rosenzweig and Blackmar 1992). Stover added a number of city-run playgrounds, tennis courts, and band concerts, and by 1915, there were some seventy playgrounds in the city (Harris 1999). However, Stover's views clashed with the more influential and more traditional Central Park architect, Samuel

Parsons (Rosenzweig and Blackmar 1992). Parsons was ultimately fired over policy differences, and in response, the newspaper editorials began attacking Stover for trying to "popularize" Central Park. Parsons' departure from the Parks Department spelled the end of serious systematic landscape design planning for Central Park until recent times, when social reformers, recreation specialists and event organizers increasingly came to dominate park administration (City of New York Department of Parks & Recreation 1990). Three popular views existed at the time among various advocates of park usage: the recreational park for all, the civic park of the City Beautiful Movement; and the Olmstedian natural park. In this competition of views, Stover received so much criticism that he resigned his position and a new park commissioner was appointed. The new park Commissioner, George Cabot Ward, was a proponent of the City Beautiful Movement.

Inwood Hill Becomes a Park

In 1912, the northern tip of Inwood Hill was sold to a private dock company, but plans fell through for the construction of docks and warehouses and the land was sold to private land speculators: The Inwood Land and Improvement Company, which had thirty-seven parcels of land in the Seaman Avenue section (NY Times 1926). By 1916, Inwood Hill had been officially declared a park by the City of New York Parks Department hence paving the way for land acquisition and demolition of the many estates.

In 1926, a Supreme Court opinion was handed down to New York City. The decision ordered the city to pay $5,251,446 to property owners for land taken in condemnation proceedings to establish Inwood Hill Park and to enlarge Isham Park (NY Times 1926). Title to this property, according to the Times (1926), became vested in the city by a Supreme Court order issued April 21, 1925, although the proceedings originated in 1903. Inwood Hill Park, according to the map (Blackwell Plan and Manuscripts, Schack 1936) which was used in the hearings, included all the land lying north of Dyckman Street up to the Harlem Ship Canal, and between the Hudson River and old and new Payson and Seaman Avenues. The largest award of $833,329 was given to the Inwood Land Improvement Company, with lesser amounts of $505,316 to the William B. Isham estate; $305,776 to the Jewish Memorial Hospital and House of Rest; $398,524 to the House of Mercy; and $126,299 to the Bryan L. Kennelly estate (NY Times 1926). Fifty-three buildings and thirty-five garages and sheds were eventually cleared from the newly-acquired site (NY Times 1925).

When the first map was drawn, it was to have included only the “westerly part of Inwood Hill,” which rose 230 feet above the Hudson, and was densely covered with many old trees and underbrush. The area of about 110 acres of the western scarp had been acquired by the city in 1917 (NY Times 1922). At no other point had the “original natural beauty of Manhattan Island with its historic associations been preserved and essentially unchanged”, wrote the New York Times in 1922...[and this] “despite the encroachment of paved streets and continuous building of apartment houses as here.” Since the condemnation proceedings of 1903, many of the old estates and homes, particularly those lying on the scarp of the hill on Dyckman Street, were abandoned years before, relicts of architectural grandeur and elegant gardens, rather a lost chapter in New York City’s history as little was preserved and none of botanical description.

Land owned by John D. Rockefeller, Jr., and which included the old Billings estate, was offered as a gift to New York City for an extension of Inwood Hill Park (NY

Times 1926). The tract of 57 acres was situated on the south side of Dyckman Street, facing north to the Dyckman Library on the opposite side, in what is now known as Fort Tryon. The property ran from Dyckman Street down to 191st Street between Broadway and what is now Riverside Drive. The acquisition of the Rockefeller tract and the consummation of plans for additions to Fort Washington Park and Inwood Hill Park would give the city a great chain of parks along the riverfront from 158th Street to the Harlem River, with Riverside Drive and proposed extensions running past or through them, and ultimately a bridge (Henry Hudson Memorial Bridge) connecting Manhattan and the Bronx near the Hudson River (NY Times 1926). The total area of this park system would be roughly 300 acres.

In yet another action by the city to acquire additional acreage for Inwood Hill Park, the Board of Estimate voted unanimously to add 92 acres on April 13, 1926. The additional acreage took in all of the eastern escarpment and ravine (valley-clove) and a considerable section of the southern bank of the Harlem River (salt marsh). Part of the William B. Isham property was also included. Representatives of a number of the organizations interested in the parks were present at the hearing, most notably Reginald P. Bolton, Washington Heights historian, who spoke for the groups. Addressing the then Mayor Hylan on the importance of preserving Inwood Hill for posterity, Bolton said that "no one could question the desirability of acquiring the property as it is our most priceless possession," as objections had been raised by City Comptroller Craig as to the cost of paying the owners of the properties an exorbitant sum of money for land that he (Craig) considered to be a "just a bunch of rocks" (NY Times 1923). On May 5, 1925, the City of New York formally turned over to the Parks Department the northeastern tip of

Manhattan Island known as Inwood Hill, after having made a final purchase from the estate of the Isham family for $600,000, appropriated on April 21, 1925. The area was to be known as "Inwood Hill Park, distinguishing it from Inwood Park, to which it is contiguous" (NY Times 1925).

The picturesque cottage that stood for more than a century in the shadow of the famous tulip tree (Figure 7.3) in Inwood Park was restored by the Park Architect to its original appearance and was opened as a public museum (NY Times 1928). The trustees of the Dyckman Institute had volunteered to protect and care for the park's natural and archaeological treasures. Commissioner Francis D. Gallatin had appointed the Institute honorary curators and caretakers of an interesting tract of about 20 acres, which included historic evidence of the aboriginal life that had occupied the place more than 200 years before. He dedicated the tract for the "Indian Life Reservation," which also included the Great Tree, the little cottage nearby, and the buildings which housed the Inwood Pottery (Bolton 1932). The waterfront of the ancient Spuyten Duyvil Creek, in front of the Great Tulip tree, still remained but all other parts of the ancient waterway had been buried when the United States Ship Canal was built (Bolton 1932). The cottage was destroyed when Robert Moses became Parks Commissioner and the ancient waterway filled in with debris from the excavations of the Municipal Subway. Six ball fields were created as well as a soccer field built in the early 1940's after the hurricane of 1938 toppled the Great tree. The Indian relics and pottery were moved by the Heye Foundation to the American Museum of Natural History.

It was during these times that Inwood Hill Park had became a focal point for many activities calling attention to its Indian antiquities, botanical richness, and the need for their preservation. On October 30, 1912, exercises were held under the auspices of Park Commissioner Stover at the foot of the old tulip tree. One of the speakers was Dr. Nathaniel Lord Britton, then the director of the New York Botanical Garden, who spoke about the native species still extant within the Park and about tulip trees in particular. Others who spoke included General James Grant Wilson, historian, and Reginald P. Bolton, archaeologist and historian. Bolton spoke of the “extraordinary collection of archaeological relics” taken from Inwood and that were “now preserved in the American Museum of Natural History.” He urged that this site from which they were taken be preserved (Annual Report of the American Scenic and Historic Preservation Society 1913). At that time, the Torrey Botanical Club was compiling lists of the plants of Inwood Hill to be published in the Bulletin of the Torrey Botanical Club.

Another civic group, The City Gardens Club of New York, had appealed to the city to grant the $100,000 appropriation requested by Parks Commissioner Francis D. Gallatin for the reforestation of Inwood Hill Park (and other Manhattan parks), as much damage had been done to the forested areas of Inwood with the razing of the homes and other buildings during acquisition of the sites (NY Times 1923).

The Park was also used to celebrate the Native American Indians whose ancestors had lived and thrived in this area for centuries. Descendants of the original aborigines had been gathering at Inwood Hill Park annually since Inwood officially became a park. In the Seventh Annual Indian Day Event of September 27, 1937, set up by Governor Herbert H. Lehman, Reginald P. Bolton spoke movingly of the plight of the American Indian. He deplored the necessity for such an observance, saying: “There should be no differentiation between them and other American citizens because of a mistake that was made three centuries ago. They have shown great patience and are worthy of emulation by us." Another speaker, Dr. Clarence T. Lansing, naturalist, and member of the Sons of the American Revolution, said that it was "appropriate that the observance was held at this spot, the last invaded by the city in its destruction of the original forest." (NY Times 1937).

Inwood Hill Park and the Robert Moses Years

Inwood Hill Park used to comprise some 300 acres (WPA 1992). In 1934, Robert Moses became the New York City Parks Commissioner**.** On the very day that Moses was sworn in by Mayor Fiorello La Guardia, he announced to the attending reporters that the five borough park commissioners and five park superintendents were fired immediately. This was the way Moses became the first commissioner of a citywide Parks Department (Caro 1974).

Robert Moses (1888-1981) was a New York state and municipal official whose ambitious public works of the 1930's, 1940's, and 1950's transformed the urban landscape. Appointed to head the parks commissions of New York and Long Island in 1924, Moses expanded the state's park system and built numerous parkways. With his appointment in 1934 as New York City Parks Commissioner and head of the Triboro Bridge and Tunnel Authority, Moses built hundreds of new playgrounds and parks, and important highways, bridges and tunnels linking the boroughs of New York City (Caro 1974).

In the early days of his career, Moses was under the influence of his times, that mainly said: parks were for the "upper and comfortable middle classes" (Caro 1974). These upper and middle class people could drive through "landscaped" areas at a leisurely pace enjoying the “beautiful scenery.” Instead of preserving the most beautiful areas for the general public overall, roads were placed in the most scenic locations. Up to the Moses Era, the emphasis on parks had been largely on preservation of natural areas (Olmstedian view). However, in a 1922 report by the New York State Association (backed by Moses), emphasis was placed on the “promotion of recreation, instruction and health of the people” as the guiding principle. There was virtually no mention of the preservation of natural resources. Under Moses, the facilities developed were primarily recreation grounds (Nelson A. Rockefeller Institute of Government 1993). Moses represented a new approach as opposed to the older view which upheld that the purpose of parks was “primarily conservation,” not “recreation” (Caro 1974).

Moses decided to build the Henry Hudson Parkway (West Side Highway) along the Hudson River, and run the parkway straight through Inwood Hill Park and over the Harlem River Ship Canal. Official New York City Parks Department renderings of Inwood Hill Park in 1934-1936, show the proposed routes of the “new” parkway (New York City Department of Parks Topographical Division 1935). Since this was parkland, the land was readily available and easy to get. Robert C. Weinberg, Park Department Architect, and William Exton, Jr., raised objections to the plan as both were involved with the American Scenic and Historical Preservation Society, and both lived in the Inwood Hill section. They studied Moses’ West Side Improvement Plan to look for alternative routes. They proposed that the parkway could run further west of Inwood Hill Park instead of straight through it (which the Moses plan showed to be further east and running atop the westernmost ridge) (Caro 1974). However, there were no terms such as “ecology” and “environment” in the 1930's, and the two men could not explain adequately enough why it was important to preserve the forests of Inwood to convince Moses to change his plan (Caro 1974).

Moses had little concern for the environment despite the pleadings of both college and public school biology teachers of the ultimate destructive impact this would have, not only on Inwood Hill Park's forests, but those of Van Cortlandt Park as well (Caro 1974). Weinberg and Exton went to other agencies for help in fighting Moses' plan, and Moses finally agreed to a public hearing on his plans. But two weeks before the hearing, Moses used the time to "cut down hundreds of trees in Inwood Hill Park for the new highway right-of-way." (Caro 1974). A 160 year old tulip tree believed to have been a sizeable sapling when the British and Hessian troops occupied New York, was felled in Inwood Hill Park, sacrificed to make room for the new Henry Hudson River Parkway (NY Times 1935). Many other very old tulip and oak trees were removed and much of the shrubbery (NY Times 1932). Moses triumphed over the many protests of civic and community groups of Inwood Hill. Letters written to Moses in the early 1930's were mainly from people who lived in Inwood stating their objections to the ultimate destruction wrought by the building of the highway and Henry Hudson Memorial Bridge to Inwood Hill Park (Municipal Archives of the City of New York, Borough of Manhattan, Department of Parks and Recreation).

Moses constructed a highway by driving bulkheads into the Hudson River off the shore of Riverside Park. He used some six-thousand WPA-paid workers to move earth and rocks into place, and then poured cement over the entire surface Ultimately, he transformed and created a new shoreline for northern Manhattan. It was at this time that the old dirt paths through Inwood Hill Park were paved over (Barlow 1971). The whole

West Side Improvement was completed by October 12, 1937 (WPA 1992). William Exton, one of Moses' chief opponents of the Improvement Plan, was moved to comment after he had climbed to the top of the Park, saying, "even before I got up to the top, it was all changed; there were concrete staircases where there used to be dirt paths, and drinking fountains, and a whole drainage system… [as] cutting down the trees on top had destroyed the natural drainage, so now they are laying a new one." Commenting on the changed view, he added, [now] " there was a view alright, a view of the road, a great roaring concrete gut through the forest." (Caro 1974).

Additional changes occurred when the western boundary of Inwood Hill Park was extended by filling in of the waterfront with debris from the Municipal Subway excavations. It added a flat tract of about 50 acres to the park where tennis courts and ball fields were built to compensate for the areas used for parkway connections to the Henry Hudson Bridge. The resolution was adopted by the Board of Estimate of the City of New York on December 4, 1942, changing the map of the Borough of Manhattan along the northerly side of Dyckman Street from the Hudson River to a point of about 287 feet north (Municipal Archives of the City of New York, Department of Parks and Recreation). A pedestrian bridge was constructed over the New York Central Railroad tracks to connect centrally the two parts of the park to make the new recreational facilities accessible. A small boat basin was also provided by the Hudson Parkway Authority (of which Moses was the sole authority) at the southerly end near Dyckman Street and four baseball diamonds just north on the newly extended land. These took up more than half of the fifty acres of new land as the rest was landscaped and improved with promenades and benches (NY Times 1938). At the end of all the building of the

Westside Improvement project, the construction of ball fields, tennis courts, and other active play facilities, Inwood Hill Park comprised just 192 acres out of the original 300 acres (Caro 1974).

Vandalism also plagued Inwood Hill Park during the 30's, 40's and 50's. Squatters shacks were still in evidence right up into the 1950's. Many fires were set to these shacks which caused a neighborhood outcry as did the ubiquitous trash from the squatters. Moses answered many of the letters of complaint himself during these years that encompassed the Great Depression and the outbreak of World War II (Municipal Archives of the City of New York, Borough of Manhattan, Department of Parks and Recreation). He always advised that his staff was checking on these problems and that they would ultimately be cleared up, especially the “rowdiness and drinking” of the WPA workers. Letters addressed to the Editor of the New York Times complained that Moses was “re-shaping” Inwood Hill Park, and that the “altered shoreline” of Spuyten Duyvil Creek (the bend around the Johnson Foundry that had been straightened in Figure 7.9 and filled in) would connect Manhattan with the Bronx and thereby “eliminate” the distinction between the boroughs; thus Manhattan would no longer be an island. Moses responded characteristically in a letter to the Editor of the New York Times arrogantly dismissing the claims, with his vision firmly entrenched on the future of what parks should be and what they should not be. He envisioned a yacht club in the boat basin he was creating at the time (conveniently located next to the properties now owned and occupied by Columbia University on landfill dredged from the canal) (NY Times 1936). During the Moses years, there was no special training required to instruct park visitors as it was in the past. The old idea of Olmsted’s vision of natural beauty and conservation of resources with trained park attendants no longer fit Moses' view of park usage. Under Moses, park usage had changed "to one of unrestrained pleasure" (Harris 1999).

Inwood Hill Park: 1960 to Present Day

As the Moses Era began to end in the late 1950's and early 1960's, the vegetation of Inwood Hill Park was already in steep decline. Although the Parks Department had allotted monies for the planting of trees and shrubs in the early part of 1960, there were not enough workers to monitor their growth and many of the new plantings succumbed. Dead and decaying trees, damage to exposed roots, thin and eroding soils, fires, vandalism, and indiscriminate use of the park to create bike paths through heavily forested areas, all took a toll on Inwood Hill Park. Compaction of the soil allowed water run-off, increasing wider swaths of bare soils and canopy gaps. Herbs, shrubs, and subcanopy trees declined due to human disturbances and activities.

When John V. Lindsay became mayor of New York City in 1966, he chose Thomas B. Hoving as Park Commissioner; this agenda for the parks favored recreational events in Central Park. A master at public relations, Hoving promoted "happenings" that attracted thousands to these events. As a result, the landscaping of Central Park was obliterated. Hoving lasted only one year in his position as commissioner. He ignored the maintenance and upkeep of most of the other city parks so that further degradation of Inwood Hill Park became increasingly evident. Mayor Lindsay strongly advocated community involvement in local parks as the city was in a deep fiscal crisis. This led to the slashing of the budgets allotted to the Department of Parks. From 1974 to 1980, there was a drop of 60% in the department's appropriations, and an accompanying loss of park work force. The parks began to fall into "an advanced state of deterioration," stated a

New York Times reporter (Rosenzweig and Blackmar 1992). Longtime residents of Inwood who had a deep interest in the park volunteered their efforts and worked tirelessly to fill in erosion gullies that had developed over the years with the loss of so many trees. Through their efforts, along with a few Parks Department workers assigned to help them, trash was cleaned up and trees and shrubs were planted (Friends of Inwood Hill Park 1976, unpublished report). A newly appointed Parks Commissioner, Gordon J. Davis, believed that there must be and are limits to the use of city parks. This new policy was reinforced by the fact that the city had no money. The policy forced the city to turn to "private money" to maintain public services (Rosenzweig and Blackmar 1992).

The new policy of restricted park usage was reinforced by the newly formed Central Park Conservancy whose domain covered mostly Central Park.
The establishment of this group in 1980 by Mayor Edward I. Koch, indicated a shift in control from city government to control by the private wealthy sector. Koch picked philanthropist William S. Beineke as board chairman, and he in turn, chose the other private sector board members (Rosenzweig and Blackmar 1992). With the coming of greater and greater control in the hands of the wealthy, the park philosophy turned back to the earlier "Olmstedianism," with the greatest emphasis being on care for the "landscaped Central Park itself" with a consequent de-emphasis on "access by all" to the park (Rosenzweig and Blackmar 1992).

In the years following, the successor to Commissioner Davis was Henry J. Stern and a close friend of Mayor Koch. Stern stopped the large concerts from being held in Central Park as "too costly for cleanup," and any further concerts would be required to make a "$100,000 dollar contribution" to the Parks Department for possible damages to the park (Rosenzweig and Blackmar 1992). Although Central Park may be protected by the wealthy that surround the park on three sides, Inwood Hill Park does not have such wealth in its neighborhood. It is still open to predation, homeless people, stray dogs, and vandalism.

With the oncoming of the President Reagan tax revolt of 1983-4 that led to a decline in the resources available to parks (Nelson A. Rockefeller Institute of Government, 1992), the “unrestrained pleasure” (Harris 1999) could not be contained because there were so very few park officials or law enforcement officials to regulate the parks. The result had been more one of anarchic pleasure, with everyone able to “do their own thing” (Harris 1999), and with little regard for others or for the long range health of the parks.

The mayors of New York City came and went as did the various park commissioners, and a greater emphasis was placed on preservation of the natural areas: ecologically valuable and fragile environments of city parks. New York City Parks Natural Resources Group (NRG), established in 1984, embarked on an extensive natural areas acquisition and restoration program in New York City Parks which currently comprise some 28,000 acres. Included was the initiation of its Rare Plant Program, propagating more than 4,700 rare and endangered plants collected from indigenous seeds. The goal is to restore rare plants back into the Parks urban wild areas, and restore critical and threatened resources to sustainable levels while maintaining the genetic integrity of the City’s plant communities. With this new emphasis on restoration and plant re-introductions, Inwood Hill Park was chosen as one of the recipients of a capital investment project to restore and enhance woodlands, meadows, and marshes, and to keep it structurally free of any type of facility. During the 1930's, the WPA had cut nature walks throughout the park, and in the early part of the 1960's, under Parks Commissioner August J. Heckscher, the Department used federal “beautification” funding to install iron lamps along the paths. Retrospectively, Heckscher wrote that he “regretted this intrusion,” and that the park’s forest should have been left as natural as possible Heckscher (1974).

In a 1990 Executive Summary published by The City of New York Department of Parks and Recreation, on North Manhattan Parks, a plan had been drawn up to provide for the protection, preservation, and history of Fort Tryon, Fort Washington, Inwood Hill, and Highbridge Parks. During 1987-1988 under the plan, an erosion control project which involved the planting of 500 trees and shrubs in Inwood Hill Park was completed by the borough office. Manhattan Natural Resources, with the cooperation of the Natural Resources Group, completed an entitation study which included the complete mapping of Inwood Hill Park’s vegetative cover, soil surveys, hydrology studies, and wildlife assessments. This preliminary design investigation was allotted $84,987.00 to investigate the restoration needs of Inwood, and to focus on ‘natural’ lands of the park (No. MRE-42-100 Capital Project Location: Inwood Hill Park, May 1989, Executive Summary 1990).

An Urban Ecology Center was to be built from the remaining boat house which was constructed in the 1930's for canoes but never used for that purpose. The Center was built with funds donated from the private sector through the auspices of the City Parks Foundation, an arm of the Parks Department. Sitting on the edge of Manhattan’s last remaining salt marsh, the building was designed to serve the public as an interpretive center for the history, geology, and ecology of Inwood Hill Park (Figure 7.11 Map of Inwood Hill Park).The Center opened in 1993, and today, it is a focal point for teaching New York City's schoolchildren about the environment of Inwood Hill and its unique salt marsh. Before the Urban Ecology Center was constructed, the older building had served over 12,000 schoolchildren since 1985 in conjunction with the Parks Department and the Inwood Heights Parks Alliance, playing a vital role in educating students in science, social science, and history. This author was a former instructor and teacher of these very important programs from 1987 to 1993.

Initial efforts to maintain and restore Inwood Hill Park from the many years of decline actually began in 1985 and focused on the most immediate problems of serious erosion on the high slopes of the two ridges. Cribbing was emplaced to prevent further erosion of top soils; slopes were reconstructed and replanted; and the long neglected drainage system was cleared out. Despite these earlier efforts, the park's complement staff and numerous volunteers of the Inwood Heights Parks Alliance, were not enough to correct the park's more serious problems. The woodlands, meadows and marshes were being invaded by nonnative and invasive species as well as the dense, forest canopy of the Valley-Clove, and vandals had also set many fires on the ridges.

Because most city parks had their beginnings as wealthy estates, the "planting process unfortunately facilitated the spread of greater disasters — chestnut blight and Dutch elm disease, which nearly eliminated populations of former city dominants." (Loeb 1987). It also facilitated the rise of invasive, nonnative (exotic) species, whose introductions and newly established communities at a significant distance from their former geographic ranges, have become a scourge on the landscape. In the years

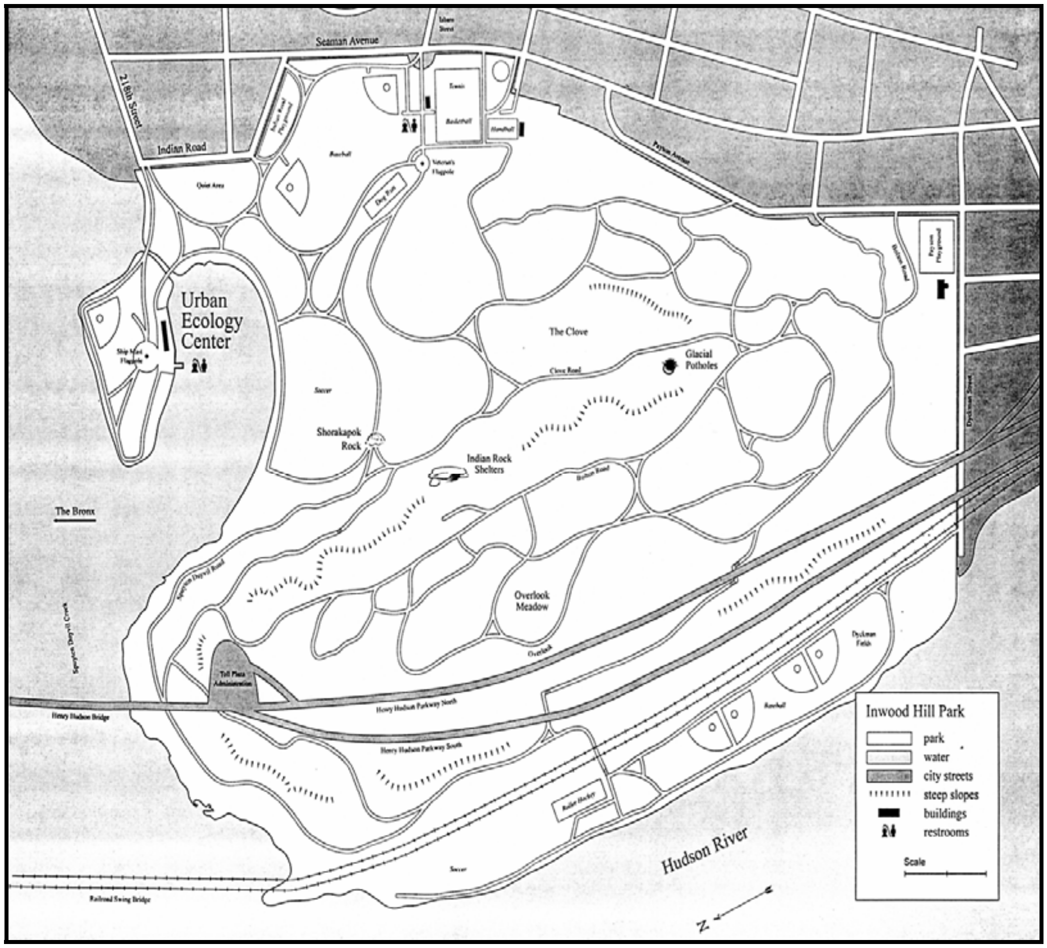


Figure 7.11 Map of Inwood Hill Park today. Urban Ecology Center, Dept. of Parks and Recreation.

following the establishment of the estates in Inwood from the 1850's to the early 1900's, many nonnative species were introduced to this area. Some of these have become highly invasive, such as: *Robina pseudoacacia* introduced in 1850; *Ailanthus altissima* in 1857; *Lonicera japonica* in 1875; *Acer platanoides* in 1879; *Rosa multiflora* in 1909; *Celastrus orbiculatus* in 1919 (Moore et al. 2002).

As a result of the introduction of more nonnative plants, habitat loss and destruction ensued, and the native species have been in decline. Some have even been extirpated entirely. In 1930, Graves listed 70 woody species growing in Inwood Hill Park without cultivation, 20% of which were introduced. Other unofficial reports include Denslow (1866-8), who listed 8 species of orchid, and all reported extirpated by Graves (1930). Loeb (1986) noted that “many successional fields in New York City parks develop from abandoned estate lawns and gardens,” and that the use of fertilizers in these gardens have enhanced the growth habits of many of the introduced plants, i.e *Vinca minor*, *Wisteria floribunda*, *Lonicera* spp., and *Commelina communis*, all of which are present today in Inwood Hill Park. All of New York City’s park forests are considered disturbance communities (Loeb 1987), that include woodland fragmentation from re-growth and partial clearing following landscaping for 19th century estates, soil surface disturbance, and the introduction of exotic species (Yost et al. 1991).

In 1986, the City Parks Foundation was the recipient of a six million dollar grant from the Lila-Wallace Reader’s Digest Fund for the restoration of native species in three of New York City’s urban parks including Inwood Hill Park (Woodlands, Wetlands, & Wildlife, A Guide to the Natural Areas of New York City Parks, Urban Forest and Education Program, City of New York/Parks & Recreation and City Parks Foundation

1994). With the addition of new funding and monies allotted from the Capital Project of 1987-88, an ambitious program of forest restoration has been in continual progress. The Forest Project Manager, Anthony Emmerich (Urban Forest & Education Program), planted many species of trees and shrubs indigenous to Inwood. A small nursery for native seedlings, saplings, shrubs, and herbs is maintained at the Urban Ecology Center by the Natural Resources Group.

With this new project of conservation, protection, and restoration of native plant communities, Inwood Hill Park has come full circle with respect to the Parks Department's changing philosophies regarding its natural resources and park usage. Conflicts of interest still remain however, as there is a divided sense of what purpose parks should serve, and this is reflected in the need for conservation on the one hand, and the need for recreation on the other. In 1976, a law was passed in New York State recognizing a special classification of lands as preserves that are not suitable for extensive recreational facilities. Two examples are Clay Pit Ponds Preserve on Staten Island and the Rockefeller Preserve in Westchester County (Municipal Archives of the City of New York, Nelson A. Rockefeller Institute of Government 1992)

The situation in New York State Parks is summarized in the *Report on the State of Parks*, issued by Governor Rockefeller (Municipal Archives of the City of New York, Nelson A. Rockefeller Institute of Government 1993): "From the end of the 'days of wine and roses' to today's recession-driven budgets, support for the state's parks and historic sites have not been adequate to protect and preserve them." This is especially tragic [because]... "without stewardship, neither recreation nor interpretation is possible in the long run." City and state parks "exist for purposes of conservation, recreation, and education, but their availability for those purposes tomorrow depends on always putting stewardship first today."

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