SETTING THE CONTEXT FOR AN ECOLOGICAL FRAMEWORK
The landscape ecology of the University of Washington campus can be described as an urban ecosystem comprised of a heterogeneous mosaic of spatial elements: vegetation patches of various sizes, vegetated corridors, and the surrounding urbanized and regional matrix in which they are embedded. Each piece of the mosaic interacts with and impacts ecological processes in specific ways, resulting in a suite of modified ecological services, the processes by which the environment naturally produces resources such as clean water, flood protection, carbon sequestration, and pollination of native and agricultural plants.

As human-dominated systems, urban ecosystems differ from natural ecosystems in a number of ways. While a natural ecosystem performs fundamental life-support services, upon which human civilization depends, an urban ecosystems differs in the following ways:

- It is comprised of small habitat patches isolated from each other by a matrix of built environment. This isolation makes migration and dispersal difficult and risky for less mobile organisms. The extent and connectivity of green spaces is an important factor impacting the occurrence of species in urban landscapes.
- Many of its habitats are kept at an early successional stage by regular disturbance, such as mowing of turf lawns or active use of waterfront edges.
- Introduction, and in many instances, successful invasions, by non-native species of plants. Some of these species have become invasive and now dominate certain areas of campus, ultimately reducing the biodiversity and habitat quality.
- Warmer microclimates due to the urban heat island effect of excessive amounts of pavement and manmade materials radiating heat generated from solar exposure.
- Natural hydrologic flow above and below ground is altered through the introduction of impervious cover, which leads to increased runoff and piped/channelized storm water systems, topographic changes, and underground structures.
- Altered soils which suffer from compaction, erosion, and contamination.

AN EVOLVING ECOLOGY
Over the last century, the land that comprises the UW campus has been dramatically altered and highly manipulated; forest habitat was cleared, topography was altered, streams were buried in pipes, the lake level was lowered, many species of non-native plants and animals were intentionally or unintentionally introduced, and most, if not all, of the living layers of the soil profile were removed. Humans are now the predominant species, largely determining the form and function of the landscape, and in the process creating new ecosystems directly or indirectly.

When evaluating such urbanized landscapes in terms of ecological health, relevant factors include vegetative structure, functionality, biodiversity, habitat value, adaptability to changing environmental conditions, and the extent to which the system is capable of self-regulation to maintain the desired condition. Recommendations for ecological enhancement consider the importance of incorporating native plants of the greater Seattle region, but also recognizes a healthy urban ecosystem can include non-native ornamental species without limiting its ability to provide valuable ecosystem services.
URBAN FORESTS

Less than 200 years ago, the Seattle area was dominated by coniferous forests of Douglas fir (Pseudotsuga menziesii), western hemlock (Tsuga heterophylla), and western red cedar (Thuja plicata). A Seattle Public Lands Habitat Survey, conducted in 1999-2000 by Seattle Urban Nature (SUN) assessed citywide vegetation on 8,000 acres of public land and open space, and revealed only 11% of the city’s public forests, nearly 293 acres, are dominated by conifers, indicating a significant decline in the historically dominant forest type for the region. Within these forests, 97 plant species were identified: 65 native, 30 non-native, 2 identified only to genus. The most common canopy tree is Douglas fir, with smaller amounts of western hemlock and western red cedar. Surprisingly, the survey identified 70% of 2,737 total acres of forest are now dominated by deciduous species. This drastic altering of the forest ecosystem has many ramifications for forest health and the ecosystem services they provide, such as:

- Intercepting and slowing precipitation and storm water in urban areas. Most of the precipitation in the Pacific Northwest occurs during the winter months, when conifer forests are actively growing but deciduous trees are dormant. Evergreen trees therefore intercept more rain than deciduous trees.
- Regulating and improving air quality in urban areas by producing oxygen, taking up carbon dioxide from the atmosphere, and removing pollutants and particulates from the air year-round.
- Improving water quality in urban areas by filtering pollutants from water and preventing sediments from entering streams and degrading salmon habitat.
- Preventing erosion on steep slopes by anchoring the soil with deep roots.
- Reducing global warming by storing carbon in woody tissues for the lifetime of a tree (conifers can live for more than 1,000 years whereas deciduous trees live about 100 years).
- Providing visual and noise buffering.

URBAN BIODIVERSITY

A report on the biodiversity of the Puget Sound by the Center for Biological Diversity (2001) concluded that of the 7,013 species in Puget Sound, 957 (14%) are imperiled, including 519 plants, 296 animals, 129 fungi and 13 marine algae. The imperiled animals include 119 invertebrates, 80 birds, 44 mammals, 38 fish, 11 amphibians and 4 reptiles. Seventeen species are listed as threatened or endangered under the Endangered Species Act and another 13 are candidates for listing.

Local and landscape scale attributes are important for biodiversity and abundance of species. Habitat fragmentation in urban ecosystems can be extreme, leaving fragments of natural vegetation that are too small or isolated to support some species. Urban woodlands are important for bird diversity; the larger the woodland, the more species supported. Tree species selection is also important. For instance, conifers provide nesting and winter cover for various bird species, fruit trees attract fruit-eating birds, and other bird species rely on shrub thickets for nesting and foraging.
WEATHER AND CLIMATE

As a result of its location on the eastern shore of the Puget Sound, in a lowland area between the Cascade Mountains to the east and the Olympic Mountains to the west, Seattle has a mild, moderately moist climate. Winters are relatively warm, with average temperatures in January of 40.8°F, and summers are relatively cool, with average temperatures in August of 66.1°F. Average annual rainfall is 36.6 inches, falling mostly between October and March.

GLOBAL WARMING

Seattle and the larger Pacific Northwest can anticipate significant climate change related to global warming, as well as associated ecological and sociocultural impacts. According to the Washington Climate Change Impacts Assessment prepared by The Climate Impacts Group at the University of Washington in June 2009, climate change could affect regional ecology relative to temperature increase, intensity of precipitation, reduction of snow pack, and air quality.

TEMPERATURE

Records indicate that Pacific Northwest temperatures have increased 1.5°F since 1920. Climate models from the Intergovernmental Panel on Climate Change project increases in annual temperature on average of 2.0°F by the 2020s, 3.2°F by the 2040s, and 5.3°F by the 2080s. Regional models indicate that climate warming rates will be greater in the 21st century than those observed in the 20th century.

PRECIPITATION AND HYDROLOGY

Regional climate model simulations generally predict increases in extreme high precipitation of the next half century, particularly around Puget Sound. April 1 snowpack is projected to decrease by 28% across the state by the 2020s, 40% by the 2040s, and 59% by the 2080s compared with 1916-2006 historical average.

Peak river flow will shift from late spring (driven by snow melt) to winter (driven by precipitation). In the major river systems of Puget Sound and lower elevation basins in the interior Columbia Basin, flood risk will likely increase, which in turn increases the risk of streambed scouring of salmon spawning habitat. Design standards developed to accommodate mid-20th-century rainfall records and existing drainage infrastructure built in accordance with these standards may need to be modified.

The amount of water stored in reservoirs will be lower from late spring through early fall, affecting water supply for campus or municipal use and other operating objectives, such as hydropower production.

AIR QUALITY

Global warming will likely lead to significantly more heat- and air pollution-related health impacts.
IMPACTS OF GLOBAL WARMING
Combined impacts on tree growth, regeneration, and greater susceptibility to insects and disease will fundamentally change the nature of forests, particularly in ecosystems where water deficits are greatest.

Rising stream temperatures will likely reduce the quality and extent of freshwater salmon habitat. The greatest increases in thermal stress would occur in the Interior Columbia River Basin and the Lake Washington Ship Canal.

In a report by the Washington Department of Fish and Wildlife and the National Wildlife Federation (Summary of Climate Change Effects on Major Habitat Types in Washington State, July 2011), the following impacts are predicted:

- Douglas fir: About 32% of the area currently classified as appropriate climate for Douglas fir would be outside the identified envelope; decline in climatically suitable habitat for Douglas fir is most widespread at lower elevations, particularly in the south Puget Sound/southern Olympics.

- Pine Forests: Climate is likely to be a significant stressor in pine forests in the Columbia Basin and eastern Cascades as early as the 2040s. About 85% of the current habitat for pine will be outside the climatically suitable range for one or more pine species.

- On the scale of individual plants, temperature may influence rates of leaf photosynthesis and respiration, frost tolerance of tree needles, flowering, bud dormancy, and the ripening of fruits and cones. On a larger scale, mean and annual variation in annual temperature and precipitation may jointly determine general patterns of distribution and growth.

- Changes in ecosystem productivity and phenology
- Increased frequency and magnitude of wildfires
- Increased susceptibility to insects and disease
GEOLOGY & SOILS
According to the USGS Geologic Map of Seattle, the UW campus west of Montlake Blvd. is underlain predominantly by younger Pleistocene (12,000 – 18,000 YA) deposits, mainly subglacial till consisting of silt, sand, and subrounded gravel, with some small areas of ice-contact deposits and glacial outwash. East of Montlake Blvd, the geology is mainly Holocene (12,000 YA) peat – predominantly organic matter consisting of plant material and woody debris. Peat accumulations are greatest in the floors of recessional-outwash channels and where the lowering of Lake Washington 100 years ago exposed extensive lake floor deposits. This organic material is commonly interbedded with silt and clay. A small area north of 45th St consists of alluvium – sand, silt, and cobbles deposited by streams and running water.

In several areas, numerous examples of loose stones, rocks, and gravel comprising various mineral compositions were observed, which is consistent with the USGS map. Such surficial geology often promotes relatively rapid drainage of stormwater. Consistent with this scenario, observations of campus areas during the prolonged rain events reveal very few areas of accumulated surface water.

However, it is not clear from this level of geological analysis whether the rocky soil composition on campus is naturally occurring or the result of human activity. Urban soils are notoriously highly disturbed as a consequence of activities such as earthwork (excavation, grading), demolition and construction. Naturally occurring soil profiles are often mixed or inverted, and native materials could have been supplemented or replaced entirely by imported fill.
Visible or invisible, water in various forms is a defining feature of the UW campus. Viewed from some distance, UW is literally perched along and atop Lake Washington. Various wetlands interweave between campus upland and open waters of the lake. Thirty-plus inches of rain per year drain over sloping streets and hardscape of the campus or infiltrate into planted areas and natural areas. Pools and fountains dot the campus. Municipal water is consumed for various purposes. Each of these water facets may be viewed as a subsystem of an overall hydrologic system. To varying degrees, each hydrologic subsystem interacts with some or all of the others. With progressive hydrologic strategic planning, all of these subsystems can be made to interact beneficially at a functional level much higher than that which currently exists.

**OPEN WATER**
Several areas of shoreline along Lake Washington and Union Bay contain valuable emergent marsh habitat. In contrast, the highly channelized ship canal and Portage Bay contain little to no natural shoreline, and the ship canal is constantly subject to wake action produced by numerous passing vessels.

Posted signs warning against human consumption of fish caught in Lake Washington speak of chemical inputs impacting the ecological health of lake waters. According to Union Bay Natural Area and Shoreline Management Guidelines (2010), a pipe connection between Ravenna Creek and North University Slough was established in 2006, thereby providing for a flowing stream system. This stream emerges on the south side of NE 45th Street. The northern reaches of the daylighted portion of the stream contain minimal streamside buffer and generally poor riparian habitat. Ecological conditions improve after the stream passes the golf driving range. Even with compromised ecological conditions, the relatively protected waters of the University Slough, as well as Central Pond in Union Bay Natural Area (UBNA), provide valuable habitat for various mammals, birds, reptiles, amphibians, fish, and macro invertebrates. From a natural history perspective, the University Slough is significant for serving as the continuation of largely groundwater fed Ravenna Creek, which—prior to the lowering of Lake Washington—served as an important tributary and major provider of sediment to Union Bay. Outside of Union Bay Natural Area, the UW campus is essentially devoid of natural or naturalistic bodies of water.

**WETLANDS**
The only detectable wetland habitats on campus are found in UBNA. These habitats exhibit varied vegetative structure, making for valuable diversity of vegetative cover. Most of the wetlands in the interior of UBNA are seasonal, their hydrology fluctuating in accordance with Seattle’s typical precipitation patterns. Perennial wetlands generally occur at the mainland edges, offering valuable cover for waterfowl. The remote reaches of the Yester Swamp appear particularly inviting to a range of wildlife.
CAMPUS VEGETATIVE COVER
LAND COVER TYPES
Built elements such as buildings and pavement comprise the largest land cover type on campus: buildings, 112 acres; city roads, 39 acres; university internal roads, 132 acres; university paths and walks, 82 acres; and parking, 59 acres. This impervious land cover type functions as the matrix in which vegetative patches and corridors are situated and function. Turf sports fields and courts comprise 4.38 acres of campus land cover and are a mix of impervious and pervious surfaces.

LAWN
There are 75.5 acres of lawn areas consisting of common turf grass species. Since most turf species are native to areas in Europe that are generally wet year-round, these lawns go dormant and turn brown during dry seasons unless they are regularly irrigated. During rainy months in Seattle, UW’s lawns generally appear green and lush. Most are managed by frequent mowing, with mowing height across the campus generally uniform. In addition to many open spaces covered by expanses of turf grass, many sidewalks and walking paths are bordered by closely cropped lawn.

PLANT BEDS
Planted beds constitute 44.3 acres of the campus land cover. These areas vary widely in terms of aesthetic appeal, plant community health, extent of soil cover, density of planting, and species used. In many instances, planted beds appear to be performing successfully as intended. In such spaces, the plants thrive, visual impact is strong, stormwater is managed effectively, and weeds are minimal. In many other instances, however, plants are struggling, bare soil is prevalent, weeds are abundant, and aesthetic appeal is compromised. Usually in such spaces, the installed plants are not appropriate for the environmental conditions of the site. Some commonly observed issues include plants poorly suited to existing light conditions, plants overly stressed by the heat island effect from buildings or paved areas, and wetland plants struggling in rain gardens and stormwater collection areas where drainage is relatively rapid because these systems are actually designed to mimic upland forests, not wetlands.
WOODED OR MINIMALLY MANAGED LANDSCAPES

Kincaid Ravine serves as one of the most important natural areas on the UW campus. At about four acres, this urban forest is the largest natural area after UBNA. Benefits provided by this tract of forest include varied vegetative habitat for wildlife, good water storage capacity, and microclimate regulation in the area between the Burke-Gilman Trail and North campus.

Kincaid Ravine is primarily a deciduous forest with big-leaf maple (Acer macrophyllum) as the dominant canopy tree, accompanied by species such as black cottonwood (Populus balsamifera) and red alder (Alnus rubra). The woody understory is predominantly non-native, including English holly (Ilex aquifolium), Himalayan blackberry (Rubus armeniacus), and English laurel (Prunus laurocerasus). The forest floor is likewise dominated by non-native species, such as English ivy (Hedera helix), bindweed (Convolvulus arvensis), and garlic mustard (Alliaria petiolata). Noteworthy within this forest is the absence of typical native Seattle-area conifers in the canopy and understory layers.

A small system of rogue trails is present in parts of the forest. However, no clearly defined pedestrian trail system is apparent. During visits to this area, usage by various bird species was high in comparison to other sections of the campus. Although Kincaid Ravine is rightly classified as a disturbed forest ecosystem, even in its present state, it provides a valuable array of ecosystem services.

Current student-initiated activities to restore the Kincaid Ravine and Whitman Court forested landscapes have contributed to the public awareness of the significant contributions these landscapes provide to the ecological health of the campus. These efforts should continue to be supported by the University as a unique and valuable use of the campus for research and learning opportunities and direct engagement of students in the understanding of natural systems, leadership in organizing student work parties, and public outreach.

HERBACEOUS AND GRASSLANDS

At 73.5 acres, the Union Bay Natural Area (UBNA) is the most ecologically significant land parcel on campus. From both a campus and regional perspective, the size and continuous nature of the natural area by itself is of paramount value: UBNA comprises over 10 percent of UW’s total land cover, and it is the second-largest naturalized ecosystem residing along the shoreline of Lake Washington.

The parcel supports many mammal, bird, fish, and herptofaunal species, along with numerous invertebrates. According to the 2010 Union Bay Natural Area and Shoreline Management Guidelines, UBNA is considered the best birding area in Seattle, with more than 200 species recorded by birders on eBird (ebird.org) including waterfowl, songbirds, and raptors.

UBNA also provides significant urban ecosystem services such as stormwater management, capture and filtration of sediments and pollutants, and mitigation of heat island impacts.

Much of the high ecological value provided by UBNA derives directly from its wide variety of plant community and habitat types, which provide breeding, roosting, cover, hunting, and foraging opportunities for numerous vertebrates and invertebrates. These communities and habitat types include:

- upland grassland / meadow / prairie
- wet meadow
- emergent marsh
- upland forest
- riparian forest
- swamp forest
- creek / slough
- pond
- littoral zone (vegetated standing water extending out toward open water)
- open water (lake)
Of significant ecological note, UBNA is a very young natural area. Prior to 1916, UBNA was part of a submerged delta formed by sediment flow from Ravenna Creek, Yester Creek, and Kincaid Ravine drainage. After a lowering of Lake Washington, the delta was exposed and soon used for landfill purposes. The closing of the Montlake Landfill in the late 1960s essentially marked the “birth” of the ecosystems comprising UBNA. Other than about 15 acres that have been subject to intervention for restoration purposes, nearly 60 acres of UBNA are in the early stages of development and “natural healing.” Hence, the majority of UBNA land cover is in the early phase of its successional trajectory, and accordingly, much of the UBNA vegetation is composed of early successional species, including common exotic species, several of which are considered invasive. From an urban ecology perspective, the ecosystem dynamics occurring at UBNA are highly typical of recently disturbed areas reverting to nature.

TREES AND TREE CANOPY
The UW Campus contains a well-established population of mature canopy trees, with a much higher proportion of deciduous species than conifer species. The campus deciduous–conifer ratio is markedly different from historic natural conditions in the region, where coniferous species tend to predominate in the canopy. Typical of many university campuses, monocultural groves or single-species allees (e.g., flowering cherry, London plane, horse chestnut) are prominent in several areas. Tree health, in general, appears good. The climactic conditions of the Seattle area are favorable to a wide variety of tree species, both native and non-native alike. The Brockman Campus Tree Tour Species List serves as a good illustration of the wide array of species that grow well amidst the environmental conditions present on campus.
KEY CAMPUS CORRIDORS

- 45TH STREET
- NE CAMPUS PARKWAY
- NE STEVENS WAY
- OPEN WATER TERRESTRIAL EDGE
- UNIVERSITY SLOUGH
- MONTLAKE BOULEVARD
- BURKE-GILMAN TRAIL
- 15TH AVENUE
- MEMORIAL WAY
- NE CAMPUS PARKWAY
- PACIFIC STREET
- RAINIER VISTA WAY

Canopy Tree
Wooded, Minimally Managed Areas
Major Vehicular Corridors
Small Pathways
Burke Gilman Trail
Open Water Terrestrial Edge
Canopy Tree

0 400 800

CAMPUS CORRIDORS
In landscape ecology, corridors are elements that may connect different vegetative patches in the surrounding matrix, or they may exist as isolated strips. Small strategically located patches can also function as corridors (stepping stones). Corridors can provide habitat for wildlife (typically edge and generalist species predominate); act as a conduit for movement (e.g., animals, water, sediments, nutrients, invasive species); and act as a filter or barrier to movement (e.g., roadways where animals are killed) (Forman, 1995). Attributes such as interior width, gaps and connectivity, and context (adjacent landscape character) influence how well a corridor contributes to overall ecological landscape health (Forman, 1995; Cook, 2002). Corridors may be beneficial to some species (e.g., reducing habitat fragmentation) and harmful to others (e.g., filter/barrier effect), especially in an urban landscape.

SHIP CANAL EDGE UPLAND
Much of the land adjacent to and above the constructed bays of the Lake Washington Ship Canal is composed of mixed vegetation that appears minimally managed. On either side of the support structure of the Montlake Bridge, vegetation is generally dense and includes various trees, shrubs, vines, forbs, and grasses. This area is traversed by several poorly defined footpaths. Steep slopes characterize much of the terrain.

While much of this waterside edge displays signs of typical edge effects, such as vine overgrowth and abundance of opportunistic species, the vegetation also provides valuable habitat and protective cover for wildlife. A variety of vegetative structure and density of plant growth immediately adjacent to a land-open water interface is especially beneficial to many species of birds.
**NE 45TH STREET**
Like 15th Avenue, 45th Street is a heavily utilized connector for pedestrians, cars, and buses, providing direct east-west connection. Vegetation planted in layers along the south side of 45th Street is nearly continuous. Canopy trees along the street have a direct connection to the forest of Kincaid Ravine.

Between 15th Avenue and 22nd Avenue, much of the campus edge along 45th Street is covered by vegetation that is narrow in planting width but generally high in plant density. The mix of plant species in this area is somewhat diverse and includes native species, exotic specimens, and patches of invasive growth (most notably English ivy and Himalayan blackberry). From roughly 18th Avenue to 22nd Avenue, a line of tall conifers is prominent. Running along the sidewalk edge of this area is a mowed turf edge that is green in April and brown in August. During visits to this area, wildlife activity was relatively high.

The woodland edge along 45th Street is a valuable natural area providing stormwater management, microclimate control, and protective habitat for wildlife. Strategically, it lies adjacent to Kincaid Ravine and provides animals with a mostly continuous, vegetation-covered connection between the ravine forest and the semi-wild landscape outside the Burke Museum.

**NE CAMPUS PARKWAY**
NE Campus Parkway is a wide connecting boulevard located in west campus. Notable along this roadway is a wide median that runs between 15th Avenue and the University Bridge. Street trees and turf grass are prominent within this green swath. Also of note is a stately American elm growing amidst a lush native groundcover planting established during the phase 1 of the west campus housing in 2010. A somewhat large patch of cool season grasses is located in front of Condon Hall. Ecological value within the green space of NE Campus Parkway is currently low to moderate, but potential for marked improvement is high.
MEMORIAL WAY
Memorial Way is a relatively short corridor that offers moderate ecological value. The defining element of the drive is the ceremonial double row of London Planes extending from 45th Street to the War Memorial. In addition to intersecting the minimally managed wooded corridor of NE 45th St, Memorial Way connects to Parrington Lawn, Denny Yard, and the wooded grove near Paccar. To the north, it serves as a connector to 17th Ave NE, which in turn connects to Ravenna Boulevard with key greenway connections to Green Lake and Cowen Park.

NE STEVENS WAY
NE Stevens Way serves as the primary modal connector for users within the core of the UW campus. Other than direct connections with several green pockets located within the inner campus, its ecological value is low. Such green pockets include the Medicinal Herb Garden, planted areas near the Botany Greenhouse and Plant Lab, Island Grove, Sylvan Grove, the wooded area near McMahon, and the wooded area near Paccar Hall. Much of Stevens Way is planted with premature canopy trees.

PACIFIC STREET – MONTLAKE BOULEVARD
The corridor formed by Pacific Street and Montlake Boulevard is heavily used by cars, buses, and pedestrians. Throughout much of the day, intense traffic activity is present in the vicinity of Montlake Blvd. On Pacific Street, much of the streetscape is dominated by the interconnected complex of UW Medical Center. Along Montlake Boulevard, the street level is largely consumed by an athletic complex that includes Husky Stadium, Edmundson Pavilion, numerous athletic fields and facilities, and vast surface parking lots. A new light rail station next to Husky Stadium is slated for completion in 2016.

The ecological value of the Pacific Street – Montlake Boulevard corridor is low. In fact, the corridor acts as a barrier to terrestrial wildlife that may attempt to pass between the waterfront area and the inner portion of the UW campus. Occasionally planted beds and street trees offer little in the way of valuable habitat or ecosystem services.

RAINIER VISTA
Rainier Vista is a very wide pedestrian corridor distinguished by vast lawn areas. Following the current construction in the lower region of this promenade, turf lawn coverage will increase considerably. Rainier Vista offers marginal ecological value through its adjacency to Island Grove, Sylvan Grove, and to its connection with the Burke-Gilman Trail. Opportunity for ecological improvement within the vicinity of Rainier Vista Way is high.

Currently, the crabapple trees in front of Guggenheim Hall provide a seasonal source of food for Canada geese, which are often viewed as a nuisance rather than benefit. The wooded areas of Island Grove and Sylvan Grove have in the recent past been home to a small heron colony, with up to twenty-four nests sighted in one year. Although the location provides immediate access to the wetlands, a source of food, it has yet to establish as a stable nesting site, potentially attributed to the various activities of the University during critical nesting season. Also, the water of Drumheller Fountain serves as resting habitat for various waterfowl species and often welcomes an annual hatchling of ducks.
BURKE-GILMAN TRAIL

The Burke Gilman Trail (BGT) is a significant pedestrian corridor for both the UW campus and the overall region. Free of motorized vehicles, it is regularly and frequently used by walkers, joggers, and bicyclists, many of whom ride at high speeds. Most of the trail is lined with vegetation and a tree canopy – some managed, some minimally managed.

Throughout the eastern edge of central campus, the BGT is a valuable provider of ecosystem services for UW. It is essentially perched on a graded terrace, formerly used as a rail bed. As such, the trail is a primary receptor of storm water runoff that flows from the campus down a generally steep gradient. The vegetation on the north and west sides of the trail slows the velocity of overland flow and captures much of the sediments and particles suspended in the stormwater. At various points along the BGT, stormwater infiltrates, enters storm drains, or sits in swales before evaporating or infiltrating. The layered vegetation along the BGT also regulates the microclimate of adjacent built areas.

The BGT provides significant ecological value as a wildlife corridor. At various spots along the trail, habitat is suitable for small mammals, birds, reptiles, and amphibians. At certain points, such as Kincaid Ravine, the BGT intersects relatively large swaths of natural area. The proximity of the BGT to Lake Washington allows the trail to serve as a useful island flyway alternative for avian wildlife and bats. Along the BGT, the wider the vegetated buffer, the higher the ecological value.

Portions of the BGT from Rainier Vista west are not as fully or consistently vegetated, and the corridor is more frequently intersected by roadways and major pedestrian crossings, reducing the ecological value somewhat. However, the potential to retain a generous buffer and improve the vegetative quality of the plantings that line the trail could provide significant impacts that will encourage corridor connections along the trail, particularly with enhanced connections to the water.

ISLAND GROVE PATHWAY

SMALLER PATHWAYS

The UW campus contains an established network of smaller pathways, many of which are for pedestrian use only. Depending upon factors such as density of vegetation and proximity to larger tracks of vegetated space, the small paths vary widely in their value in terms of ecosystem services and wildlife habitat connectivity. An example of a small pathway offering relatively high ecological value is the footpath that runs parallel to Whitman Court on North Campus, which has been actively managed by a group of students from the Society of Ecological Restoration housed within the School of Environmental and Forest Sciences. Another higher value path is the one passing through Island Grove. A pathway with moderate ecological value is the connection between NE43rd Street and Memorial Way, which benefits from the dense growth of vegetation along the northern edge of William Gates School of Law. The grassy median running along this lane offers additional opportunity for ecological improvement.
OPEN WATER–TERRESTRIAL EDGE
An outer edge of upland terrestrial vegetation begins just southeast of the Marine Sciences building and runs nearly continuously around the southern and western campus rims to the relatively large confines of the Union Bay Natural Area. Woody vegetation is densest along NE Walla Walla Lane, parallel to the Lake Washington Ship Canal. Connectivity in this area is broken by the Montlake Bridge. As a whole, this outer edge of vegetation serves as a wildlife habitat corridor of moderately high ecological value. To varying degrees along this corridor, depending upon width and thickness of vegetated sections, wildlife can find protective cover and relatively safe options for passage or migration. Further, the vegetation growing along the steep slopes above the Ship Canal and Union Bay serves as a buffer that helps to lessen overland stormwater flow velocity, capture suspended solids before they enter open water, and reduce hillside erosion.

UNIVERSITY SLOUGH STREAM CORRIDOR
The University Slough/Drainage Canal is a flowing stream system fed via sewer pipe by base flow and surface flow from Ravenna Creek. The stream system is daylighted just after passing beneath the University Village Shopping Center and 45th Street, close to the northeast corner of the Golf Driving Range. Between this point and the open water of Union Bay, the stream and its bays serve as a riparian corridor. The stream corridor is clearly stressed in terms of its ecological health; it is highly confined and channelized, and occasionally subject to combined sewer overflow (CSO). However, this riparian ecosystem provides suitable habitat for small mammals, birds, reptiles, amphibians, fish, and macroinvertebrates. Hence, when considering all of the natural systems found on the UW campus, the University Slough stream corridor provides relatively high ecological value.
KEY CAMPUS PATCHES

- Union Bay Natural Area
- Kincaid Ravine
- Ship Canal Edge Upland
- Wetland Edges
- Parrington Lawn
- Sylvan Theatre
- Roof of Physics/Cyclotron Building
- Golf Driving Range
GENERAL CAMPUS BIODIVERSITY
The apparent overall level of biodiversity on the UW campus, excluding the Union Bay Natural Area and lake-front wetlands, is typical of similar urban campus landscapes.

Campus plant communities include a relatively diverse array of tree species, which appears to have resulted from the combination of intentional specimen plantings throughout the campus and a fairly good representation of typical native forest trees in several wooded areas. Diversity of shrubs and herbaceous species is relatively low.

Wildlife is comprised of common urban species. Mammals sighted include: Eastern gray squirrel (Sciurus carolinensis) and Norway rat (Rattus norvegicus). Birds frequently encountered included American crow (Corvus brachyrhynchos), Canada goose (Branta canadensis), gulls (species not identified), mallard (Anas platyrhynchos), black-capped chickadee (Poecile atricapillus), and American robin (Turdus migratorius). Thirty-nine bird species were recorded by area birders for the campus on eBird during April 2014, including several migratory songbirds (e.g., Orange-crowned warbler, Vermivora celata; ruby-crowned kinglet, Regulus calendula). No presence of reptile or amphibian activity within the campus core was observed. No inventory was made of invertebrate species. There is a possible correlation between low diversity of understory shrubs and groundcover and low diversity of vertebrate species.

A landscape ecology view shows that the UW campus mosaic is composed, with few exceptions (Union Bay Natural Area and wetland edges near the athletic facilities, Kincaid Ravine), of spatial elements designed almost exclusively for human use. The matrix consists primarily of buildings and infrastructure. Patches (lawns, plant beds, etc.) are designed primarily for aesthetics and recreation, although these areas still retain various levels of ecological function depending on such factors as the type and amount of human usage, campus location, size of planted area, and proximity to less human-dominated landscapes. Corridors (streets, paths) are generally vehicular/pedestrian thoroughfares with limited wildlife value that do not provide true ecological linkages. Campus-wide ecological enhancement and restoration, therefore, depend on strategies to improve the habitat and ecosystem services quality of vegetative patches and corridors, as well as the functional connectivity between them.
ECOLOGICAL VALUE
The ecological value of the campus is varied as noted by vegetation type and management practices. In addition, the following factors can affect ecological value of landscapes (adapted from Forman, 1995: Cook, 2002):

Type of Landscape
- Remnant: original character following changes in surrounding matrix
- Regenerated: previously disturbed/changed and has since naturally re-established vegetation
- Introduced: previously disturbed/changed and vegetation is of human origin

Patch Size
- Large: better, large benefits
- Small: small, supplemental benefits

Corridor Size
- Internal area/width: more distance from edges is better
- Length/continuity/gaps/connectivity

Habitat Quality
- Structural diversity: layers/stratification typical of native community
- Native species diversity
- Limited/lack of fragmentation
- Limited/lack of invasive species
- Connectivity

Ecological Stressors
- Altered hydrology/impervious surfaces
- Invasive species
- Soil compaction
- Habitat fragmentation
- Obstacles to movement, collision hazards

Context
- Adjacent conditions compatible, adequate buffers
- Degree of isolation: proximity to other patches or corridors
## Sample Ecological Value Rankings

<table>
<thead>
<tr>
<th>Location</th>
<th>Type</th>
<th>Patch/Corr. Size</th>
<th>Context</th>
<th>Habitat Quality</th>
<th>Eco Stressors</th>
<th>Average Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parrington Lawn</td>
<td>Introduced</td>
<td>2.0</td>
<td>1.5</td>
<td>1.0</td>
<td>1.0</td>
<td>1.4</td>
</tr>
<tr>
<td>Sylvan Grove</td>
<td>Introduced</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.6</td>
</tr>
<tr>
<td>Island Grove</td>
<td>Introduced</td>
<td>2.0</td>
<td>1.0</td>
<td>2.0</td>
<td>2.5</td>
<td>2.0</td>
</tr>
<tr>
<td>North Physics Lab Roof</td>
<td>Introduced</td>
<td>1.5</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
<td>1.6</td>
</tr>
<tr>
<td>Drumheller Rose Garden</td>
<td>Introduced</td>
<td>1.0</td>
<td>2.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.3</td>
</tr>
<tr>
<td>Golf Driving Range</td>
<td>Introduced</td>
<td>2.0</td>
<td>2.5</td>
<td>1.0</td>
<td>1.0</td>
<td>1.6</td>
</tr>
<tr>
<td>Whitman Court Woodland</td>
<td>Introduced</td>
<td>1.5</td>
<td>2.0</td>
<td>2.0</td>
<td>1.5</td>
<td>1.8</td>
</tr>
<tr>
<td>UBNA</td>
<td>Regenerated</td>
<td>3.0</td>
<td>2.0</td>
<td>3.0</td>
<td>2.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Kincaid Ravine</td>
<td>Remnant</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>1.0</td>
<td>1.8</td>
</tr>
<tr>
<td>45th Street Wooded Edge</td>
<td>Introduced</td>
<td>2.0</td>
<td>3.0</td>
<td>1.5</td>
<td>1.0</td>
<td>1.9</td>
</tr>
<tr>
<td>Ship Canal Edge</td>
<td>Regenerated</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.6</td>
</tr>
<tr>
<td>Wetland Edge</td>
<td>Remnant</td>
<td>2.0</td>
<td>3.0</td>
<td>2.0</td>
<td>1.5</td>
<td>2.1</td>
</tr>
<tr>
<td>15th Ave NE</td>
<td>Introduced</td>
<td>1.0</td>
<td>2.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.3</td>
</tr>
<tr>
<td>NE 45th Street</td>
<td>Introduced</td>
<td>2.0</td>
<td>3.0</td>
<td>1.5</td>
<td>1.0</td>
<td>1.9</td>
</tr>
<tr>
<td>NE Campus Parkway</td>
<td>Introduced</td>
<td>2.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.3</td>
</tr>
<tr>
<td>Burke Gilman Trail</td>
<td>Regenerated</td>
<td>2.0</td>
<td>3.0</td>
<td>1.5</td>
<td>1.5</td>
<td>2.0</td>
</tr>
<tr>
<td>NE Stevens Way</td>
<td>Introduced</td>
<td>1.0</td>
<td>2.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.3</td>
</tr>
<tr>
<td>Memorial Way</td>
<td>Introduced</td>
<td>1.0</td>
<td>2.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.3</td>
</tr>
<tr>
<td>Rainier Vista</td>
<td>Introduced</td>
<td>2.0</td>
<td>2.0</td>
<td>1.0</td>
<td>1.5</td>
<td>1.6</td>
</tr>
<tr>
<td>Pacific St / Montlake Blvd</td>
<td>Introduced</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Smaller Pedestrian Paths</td>
<td>Introduced</td>
<td>1.0</td>
<td>1.5</td>
<td>1.0</td>
<td>1.5</td>
<td>1.3</td>
</tr>
<tr>
<td>Open Water - Terrestrial Edge</td>
<td>Regenerated</td>
<td>2.0</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.6</td>
</tr>
<tr>
<td>University Slough</td>
<td>Regenerated</td>
<td>2.0</td>
<td>3.0</td>
<td>3.0</td>
<td>1.5</td>
<td>2.1</td>
</tr>
</tbody>
</table>

Ecological Ranking:  
3 = Good  
2 = Moderate  
1 = Poor
ECOLOGICAL ENHANCEMENT AND RESTORATION OPPORTUNITIES
Moving forward, campus ecosystem improvements can be designed with strong appeal to the primary users along a spectrum of formal garden to apparent naturalness or wildness. While continuing to prioritize human use, this would help rebalance the relationship with nature on a bustling urban campus like UW.

Specific areas where there is significant room for ecological improvement, in the form of ecological horticulture principles, include alternatives for:

- lawns
- planted beds
- tree canopy (urban forest)
- naturally occurring/minimally managed landscapes
- ecological corridors

APPLYING ECOLOGICAL HORTICULTURE
The ongoing stewardship of the UW campus should be based in an understanding of ecological context including climate; soils; hydrology; diverse flora and fauna and their native communities; and other site, local, and regionally specific factors. Applied to landscape design and management, the practice of ecological horticulture will maximize the ecological health of planted environments on the campus and enable UW to achieve the vision articulated in the University of Washington Climate Action Plan:

> We strive to envision the whole campus landscape as an ecological sustainable urban system that satisfies University functions while promoting healthy aquatic and terrestrial ecosystems. Landscape should be viewed as more than an aesthetic amenity. Understanding the campus ecology and the vulnerability of certain ecosystems relative to new construction will help UW design, build, restore, maintain, and manage the built environment more knowledgeably and

GUIDING ECOLOGICAL HORTICULTURAL PRINCIPLES
The following high-level guiding principles for ecological horticulture relative to landscape design and maintenance practices should be applied to all projects and provide an opportunity to re-examine and evaluate current practices.

1. LET SITE CONDITIONS GUIDE SPECIES SELECTION
2. ENHANCE PLANT COMMUNITY STRUCTURE
3. PROMOTE DIVERSITY, RESILIENCE, AND REGENERATION
4. UNDERSTAND AND ENHANCE MICROCLIMATES
5. APPLY STRATEGIC MAINTENANCE
6. MANAGE STORMWATER ECOLOGICALLY
preserve and enhance our ecosystem services.

1. LET SITE CONDITIONS GUIDE SPECIES SELECTION

**FUNCTION AND CHARACTER**
Plants that are suited to their location have the greatest potential to thrive and grow with the least amount of maintenance. Plant selection can help contribute to optimizing campus experience while also conserving resources.

**STRATEGY**
Determine site conditions and properties prior to plant selection, e.g., soil characteristics, hydrology, light exposure, proximity to reflective building surfaces and pavement (urban heat island impacts). Select plant species that are well-suited to specific conditions. Place high priority on selecting native plants from the Seattle area (see lists at the end of this chapter).

2. ENHANCE PLANT COMMUNITY STRUCTURE

**FUNCTION AND CHARACTER**
Single specimens have less experiential and ecological value as compared to layered plant communities. Complex community structure provides habitat, food for wildlife, carbon sequestration, improved localized air quality, efficient stormwater management, and enhanced weed suppression.

**STRATEGY**
For new construction, or simply to add value to an existing landscape, plant in layers to mimic the vertical stratification in naturally occurring ecosystems, e.g., tree canopy, understory, shrub and tree seedling, groundcover.
3. PROMOTE DIVERSITY, RESILIENCE, AND REGENERATION

In its earliest days, the campus landscape was conceived of as an arboretum. The legacy of this idea, along with its periodic revivals, has contributed to a good range of tree species on campus that add to the experience of the campus and its ecological resilience.

**STRATEGY**
Maintain the campus tree inventory through strategic planting of seedlings and young trees. Select diverse plant species to ensure resilience to changing climatic conditions. Develop a contingency plan to respond effectively to potential mass mortality events (e.g., disease, insect infestation) that may impact single-species plantings such as allees and groves of London plane or flowering cherry.

4. UNDERSTAND AND ENHANCE MICROCLIMATES

Diverse microclimates make the campus a more comfortable place for plants and humans. Depending on the season and the weather, the combination of architecture and existing plant communities creates environments that can shelter from or provide exposure to sun, rain, and wind. New plantings respond to existing microclimates and contribute to new ones.

**STRATEGY**
Determine existing microclimatic conditions such as wind and urban heat island effects that will impact plantings and/or that can be mitigated by plantings. Include canopy trees in planted beds and along pathways. Deciduous, single leader conifers planted near buildings provide summer shade, allow winter light penetration, and can be successfully long lived in tight spaces.
5. APPLY STRATEGIC MAINTENANCE

Ongoing maintenance helps sustain the experiential excellence of the campus, as well as its overall function. The size of the campus and the available resources suggest that efforts should be made to maximize need and maximize the effectiveness of maintenance.

**FUNCTION AND CHARACTER**

Find opportunities to reduce need for irrigation through reuse of precipitation, allowing lawns to brown out, and selection of drought-tolerant species. Maintain turf at a taller height. Less frequent mowing will reduce soil compaction, cut carbon emissions, and increase savings in energy costs. Taller grass is also more effective at slowing stormwater runoff and managing the “first flush” during a storm event. Convert lawns to meadows and grasslands, which generally perform best and require less intensive maintenance when planted in large, sunny areas.

6. MANAGE STORMWATER ECOLOGICALLY

Plantings can be intentionally designed to add value to the experience of the campus while also minimizing the amount of stormwater conveyed from impermeable surfaces to CSOs during storm events.

**FUNCTION AND CHARACTER**

Increase infiltration and reduce stormwater runoff-related stressors by installing porous pathways made of gravel, wood chips, or other loose material. Create roof garden ecosystems, which are well-suited to Seattle’s climate, to capture precipitation on buildings and reduce the urban heat island effect.
ALTERNATIVE LAWN STRATEGIES
Similar to many university campuses, the UW campus has abundant expanses of lawns planted in common exotic turf grass species. Keeping grass lawns green throughout the year requires irrigation when water resources are the most strained. There are simple, effective alternatives to lawn that would contribute to greater biodiversity, improved hydrologic functioning, and lower maintenance. These include replacing turf with plant species and/or communities that are suited to the environmental conditions present on the specific site, as well as the governing regional climatic patterns. Such plant communities include native warm season grasslands, wildflower meadows, savannas, shrubland, or forest (see sample lists at the end of the chapter). The UW campus contains various turf-covered areas that receive full sun that would benefit ecologically if converted to a more complex plant community.

Balancing the desire for greater biodiversity of lawn areas with aesthetic considerations and student recreational needs (passive and active) requires thoughtful consideration. The following potential lawn conversions are merely suggestions for areas that could provide the greatest ecological functions if implemented and would not markedly change the overall use of the UW campus landscape, but they could add to the overall experience and portray the University’s commitment toward a more sustainable landscape ecology.

VARIED TURF HEIGHTS
A simple intervention that could be considered for large grassy areas, such as those within Parrington Lawn and Rainier Vista Way, would entail varying height levels of turf and allowing unused sections of lawn to grow higher. A visual precedent for such a landscape practice can be observed within the large meadow spanning the entrance area at Bloedel Reserve on Bainbridge Island. In this meadow, a permeable walkway is flanked by short, frequently mowed turf, which gives way to taller, infrequently mowed grass. When turfgrass is mowed infrequently, stormwater management is improved and biodiversity is improved, as random forbs are able to grow amidst the grass.

PARRINGTON LAWN
Parrington Lawn is vast and well connected in several directions. There is room to accommodate both traditional turf landscape and managed meadow landscape while maintaining the various uses and overall character of the lawn. If meadow placement were to include frontage along 15th Ave. NE, visual interest from the street would be enhanced, as meadow grasses and forbs would provide flowing motion and varied color near the ground plane.

RAINIER VISTA
At present, Rainier Vista contains several large lawn sections. Once current construction is completed, there will be even more more turf sections framed between paths. Conversion of some of these turf sections to grassland or meadow would significantly improve the ecological value of this entire area. Varied land types in proximity offer valuable choices for habitat and food for wildlife. Rainier Vista is adjacent to multiple wooded areas: Sylvan Grove Theater and Island Grove and the landscape near Anderson and Bloedel. Locating open meadow habitat close to these wooded areas would encourage greater wildlife diversity in this area. Also, tall grasses and forbs would improve natural stormwater management of this downward-sloping area.
SYLVAN GROVE THEATER
The open lawn of Sylvan Grove Theater slopes downward to a low point close to the columns. A storm drain sits at the base of the section. If feasible from a programming perspective, disabling the storm drain and installing a mix of mesic and wet meadow species would enhance both the ecology and systems functionality of the spot. If a wet meadow creation at Sylvan Theatre coincided with meadow creation within the Rainier Vista, the biodiversity of the entire area would noticeably improve.

NE CAMPUS PARKWAY
The median of NE Campus Parkway is currently planted with turf grass interspersed with street trees. Converting this median to savanna habitat, by adding meadow grasses and forbs, along with selected shrubs, would improve the ecological viability of this corridor. In addition, properly selected species installed within strategically graded storm water catchment areas/rain gardens would greatly promote beneficial stormwater management of runoff flowing down 11th Ave., 12th Ave., Brooklyn Avenue and University Avenue.

WALLA WALLA LANE
Much of the area surrounding Walla Walla Lane, on both sides of the Montlake Bridge, is composed of mowed turf. This lightly used open space could easily be transformed into meadow, savannah, or forest habitat, each of which would promote increased biodiversity and improve stormwater management.

NORTH PHYSICS LABORATORY
An expanse of vegetation composed largely of non-native cool season grasses and weedy forbs sits atop the roof of the physics laboratory building cyclotron. Converting this area to native warm season grasses and forbs would prove ecologically valuable.

GOLF DRIVING RANGE
The expanse of turf that comprises the Golf Driving Range is vast, and the potential exists to provide ecological uplift while still maintaining the athletic function of the range. One possibility would be to reduce the size of the range and convert the portion along the forested edge of the University Slough to short grass meadow. This scenario assumes that most golf balls would be easily retrievable in the mowed turf portion of the range. Placement of a meadow near the University Slough corridor would be a boon to wildlife.

NE STEVENS LANE
The turf median set within NE Stevens Lane could be converted to a few species of warm season grasses to improve ecology and hydrology.

TURF EDGES ALONG SIDEWALKS
Along several campus walkways, mowed strips of turf of varying widths separate wooded areas from the sidewalks. Examples include sections of 45th St., 15th Ave., and Rainier Vista Way. In such areas, converting these to meadow landscapes or adding low shrubs and ground cover herbaceous species would add habitat and improve stormwater capture, significantly reducing maintenance requirements.
ALTERNATIVE PLANTING BED STRATEGY
The UW campus contains many planted beds of various types and sizes. A planting bed is any consciously planted landscape or garden, other than lawn areas and minimally managed natural areas. Given the extremely wide range of landscape types that fall within this definition, recommending specific treatments for every planting bed on campus is well beyond the scope of this report. Each decision regarding a plan for a particular bed is a product of the demands and interests surrounding that particular site. However, the guiding ecological horticulture principles presented previously have broad relevance and can be applied to all planted bed decisions.

To maximize the long-term success and ecological performance of planted beds throughout the campus, UW should undertake a campus-wide planted bed inventory, similar to a tree inventory. To pursue this strategy, each bed on campus could be identified and georeferenced on a base map. Field observations would include soil type, hydrology, gradient, light conditions, and microclimatic extremes, if any, for each bed. In addition, each site would be ranked in terms of its aesthetic appeal, ecosystem service functionality, level of required maintenance, and ecological value (primarily potential habitat structures and food offering). Intervention priorities would generally start with the lowest ranking bed sites. When contemplating any intervention strategy for a particular site recorded conditions and observations of that specific site would be available for consultation. A comprehensive planted bed inventory followed by a prioritized, systematic intervention program over time will maximize long-term performance of the campus ecosystem and minimize long-term maintenance of planted beds across campus.

TREE CANOPY STRATEGY
Compared to the number of trees that existed prior to the mass clearing that paved the way for campus development, the present number of large canopy trees contained on campus is quite small. Also, the overall total of deciduous canopy trees far outnumbers the total of conifer trees— a pattern that contrasts sharply with pre-development conditions, when coniferous forest would have been the predominant plant community type. Notably, out of the 67 tree species that comprise the Brockman Campus Tree Tour Species List, only 25 are conifers.

In general, the campus would benefit greatly from an increased number of large trees, which contribute greatly to wildlife habitat, stormwater management, microclimate regulation, and air purification. Because opportunities for substantial increase in quantity are limited, additional tree plantings must generally be implemented on an incremental basis. Specifically, a large percentage of additional tree installations should be native conifers where conditions permit.

OPPORTUNISTIC TREE INSTALLATION
The density of the existing infrastructure on campus, and the likelihood of future development, would complicate efforts to introduce many new large trees to campus. For this reason, the decision to install one or more canopy trees should be made on a case-by-case basis to ensure that long-term goals for each site are met and that undesirable long-term results are avoided. Opportunistic tree planting decisions could be made in conjunction with the suggested planting bed inventory.

A FOREST ECOSYSTEM APPROACH
The forest that once occupied the UW site featured tall climax species that including Douglas fir, western hemlock, and western red cedar. For reasons related to ecological uplift, priority should be placed upon reintroducing more of these native tree species to the campus canopy. While these species can be planted (and, in fact, are planted throughout Seattle) successfully as individual specimens, their long-term viability is increased when they are planted in association with plants that typically accompany them in natural forest settings.
Assuming that UW follows the recommended guidance to diversify certain lawn areas, implement a planting bed inventory, and analyze minimally managed areas, there will undoubtedly be opportunities to plant small native forest ecosystems in various places throughout the campus. Restoration of forest ecosystems can be facilitated by using a mix of species that are readily available from local nurseries. However, to the extent feasible, plants that represent local ecotypes (locally/regionally adapted subspecies) would provide even greater ecological resilience.

**CAMPUS AS “URBAN PINETUM”**

Indigenous forests in the Seattle region are primarily dominated at the canopy level by coniferous species, and the general visual character of the Pacific Northwest landscape is often framed or defined by the presence of tall coniferous trees. The climate of the Seattle region is generally favorable to a wide range of conifers, including some that are not native to the region. For an acclaimed research institution with strong departments in forestry and botany, conifers offer a valuable platform for ecological study. Conifers and other gymnosperms are a more ancient taxon of plants than angiosperms (flowering plants). Certain species of conifers, e.g., dawn redwood, are considered by some scientists to be akin to “living fossils.” With the onset of global warming, evergreen conifers may be viewed as indicator species worth long-term study.

A key defense mechanism that allows deciduous species to survive stressful conditions is the ability to defoliate and enter a state of dormancy. Evergreen conifers are not able to reach such a state. In Seattle, evergreen conifers generally perform photosynthesis year-round. While this offers many advantages during normal environmental conditions, photosynthesis requires the expenditure of energy. Not having the capability of effectively shutting down during times of environmental stress may render conifers initially more susceptible than deciduous species. Designating the UW campus as an urban pinetum may promote valuable long-term study of the effects of climate change upon plants.

**Local Native Forest Community Species Palette**

<table>
<thead>
<tr>
<th>Botanical Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Canopy Trees</strong></td>
<td></td>
</tr>
<tr>
<td>Acer macrophyllum</td>
<td>Bigleaf maple</td>
</tr>
<tr>
<td>Arbutus menziesii</td>
<td>Pacific madrone</td>
</tr>
<tr>
<td>Pseudotuga menziesii</td>
<td>Douglas fir</td>
</tr>
<tr>
<td>Thuja plicata</td>
<td>Western red-cedar</td>
</tr>
<tr>
<td>Tsuga heterophylla</td>
<td>Western hemlock</td>
</tr>
<tr>
<td><strong>Understory Trees and Shrubs</strong></td>
<td></td>
</tr>
<tr>
<td>Acer circinatum</td>
<td>Vine maple</td>
</tr>
<tr>
<td>Amelanchier alnifdia</td>
<td>Serviceberry</td>
</tr>
<tr>
<td>Cornus nuttallii</td>
<td>Pacific dogwood</td>
</tr>
<tr>
<td>Corylus cornuta</td>
<td>Hazelnut</td>
</tr>
<tr>
<td>Oemleria cerasiformis</td>
<td>Indian plum</td>
</tr>
<tr>
<td>Philadelphus lewisii</td>
<td>Mock-orange</td>
</tr>
<tr>
<td>Ribes sanguineum</td>
<td>Red-flowering currant</td>
</tr>
<tr>
<td>Rubus parviflorus</td>
<td>Thimble berry</td>
</tr>
<tr>
<td>Samburus racemosa</td>
<td>Red elderberry</td>
</tr>
<tr>
<td>Symphoricarpos albus</td>
<td>Snowberry</td>
</tr>
<tr>
<td>Symphoricarpos occidentalis</td>
<td>Coralberry</td>
</tr>
<tr>
<td><strong>Low Shrubs</strong></td>
<td></td>
</tr>
<tr>
<td>Rosa nutkana</td>
<td>Nootka rose</td>
</tr>
<tr>
<td>Vaccinium ovatum</td>
<td>Evergreen huckleberry</td>
</tr>
<tr>
<td>Vaccinium parvifolium</td>
<td>Red huckleberry</td>
</tr>
<tr>
<td><strong>Vine</strong></td>
<td></td>
</tr>
<tr>
<td>Lonicara ciliosa</td>
<td>Honeysuckle</td>
</tr>
<tr>
<td><strong>Wildflowers</strong></td>
<td></td>
</tr>
<tr>
<td>Achlys triphylla</td>
<td>Vanilla leaf</td>
</tr>
<tr>
<td>Dicentra formosa</td>
<td>Bleeding heart</td>
</tr>
<tr>
<td>Maianthemum dilatatum</td>
<td>False lily-of-the-valley</td>
</tr>
<tr>
<td>Oxalis oregana</td>
<td>Redwood sorrel</td>
</tr>
<tr>
<td>Smilacena racemosa</td>
<td>False Solomon’s seal</td>
</tr>
<tr>
<td>Tellima grandiflora</td>
<td>Fringe cup</td>
</tr>
<tr>
<td>Trillium ovatum</td>
<td>Trillium</td>
</tr>
<tr>
<td><strong>Woody Groundcover</strong></td>
<td></td>
</tr>
<tr>
<td>Gaultheria shallon</td>
<td>Salal</td>
</tr>
<tr>
<td>Mahonia nervosa</td>
<td>Oregon grape</td>
</tr>
<tr>
<td><strong>Ferns</strong></td>
<td></td>
</tr>
<tr>
<td>Polystichum munitum</td>
<td>Sword fern</td>
</tr>
<tr>
<td>Pteridium aquilinum</td>
<td>Bracken fern</td>
</tr>
<tr>
<td>Polypodium glycyrrhiza</td>
<td>Licorice fern</td>
</tr>
</tbody>
</table>
STRATEGIES FOR MINIMALLY MANAGED AREAS

There are many areas of campus that contain forest-like characteristics and appear to be left in a “natural” state with tall canopy trees and an understory mixed with woody shrubs and groundcover. Many of these areas on campus and throughout Seattle suffer from overrun invasive species, predominantly Enligh ivy and Himalayan blackberry, that are difficult to manage without strict and ongoing management plans. They are also often areas that attract vagrant activities, making them less ecologically viable for wildlife and areas that are often perceived of as unsafe and undesirable. The follow are some minimally managed wooded areas of campus that could benefit from additional management to make them more ecologically beneficial.

UNION BAY NATURAL AREA

Because a mitigation-related restoration plan has been approved for UBNA, this report does not make specific recommendations regarding intervention strategies for the area. What follows, instead, are some general observations that may provide additional benefit.

As stated earlier, as a recently disturbed site, UBNA has been recovering quite successfully, with some oversight but mostly on its own. UBNA contains at least ten distinct plant communities that are currently being beneficially utilized by numerous wildlife species. Most of these communities are highly dynamic, as they have emerged relatively recently and are still in the early stages of colonization and establishment. It is difficult to predict accurately how the various inter-related ecosystems at UBNA will change and evolve over time. Intentional change introduced to such areas, even if enacted in support of the goal of “restoration,” should be carried out with extreme caution since even physical restoration activity (such as re-grading plant removal, herbicide application, etc.) constitutes a new site disturbance.

From an educational value perspective, the case can be made that the opportunity for students and others to observe and interact with evolving ecosystems, especially during a scenario of impending climate change, is much more valuable than assertive attempts to quickly “restore” or “improve” ecosystems that some consider “impaired.” According to “Union Bay Natural Area and Shoreline Management, 2010,” the University uses UBNA “primarily” as a natural laboratory for the teaching of restoration ecology. The value of such a natural laboratory cannot be over stated.

As documented bird-sighting lists attest, UBNA is an ecological magnet for avian activity and is regarded as one of the top birding areas in Seattle. The area may have the potential to be considered an Important Bird Area (IBA). Usually this designation is applied to predominantly natural areas, not human-made habitats such as landfills. However, discussion with the local Audubon Society may still be warranted since other criteria for IBA designation, such as enhanced management for the benefit of birds, may be possible to meet. Such a distinction could enhance UBNA’s stature as a valued natural resource in both the local community and the greater Seattle region.

KINCAID RAVINE

There is an existing ecological improvement strategy for this area outlined in the report entitled “Kincaid Ravine Urban Forest Restoration Project – University of Washington Seattle Campus.” According to this report, project goals include:

1. Increase habitat function and complexity of the Kincaid Ravine.
2. Increase hydrological function of the Kincaid Ravine.
3. Increase habitat opportunities for area wildlife.
4. Increase community/student awareness and involvement.
5. Increase public safety.

A key objective of this restoration project is to significantly “increase native plant diversity and canopy complexity in order to transition the Ravine forest from an early successional forest with deciduous canopy to a mixed conifer forest with a layered understory.” This objective aligns with the recommended strategy, mentioned above, for enhancing and increasing the number of native coniferous forest ecosystems on the UW campus.
Based upon review of the Kincaid Ravine restoration document, one caveat to the report’s recommendation is to minimize the use of herbicide specified for invasive tree removal. Based on the relatively small scale of the project and the implied heavy student involvement, we surmise that manual removal of the invasive species would be successful without the need for herbicides. An additional recommendation would be for selective girdling of mature native deciduous canopy species to allow light penetration for newly planted seedlings and to provide valuable snag habitat.

**SHIP CANAL EDGE UPLAND**
The woodland edge between Walla Walla Lane and the Lake Washington Ship Canal currently offers positive ecological value. Accordingly, enhancement of this area would be preferable to wholesale restoration. An inventory of plant species should be conducted prior to implementation. Priority should be placed upon preserving valuable native plants and tree specimens. The site would benefit from the removal of invasive growth of English ivy and Himalayan blackberry, and selective thinning of dense shrub growth in places would open up growing opportunities for more desirable species. Once low-quality vegetation is removed, species to be planted in place of removed vegetation should be selected from the suggested Local Native Forest Community Species Palette.

**STRATEGIES FOR ECOLOGICAL CORRIDORS**
In general, strategies for improving ecological health and connectivity of the various corridors on campus are based upon appropriate strategies that have already been proposed for lawn alternatives, plant beds, tree plantings, and minimally managed spaces. This is the case because open space that lies adjacent to the streets and pathways of UW fall under the category of either lawn, bed, tree planting, or minimally managed space. If the ecological health of each of these different landscape types is maximized, then the ecological value of all campus corridors will likewise be maximized.

**15TH AVENUE NE**
Wildlife connectivity along 15th Avenue would improve considerably if native shrubs and groundcover were planted in place of the lawn strip adjacent to the sidewalk. Further improvement would follow from conversion of the eastern portion of Parrington Lawn to meadow or grassland habitat.

**NE 45TH STREET**
As discussed, valuable habitat presently exists along much of the campus side on 45th Street. Accordingly, it makes better sense to enhance this corridor rather than engage in wholesale restoration. Prior to implementation, an inventory of plant species should be conducted. Priority should be placed upon preserving valuable native plants and tree specimens. The corridor would benefit from the removal of invasive growth of English ivy and Himalayan blackberry. In addition, selective thinning of dense shrub growth in places would open up growing opportunities for more desirable species. Once low-quality vegetation is removed, species to be planted in place of removed vegetation should be selected from the suggested Local Native Forest Community Species Palette.

If the wooded habitat in this corridor was improved and the lawn edge bordering the sidewalk was replaced with native shrubs and groundcover, overall ecological value of 45th Street as an important wildlife corridor will measurably increase. Also, because of the direct
connection between the natural sections of 45th Street and Kincaid Ravine, the ecological well-being of Kincaid Ravine will benefit from any improvements made along 45th Street.

**NE CAMPUS PARKWAY**
The median of NE Campus Parkway should be converted to savanna, along with four low sections designed to capture stormwater flow from intersecting sites. Such steps would significantly increase the habitat choices available to wildlife passing through this corridor, thereby improving its overall ecological value.

**STEVENS WAY AND MEMORIAL WAY**
Both Stevens Way and Memorial Way can be improved as habitat connectors through opportunistic enhancements to planting beds along the roads combined with opportunistic installation of additional trees and small tree ecosystems in areas where there are currently gaps.

**RAINIER VISTA**
As the widest pedestrian-only corridor on campus, Rainier Vista would benefit significantly if new habitat creation were to replace a sizeable portion, for instance, half, of the turf areas that presently exist. Introduced meadow habitat flanked by the existing wooded areas nearby would greatly encourage wildlife usage without obstructing the protected viewshed. Additional habitat variety could be achieved by installing floating wetland islands in Drumheller Fountain at the upper end of the corridor.

**PACIFIC STREET & MONTLAKE BOULEVARD**
Because of the density of developed spaces in these busy corridors and the volume of automobile traffic, opportunities to markedly improve habitat connectivity are limited, although additional trees might slightly benefit birds. The location of any contemplated dense installation of plants close to ground level should be carefully evaluated so as not to create a vegetated cover spot that inadvertently invites animals to attempt to cross busy lanes of traffic.
ADDITIONAL RECOMMENDATIONS
The following list captures additional salient ideas and suggestions that do not fit neatly into our main categories.

- Expand the available root zone for the oaks in Red Square.
- Where feasible, add planting in traffic islands or along perimeters in parking lots.
- Maximize ecologically based stormwater management opportunities in conjunction with any Burke Gilman Trail reconstruction and minimize habitat loss and plant mortality resulting from future improvements.
- Maximize stormwater capture from steep cross streets and maximize ecological stormwater management functionality along NE Campus Parkway.
- Consider extending the Kincaid Ravine restoration plan to include the minimally managed forested edge along 45th street to Burke Museum and further south along the Burke Gilman Trail corridor.
- Plant native, bird-supportive plant species in campus core areas.
- Consider floating wetland islands (planted simply with uniform, low-growing sedge and rush) in Drumheller Fountain.
- Conduct an analysis of campus building roofs and walls for potential green roof and living wall opportunities.

ECOLOGICAL MONITORING PROGRAM
Among the most low-cost, high-return ecological improvement activities is collection of good ecological data. Useful monitoring already appears to be occurring in Union Bay Natural Area and Kincaid Ravine. Recorded observation of ecological conditions over time directly supports sound ecological decision-making. Further, regular and ongoing recorded observations of ecological conditions throughout the entire campus will provide the university with an up-to-date inventory of its natural resources. An effective monitoring program will also allow UW to stay abreast of changes to the natural components of the campus landscape that are occurring in response to changing environmental conditions.

Given the strength and breadth of academic programs related to environmental science at UW (forestry, botany, ecology, soils, urban horticulture, etc.), a successful faculty/student led monitoring program appears feasible. While providing UW with valuable knowledge about campus resources, such a program would also provide students with valuable laboratory and field experience.

The details of a practical student monitoring program would best be determined by appropriate faculty members with knowledge of research goals and student capabilities. Useful data collection may include floral and faunal surveys, plant community structure and function, nutrient cycling, soil properties and function, water quality analysis, as well as observations on phenology and sudden changes in floral and faunal communities, such as sudden plant mortality, or newly established wildlife, nesting or habitat use, new alien species invasions, and new native species colonization.
URBAN ECOLOGICAL AWARENESS

The opportunities for experiential learning about urban ecology run throughout the campus, and the grounds themselves should be considered an integral part of the classroom experience. With appropriate programming, many intriguing aspects of urban ecology can be made apparent or discoverable to UW students, as well as visitors to the University.

Increased awareness and understanding of the dynamic interactions between the natural and the built environments is of high value not only to students of the sciences, but to students of the arts and humanities as well. Greater comprehension of systems leads to greater appreciation and enjoyment of the natural and built wonders of the land itself. Accordingly, a program that takes advantage of the numerous opportunities that presently reside throughout the campus landscape would directly support the mission described in the University of Washington Climate Action Plan (page 51): “Leveraging the stewardship of campus ecology to create synergies between the built environment and academic research and teaching will optimize the conditions for education and learning over time. The hands-on learning and understanding that would be gained, if fully integrated into our academic programs, can be expanded to regional and global scales.”

Initiating a program similar to the Brockman Campus Tree Tour might prove valuable. Locations and discussion points for a potential urban ecological awareness program are shown on the Ecological Awareness map and following highlights.
1. KINCAID RAVINE
POTENTIAL DISCUSSION: REMNANT FOREST CHARACTERISTICS, URBAN FOREST STRUCTURE AND FUNCTION, ECOLOGICAL RESTORATION

2. NORTH PHYSICS LABORATORY
POTENTIAL DISCUSSION: WILD ROOF GARDEN, SUITABLE PLANT SPECIES/COMMUNITIES FOR SITE CONDITIONS

3. NORTH PHYSICS LABORATORY
POTENTIAL DISCUSSION: ROOFTOP WATER “FEATURE,” SUITABLE PLANT SPECIES/COMMUNITIES FOR SITE CONDITIONS

4. MCMAHON BUILDING PLANT BED
POTENTIAL DISCUSSION: EDIBLE NATIVE GARDEN, NATIVES VS NON-NATIVES
5. MACKENZIE PLAZA
POTENTIAL DISCUSSION: BAMBOO GARDEN, COLONIZATION OF BUILT SURFACES, URBAN ECOSYSTEM SUCCESSION

6. PACCAR BUILDING
POTENTIAL DISCUSSION: ECOSYSTEMS ON BUILDINGS, STORMWATER MANAGEMENT

7. BURKE GARDEN
POTENTIAL DISCUSSION: PLANT COMMUNITY STRUCTURE, NATIVE VS. NON-NATIVE SPECIES, CORRIDOR CONNECTIVITY TO KINCAID RAVINE

8. PARRINGTON LAWN
POTENTIAL DISCUSSION: ECOLOGICAL VALUE OF TURF VS. NATIVE GRASSES, LAWN ALTERNATIVES
9. THE QUAD
POTENTIAL DISCUSSION: MICROECOSYSTEMS, EPiphyte ADAPTATIONS

10. WAR MEMORIAL
POTENTIAL DISCUSSION: CLUES TO GEOLOGIC HISTORY, BIOLOGY OF ULTRAMAFIC ROCKS AND SOILS

11. NE CAMPUS PARKWAY
POTENTIAL DISCUSSION: LANDSCAPE SPATIAL CONFIGURATION AND ECOLOGICAL FUNCTION, URBAN HYDROLOGY

12. GOULD COURTYARD
POTENTIAL DISCUSSION: PLANT GROWTH ON STRUCTURES, ECOLOGICAL VALUE OF PLANTING ON WALLS
13. DRUMHELLER FOUNTAIN
POTENTIAL DISCUSSION: URBAN AQUATIC ECOSYSTEMS, AESTHETICS AND ECOLOGY, URBAN WILDLIFE HABITAT

14. ISLAND LANE HERON ROOKERY
POTENTIAL DISCUSSION: URBAN WILDLIFE HABITAT

15. BURKE-GILMAN TRAIL
POTENTIAL DISCUSSION: ECOLOGICAL CORRIDORS, URBAN HYDROLOGY AND STORMWATER MANAGEMENT

16. BOTANY GREENHOUSE BRIDGE
POTENTIAL DISCUSSION: OVERPASS MICROCLIMATE, URBAN LIMESTONE “OUTCROP,” ACID RAIN AND URBAN STALACTITES
17. SAKUMA VIEWPOINT
POTENTIAL DISCUSSION: PREDEVELOPMENT CONDITIONS, IMPACTS OF BOATS AND SHIPS ON URBAN AQUATIC ECOSYSTEMS

18. FORMER SALMON HOMING POND
POTENTIAL DISCUSSION: SALMON LIFECYCLES AND ECOLOGY, ADAPTIVE REUSE OF SITE

19. CLIMBING ROCK
POTENTIAL DISCUSSION: CONIFEROUS FORESTS, CLIMATE CONDITIONS AND GLOBAL WARMING IMPACTS

20. WATERFRONT ACTIVITY CENTER
POTENTIAL DISCUSSION: URBAN WETLANDS AND HYDROLOGY, URBAN WILDLIFE
21. PARKING LOT E1
POTENTIAL DISCUSSION: URBAN HEAT ISLAND EFFECT

22. RAVENNA CREEK AT CLARK ROAD
POTENTIAL DISCUSSION: URBAN STORMWATER INFRASTRUCTURE AND HYDROLOGY, ECOLOGICAL UPLIFT, DAYLIGHTING URBAN STREAMS

23. UBNA AND URBAN HORTICULTURAL CENTER
POTENTIAL DISCUSSION: NATURAL AND ARTIFICIAL LANDFORMING, URBAN ECOLOGICAL SUCCESSION, LANDFILL RESTORATION
CASE STUDIES: TESTING ECOLOGICAL STRATEGIES AT A PROJECT SCALE

- Red Square and Thresholds
- Stevens Way Reorganization
- N22 Parking Lot
- Denny Field and North Campus Housing
- Olympic Vista
- Portage Bay Connection
- Montlake Cut Connection
- Lake Washington Connection
- Union Bay Natural Area Connection
- Burke Museum and 43rd Street Entrance
- Parrington Lawn
- Asotin Place and NE Grant Lane
- University Bridge Landing
- West Campus Streetscape
- Burke Gilman Trail Stormwater
The UW functions primarily as a human use environment. At the same time, it is a major waterfront green space within a major metropolitan area, presenting unique opportunities for permeability, ecological connections, and large-scale green infrastructure. The areas with the greatest capacity for improvement are those where human uses overlap with natural ecology, presenting opportunities to better weave the campus into a healthy regional ecosystem, or integrate basic university functions with ecological health.
REINFORCING THE HISTORIC CAMPUS CORE

The Campus Core retains major patches of valuable green space, particularly along the northern border, as Kincaid Ravine connects to the archery range landscape and then beyond to the Burke Museum frontage. As identified in the CLF, the Historic Core is one of the most maintained areas of campus, which means there are greater opportunities to fine-tune resource management and plant palette in ways that support improved overall sustainability.

In addition to general recommendations related to planting and maintenance strategies, case studies that support this strategy include:

4. Denny Field and North Campus Housing
10. Burke Museum and 43rd Street Entrance
11. Parrington Lawn
15. Burke Gilman Trail Stormwater

IMPROVING CAMPUS CORE TO EDGE CONNECTIVITY

The UW’s four neighborhoods are structurally separate, a fact that obstructs larger ecological connections. In addition to improving human experience, strategic new landscape connections can provide a two-way conduit between ecological systems, thus allowing much broader and more valuable connections.

Case Studies that support this strategy include:

6. Portage Bay Connection
9. Union Bay Natural Area Connection
15. Burke Gilman Trail Stormwater
TRANSFORMING 15TH AVENUE FROM AN EDGE TO A CONNECTOR
The 15th Avenue NE edge is primarily green space for much of its length, but it offers only marginal ecological value. Modifications to the plant palette and maintenance regime could dramatically improve the ecological value of this important edge.

Case studies that support this strategy include:
10. Burke Museum and 43rd Street Entrance
11. Parrington Lawn

WEST CAMPUS & GREEN NETWORK
West Campus currently has very little green space, so there is tremendous room for ecological improvement in terms of introducing new permeable areas, habitat value, and connections to the waterfront. The West Campus Framework Plan will develop ideas about the appropriate locations for destination green spaces in more detail, thus reinforcing this approach.

Case studies that support this strategy include:
14. West Campus Streetscape