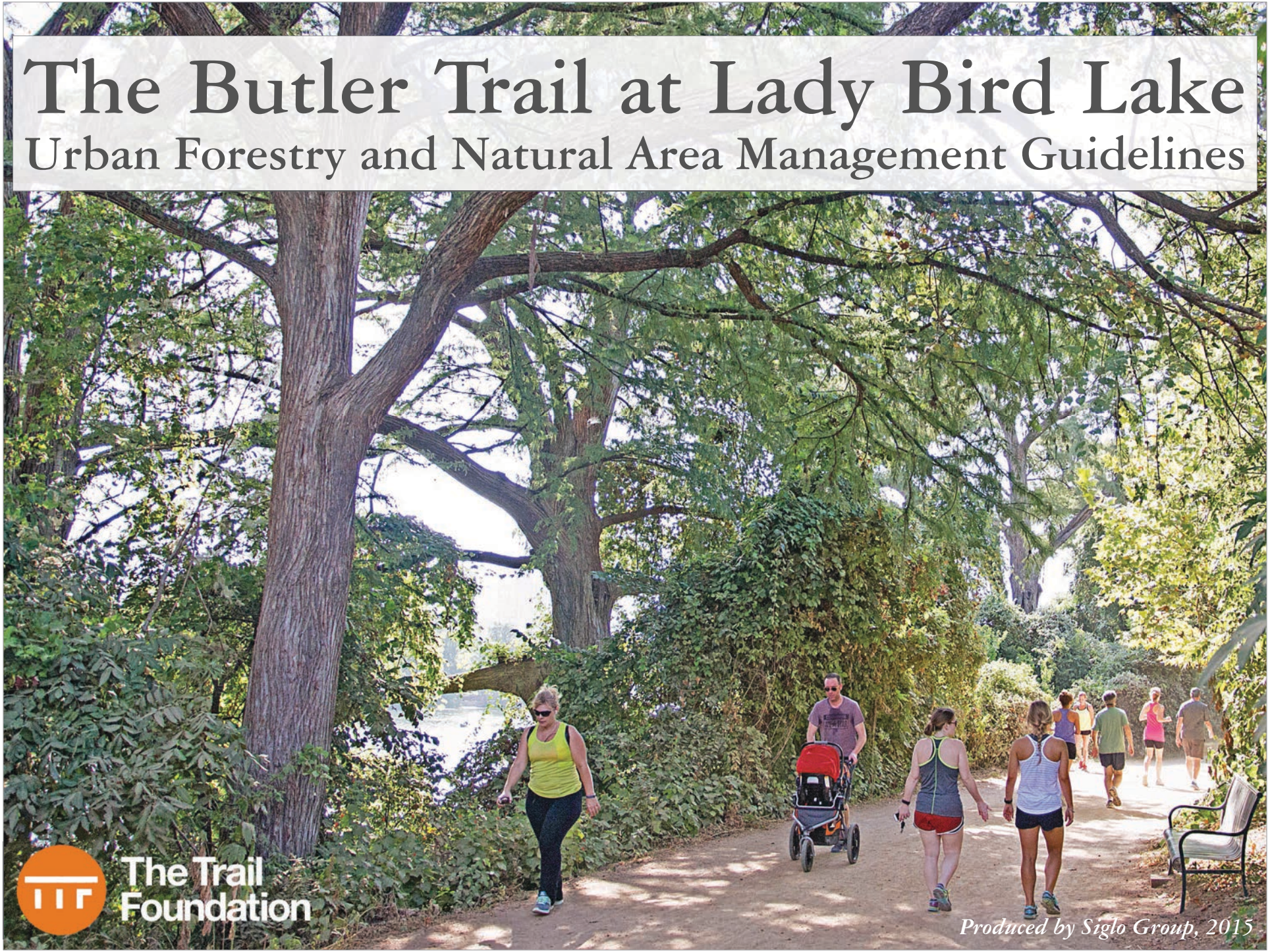
The Butler Trail at Lady Bird Lake

Urban Forestry and Natural Area Management Guidelines



The Trail Foundation

Produced by Siglo Group, 2015

www.thetrailfoundation.org, info@thetrailfoundation.org 1.855.448.7245

The Trail Foundation is a 501(c)(3) non-profit organization dedicated to protecting and enhancing the Ann and Roy Butler Hike-and-Bike Trail at Lady Bird Lake. The Trail Foundation works in cooperation with the City of Austin to close the gap between what the City provides and what the Trail deserves.

www.siglogroup.com, info@siglogroup.com 512.699.5986

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Project Team: Jonathan Ogren, Daniel Dietz, Clare Crosby, Don Gardner, and Bill Carr

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Introduction

The urban forest and natural areas around Lady Bird Lake are part of the very reason Austin exists and has become the city we know today. When President Lamar sent an expedition in 1839 to find the new capital for Texas, the report came back that a stretch of the Colorado River—the river that now forms Lady Bird Lake—between Shoal Creek and Waller Creek offered the ideal location. The area's bountiful natural resources included wooded river bottoms, clean water, and abundant wildlife. While so much has changed since 1839, Lady Bird Lake and its surrounding natural areas are still central to Austin's appeal as a place to visit and live. With over 1.5 million visits every year, the Butler Trail is the most used trail in Central Texas, and one of the most used trails in the country (COA 2003).

Like its cultural significance, the ecological importance of the study area cannot be overstated. The Lake, Trail, urban forest, and natural areas perform critical tasks for our wellbeing, including cleaning the air, reducing noise pollution, enhancing water quality, sequestering carbon, intercepting rainfall, mitigating flooding, reducing erosion, decreasing urban temperatures, shading our recreation areas, protecting the shoreline, building soil, providing wildlife habitat, increasing public health, increasing property values, reducing infrastructure costs, and making people happy (COA 2013a).

Figure 1.1: The Bulter Trail west of I-35 on the south shore.

The guidelines here acknowledge the ecological and cultural significance of the site and recommend ways to sustain and improve the user experience and ecological function of the urban forest and natural areas around Lady Bird Lake and the Butler Trail. Investments to the area are not only necessary ecologically, but make sense financially. Investments in the urban forest in Austin are estimated to have a nearly 1 to 10 return (COA 2013a).

The Trail Foundation commissioned this report to proactively look at opportunities and issues to improve the natural areas over the next four years. The motivation stems from the realization that some plans touch on the natural areas, but no existing plan looks at them in detail or with an explicit focus on their health. The recommendations highlight the beauty and desirability of the urban forest around Lady Bird Lake while outlining management practices that would improve the site by mitigating and minimizing degradation, enhancing the existing woodland, and expanding the woodland where appropriate.

While major improvements will be seen within the first several years, the full results will be unfolding for decades to come—a forest takes time to grow. The result will be a more enriching, interesting, and ecologically functional natural system that continues to make the Butler Trail and Lady Bird Lake a place for people to visit and enjoy into the future.

Project Goals

Restore and enhance plant communities:
Manage native trees, understory, and groundcover to create diverse and aesthetically appealing plant communities that provide rich wildlife habitat.

Repair and improve ecological function:
Manage landscape to better absorb and clean water, regenerate native flora, filter air, create and stabilize soil, reduce urban temperatures, and provide more shade.

Enhance resiliency:
Manage landscape to adapt to and withstand drought, heavy use, climate change, and other major disturbances.

Enhance the user experience:
Provide aesthetically pleasing, compelling, and comfortable natural surroundings.

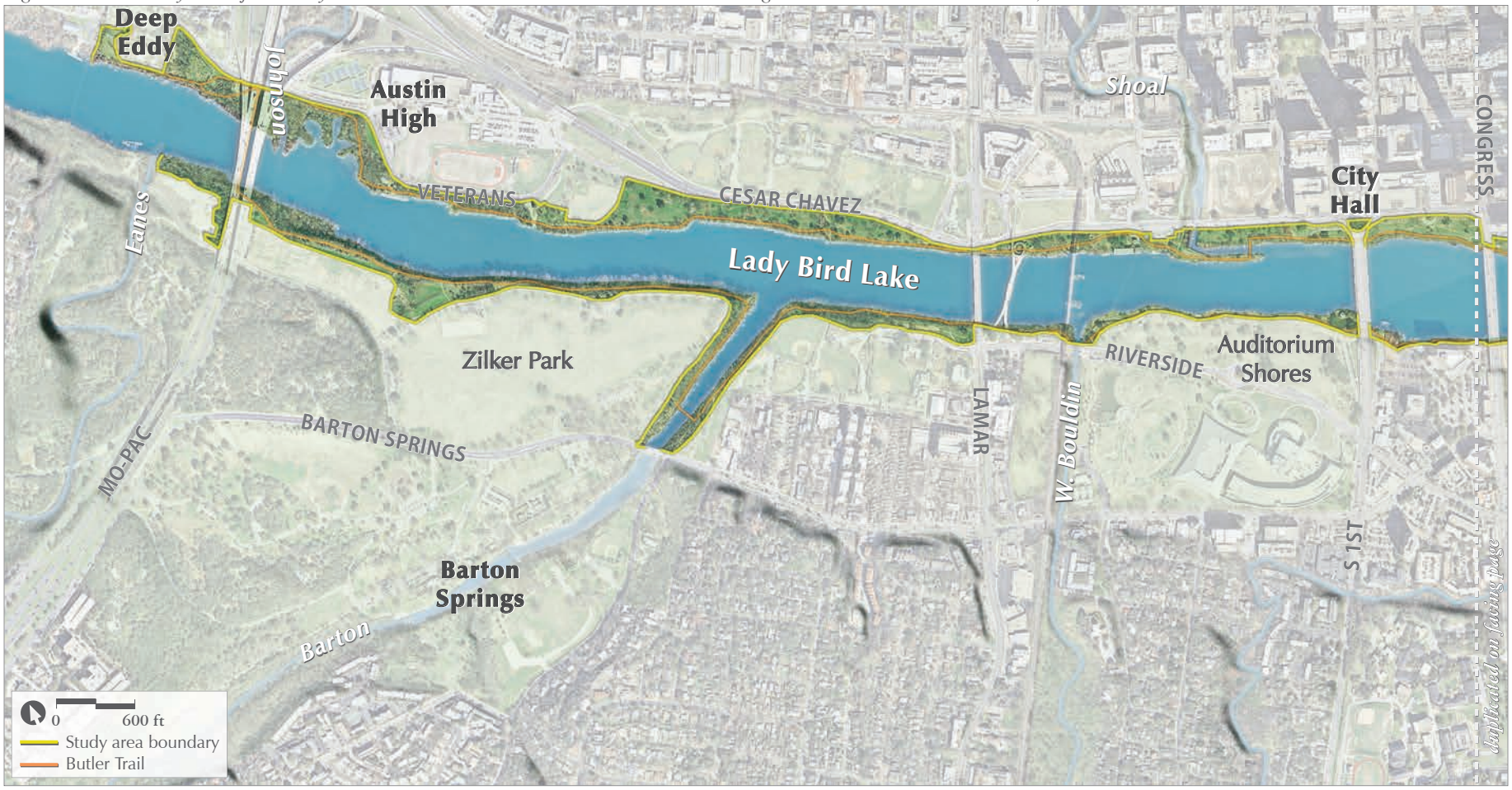
Facilitate stewardship:
Catalyze opportunities to appreciate, observe, and care for the natural environment as an ongoing part of people's lives.

THE STUDY AREA AND ITS SURROUNDINGS

The study area consists of the 5-mile journey from Deep Eddy just west of MoPac to the east end of Lady Bird Lake at Longhorn Dam (Figure 1.2). The natural areas ring the Lake from these two points, making a ribbon that can be accessed by the 10-mile Butler Trail. The 200 acre area is made up of 60 acres of woodland and 140 acres of frequently mowed lawns, occasionally mowed open space, areas without vegetation, or areas recently converted to Grow Zone—areas that are no longer mowed in hopes of passive return to woodland. The study area is surrounded by highly urbanized areas including downtown, the south shore, a small component of residential, and over 330 acres of active recreation areas. At its widest point, the study area is approximately 500 ft wide at Festival Beach. The narrowest point is less than 20 ft wide, confined by surrounding development and the southern shores of Lady Bird Lake between 1st Street and Congress Avenue.

It is important to recognize the physical context of the site and its links to surrounding natural areas and the larger ecoregions (Figure 1.3). The study area is part of the transition from the Edwards Plateau and Hill Country in the west to the Blackland Prairies in the east. It also forms part of the Colorado River Basin that carries water from eastern New Mexico to the Gulf Coast. It connects the various greenways of

Figure 1.2: The study area of the Lady Bird Lake Urban Forest and Natural Areas Management Guidelines. Sources: COA, NAIP.



our beloved creeks including Barton, Waller, Shoal, Blunn, and West Bouldin. It connects numerous active recreation facilities. The river corridor is a flyway for migrating and resident bird populations, with popular birding sites both up and downstream of Lady Bird Lake. The site is also home to the largest urban bat colony in North America. The natural areas and the bats are part of the reason why the City of Austin was named the most wildlife-friendly city in the United States in 2015 by the National Wildlife Federation (Grant 2015).

While a thorough study of adjacent land use is outside of the scope of this project, linking the recommendations here to the surrounding neighborhoods, parkland, natural areas, and downtown is crucial in working towards the Imagine Austin Comprehensive Plan priority of integrating nature into the City and the goals of Austin's Urban Forest Plan to increase the health and continuity of the urban forest.

A TRADITION OF STEWARDSHIP

There is an eloquent tale of redemption and the power of conviction nestled in the natural areas and the Lake itself. Rachel Carson included the 1961 fish kill in Town Lake—an event that resulted in a massive die off of fish for hundreds of miles downstream—as a case study in Silent Spring, her seminal 1962 book alerting the country and the world to the dangers of chemicals in our environment as

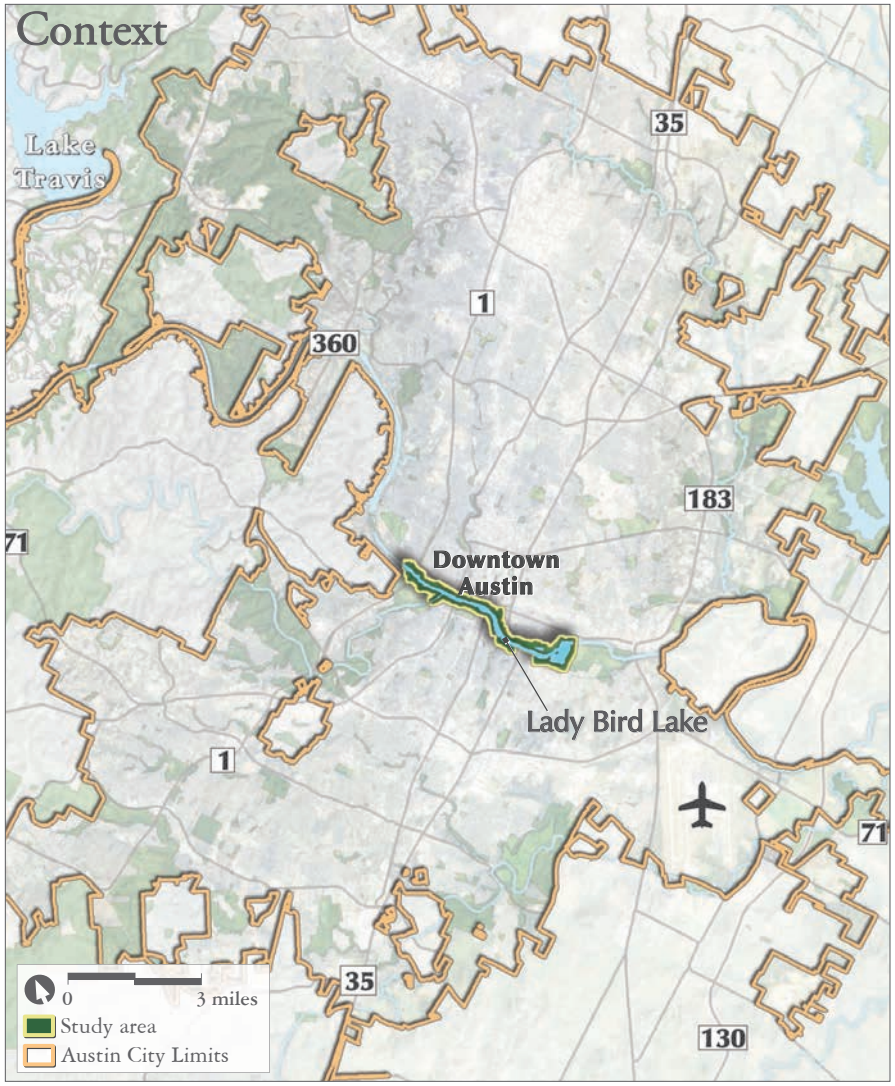


Figure 1.3: The study area in the heart of Austin forms part of the riparian corridor along the Colorado River.

pesticides and herbicides. Ten years later Lady Bird Johnson, the sitting mayor Roy Butler, Ann S. Butler, Roberta Crenshaw, and numerous others decided we shouldn't turn our backs on the Lake and saw its potential as an amenity for the City. They started the Town Lake beautification project, successfully campaigned to preserve parkland along the Lake, and establish what would become the Butler Trail.

Lady Bird's work on a national scale promoting tree plantings, native plants, and beautification and the work of the Town Lake Beautification Committee were pragmatic expressions of a deeper conviction to protect and restore natural systems and the aesthetics of place. Lady Bird's legacy of work in Austin and throughout the nation inspired the renaming of Town Lake as Lady Bird Lake in 2007. The work started over 40 years ago on the Trail has transformed it into a celebrated natural area and one of the most-used trails in the country.

Today, The Trail Foundation and the City of Austin carry on the tradition of stewardship and land management efforts through tree plantings, invasive species removal, and trail maintenance along with improvements to enhance the user experience. The Trail Foundation has supported major infrastructure projects on the Trail including the construction of the Boardwalk and numerous user improvements such as restrooms, seating areas, and gardens. Through the Healthy Trees for the Trail program, The Trail Foundation has teamed up with the City and other non-profits to lead volunteers in planting 5 major tree groves along with yearly sapling plantings in riparian areas around the Lake, as seen in Figure 1.4. Working with volunteers and American Youthworks, The Trail Foundation has also cut and treated grape vine as well as non-native invasives throughout much of the study area.

The City of Austin owns and is responsible for land management throughout the study area. Through numerous efforts by the City and its partners, the Butler Trail and its natural areas have become a central amenity in the City. The Parks and Recreation Department carries out trail maintenance, tree care, plantings, and grounds maintenance for the entire study area. The Watershed Protection Department cares for the sensitive riparian areas through invasive species removal, bank stabilization, and aquatic and terrestrial plantings. In addition, Watershed Protection monitors water quality in the Lake and associated streams and is in charge of trash clean up within the Lake. PARD and WPD are currently working together through the Grow Zone program to convert 13 acres

of previously mowed areas to woodland in sensitive riparian areas within the study area.

The recommendations outlined here build on this legacy of enhancing both ecological health and human enjoyment in nature.

ALIGNED WITH THE CITY'S VISION, POLICIES, AND PRACTICES

This project is closely aligned with the goals and objectives of Imagine Austin, Austin's Urban Forest Plan, Community Climate Plan, Invasive Species Management Plan, and Watershed Master Plan. In addition, the analysis and report were put together with input from numerous departments including Parks and Recreation, Development Services, Watershed Protection, and the Office of Sustainability.

Imagine Austin calls for the use of green infrastructure (defined on page 8) where feasible to help with water infiltration, shading, reduction of energy needs, rain interception, improvement of resiliency, and soil stabilization (COA 2012a). The "Austin is Natural and Sustainable" section of Imagine Austin's Vision states:

- We enjoy an accessible, well-maintained network of parks throughout our city.
- We protect the beauty of the Colorado River watershed, Hill Country, and Blackland Prairie and value our farmland, critical to local food production.
- Our open spaces and preserves shape city planning, reduce infrastructure costs, and provide us with recreation, clean air and water, local food, cooler temperatures, and biodiversity.

Figure 1.4: Volunteers with The Trail Foundation plant saplings near the Hosteling International building.

This project aims to apply the city-wide suggestions from Imagine Austin to the natural areas of Lady Bird Lake: "Austin must conserve, protect, and support our natural resource systems by developing and adopting better practices for long-term stewardship of Austin's environment." The recommendations here address over 35 action items in Imagine Austin, as seen in Table 1.1, and are closely aligned with four of the eight priority plans:

1. Invest in a compact and connected Austin,
2. Sustainably manage our water resources,
4. Use green infrastructure to protect environmentally sensitive areas and integrate nature into the city, and
7. Create a Healthy Austin Program.

Austin's Urban Forest Plan calls for an urban forest that is part of a "contiguous and thriving ecosystem valued, protected, and cared for by the City and all of its citizens as an essential environmental, economic, and community asset" (COA 2013a). The area around Lady Bird Lake is the centerpiece of that ecosystem. A portion of the study area is even featured on the cover of the Urban Forest Plan, as seen in Figure 1.5, with the confluence of Barton Creek and the Colorado River near the center of the picture. The plan calls for a diverse, mutli-aged urban forest of native trees that is resilient in the face of drought, climate change, and other stressors. The plan also stresses the need for care and management, the preservation of significant trees, and the protec-

Imagine Austin Action Items Associated with Guidelines

LUT A32 Develop standards for public spaces, such as parks, plazas and streets, to create integrated, tree-covered places.

LUT P34. Integrate green infrastructure elements such as the urban forest, gardens, green buildings, stormwater treatment and infiltration facilities, and green streets into the urban design of the city through "green" development practices and regulations.

CE A4 Improve policies and incentives for restoration of damaged natural resources areas.

CE A19 Review tree planting regulations to ensure that invasive species are not permitted. Create incentives to remove invasive plant species and replace them with native species.

CE A20 Create a heritage tree inventory and monitoring system to create stronger mechanisms for protecting heritage trees.

CE P2. Conserve Austin's natural resources systems by limiting development in sensitive environmental areas that including the Edwards Aquifer and its contributing and recharge zones and endangered species habitat.

CE P3. Expand the city's green infrastructure network to include such elements as preserves and parks, trails, stream corridors, green streets, greenways, and agricultural lands.

CE P4. Maintain and increase Austin's urban forest as a key component of the green infrastructure network.

CE P6. Enhance the protection of creeks and floodplains to preserve environmentally and other sensitive areas and improve the quality of water entering the Colorado River through regional planning and improved coordination.

CE P7. Protect and improve the water quality of the city's creeks, lakes, and aquifers for use and the support of aquatic life.

CE P8. Improve the urban environment by fostering safe use of waterways for public recreation, such as swimming and boating, that maintains the natural and traditional character of waterways and floodplains.

CE P9. Reduce the carbon footprint of the city and its residents by implementing Austin's Climate Protection Plan and developing strategies to adapt to the projected impacts of climate change.

CE P14. Establish policies that consider the benefits provided by natural ecosystems, such as ecological processes or functions in wetlands and riparian areas, that have value to individuals or society.

CE P16. Expand and improve regional collaboration and coordination in preserving Central Texas' natural environment.

CFS A10 Develop, through a process engaging the general public and professionals, context-sensitive trail, park, and greenway standards to ensure high-quality, environmentally sustainable design.

CFS A1 Limit, buffer, or prohibit public access to certain environmentally sensitive areas to maintain their value (i.e. wildlife protection and erosion control).

CFS A5 Ensure adequate funding for the maintenance of parks and trees on City of Austin property through Best Maintenance Practices.

CFS A7 Revise tree planting and tree care standards to be more sustainable and reduce tree mortality.

CFS A8 Restore trees and vegetation along degraded waterways, especially in eastern watersheds.

CFS A35 Create a green infrastructure plan for public land or in public rights-of-way to preserve Austin's ecosystem, improve the water cycle, reduce the urban heat island effect, improve air quality, enrich public space, and provide for traffic calming. Examples include open space, trails, wetlands, community gardens green streets, infiltration facilities, and the urban forest.

CFS P8. Reduce pollution in all creeks from stormwater runoff, overflow, and other non-point sources.

CFS P10. Protect and improve the health of Austin's streams, lakes, and aquifers for sustainable uses and the support of aquatic life.

CFS P11. Protect the health of creeks and prevent public and private property damage by minimizing erosion.

CFS P14. Integrate erosion, flood, and water quality control measures into all City of Austin capital improvement projects.

CFS P48. Maintain existing partnerships and develop new relationships among City of Austin departments, regional governments, other governments, community organizations, and volunteers to support recreational services and achieve higher levels of service.

LUT P43. Continue to protect and enhance important view corridors such as those of the Texas State Capitol District, Lady Bird Lake, and other public waterways.

LUT P44. Preserve and restore historic parks and recreational areas.

LUT P29. Develop accessible community gathering places such as plazas, parks, farmers' markets, sidewalks, and streets in all parts of Austin, especially within activity centers and along activity corridors including Downtown, future TODs, in denser, mixed use communities, and other redevelopment areas, that encourage interaction and provide places for people of all ages to visit and relax

LUT P30. Protect and enhance the unique qualities of Austin's treasured public spaces and places such as parks, plazas, and streetscapes; and, where needed, enrich those areas lacking distinctive visual character or where the character has faded.

E P5. Enhance Austin's draw as a premier national and international tourist destination by strengthening and diversifying the arts and entertainment offerings, enhancing natural resources, and expanding the availability of family-friendly events and venues

CFS P43. Maximize the role of parks and recreation in promoting healthy communities and lifestyles.

CFS P44. Feature superior design in parks and recreational facilities and include opportunities for public art and green and sustainable design solutions.

LUT P23. Integrate citywide and regional green infrastructure to include such elements as preserves and parks, trails, stream corridors, green streets, greenways, agricultural lands, and the trail system into the urban environment and the transportation network

CFS P42. Increase connectivity between neighborhoods and from neighborhoods to parks and greenways through the use of side¬walks, bicycle lanes, multi-use paths, and trails.

S P11. Develop public transportation options that link all areas of the City, are affordable to economically disadvantaged groups, and provide access to job opportunities and services.

Other related action items include: CE P1, CE P12, CFS P45, CFS P46, CFS P47

tion of wildlife habitat. The recommendations here for the urban forest and natural areas around Lady Bird Lake address the following performance measures from the Urban Forest Plan:

- Native vegetation,
- Species suitability,
- Relative canopy cover,
- Species distribution,
- Condition of the urban forest,
- Publicly owned natural areas,
- Urban forest pests,
- Size-class distribution,
- Complete urban forest recognition,
- General urban forest awareness,
- Neighborhood action,
- Public agency cooperation,
- Green industry cooperation,
- Urban forest establishment planning and implementation,
- Urban forest inventory,
- Tree canopy cover inventory,
- Urban forest risk management,
- Water use and drought response,
- Urban forest habitat suitability,
- Wildlife and human habitat,
- Sustainable practices, and
- Carbon sequestration and woody biomass.

As pointed out in the Urban Forest Plan and reiterated numerous times throughout these guidelines, the urban forest is not just trees. It is an intricate system that includes canopy trees, understory, groundcover, hydrology, soils, wildlife, and humans. Within the Urban Forest Plan, the importance of the urban forest and natural areas is stressed as part of the green infrastructure that provides the City with irreplaceable services. A list of the objectives from the Urban Forest Plan that align with this project can be seen in Table 1.2.

Table 1.1 (Left): Action items from the Imagine Austin comprehensive plan aligned with the Butler Trail at Lady Brid Lake Urban Forestry and Natural Area Management Guidelines.

The recommendations in this report to expand woodland areas and reduce mowing in underutilized areas also work towards the goals of Austin's Community Climate Plan (CPP), which calls for the use of trees as an integral component of green infrastructure to reduce atmospheric carbon, improve air quality, reduce air temperatures, and reduce energy consumption. Carbon sequestration can be as much as 9 metric tons of CO_2 per acre of urban forest, with the existing urban forest in Austin already taking the equivalent of 8,000 cars worth of carbon dioxide out of our air annually (COA 2015a). In addition to reductions in carbon in the air, the climate plan stresses the ability of the urban forest to reduce the urban heat island effect—trees and other plants make the area cooler by absorbing the sun's energy

Green infrastructure defined:

The Conservation Fund defines green infrastructure as "strategically planned and managed networks of natural lands, working landscapes and other open spaces that conserve ecosystem values and functions and provide associated benefits to human populations." Elements of Austin's green infrastructure network include parks, the urban forest, urban trails, greenways, rivers, creeks, lakes, gardens, urban agriculture, open spaces, wildlife habitat, and stormwater features that mimic natural hydrology—and the relationships between them and the rest of the city.

Figure 1.5: The cover of Austin's Urban Forest Plan features this photo of part of the study area.

Table 1.2: Alignment with Austin's Urban Forest Plan. This table includes relevant Policy Elements followed by a brief explanation of the ways in which the guidelines for the urban forest and natural areas around Lady Bird Lake support that Policy Element. Looking at the Sustainable Forest and Planting, Care, and Maintenance Policy Elements, we can see that this project is well aligned with the objectives of the Austin Urban Forest Plan.

Alignment with Austin's Urban Forest Plan

S-1 Species, Age, and Geographic Diversity
The plan for Lady Bird Lake calls for increasing diversity of the urban forest.

S-2 Urban Wood Utilization
The guidelines in this document recommend reusing forest debris on site to the extent possible or, when debris does not pose threat of spreading invasive species or pest, moving the waste to other portions of the natural areas to be reused.

S-3 Integrated Pest Management & S-8 Urban Forest Pests
This document calls for an adaptive management approach that includes integrated pest management, and a full evaluation of the trees in public areas was made to determine the need for tree care or the potential of pests affecting the urban forests.

S-4 Urban Wildlife Habitat
Urban wildlife habitat will be enhanced through the recommended restoration and enlargement of the urban forest, increased diversity, use of native plants including ones with known wildlife value, and ongoing monitoring of wildlife through citizen science.

S-6 Invasive Species Management
The plan includes best management practices to deal with invasive species and has identified over 1,200 occurrences throughout the study area.

S-7 Water Conservation and Design and Maintenance Planning
The plan calls for green infrastructure to reduce erosion problems through the site and create better infiltration within the study area, the reduction in turf areas, and the potential use of lake water for the establishment period of any plantings.

S-9 and PCM-7 Partnership
This project is founded on the premise of The Trail Foundation partnering with the City of Austin and other non-profits to work towards implementation.

PCM-1 Planting Priorities
The plan identifies many areas for woodland expansion (Figure 3.9) and includes planting 5,000 trees annually for the next three years as one of the metrics of success of implementation.

PCM-2 Species Selection
This document includes a substantial list of plants suitable for the different areas of the site, shown in Table 3.1. In addition, a full inventory of plants currently found in the study area can be seen in Table 2.1.

PCM-3 Urban Forest Planting and Maintenance Plan and Program
The project is directed towards the implementation of strategic steps laid out to increase the health and usability of the urban forest. In addition, the project included an assessment of trees within public use areas to determine needs for care, pruning, and, in some cases, removal to increase the health of the overall forest and reduce safety risks to trail users.

PCM-4 Planting Stock
The plan calls for the use of locally grown plants and seeds that are adapted to Central Texas conditions.

PCM-5 Tree Canopy Cover
Specific tree canopy cover goals are made for the study area and along the trail, with overall enlargement of the woodland area being a major recommendation of this project.

PCM-6 Landscape Maintenance Management Plans
The plan calls for continued monitoring and maintenance and for a revised plan every 5 years to protect the health of the natural areas for years to come.

PCM-8 Public Safety
The project included an assessment of trees within public use areas to determine needs for care, pruning, and, in some cases, removal to increase the health of the overall forest and reduce safety risks to trail users.

PCM-9 Prominent Trees
The project inventoried 1696 heritage and protected trees including some of the largest trees ever entered into the Austin Tree Inventory. These trees can now be observed on a regular basis for tree care needs.

and shade buildings, streets, and other impervious surfaces that otherwise get extremely hot and increase the temperature of the surrounding air.

The recommendations here are aligned with the City's Invasive Species Management Plan (ISMP) adopted in 2012. The ISMP calls for sustainable integrated land management, the prevention of invasive species establishment, early detection and rapid response, standardized controls and monitoring, restoration and rehabilitation, and prioritization of resource allocation (COA 2012b). These concepts are part of the framework within which the recommendations here were produced.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

The report is grounded in concepts of ecology, restoration, and sustainable land management. This document is broken up into the following sections: Introduction, Site Ecology and Characteristics, Natural Area Management Guidelines, Management Units, Toward Implementation, and Conclusions. The Site Ecology and Characteristics chapter provides baseline information about the site including descriptions of topography, hydrology, substrates, current plant communities, wildlife, and threats to the natural areas. The Natural Area Management Guidelines chapter recommends land management techniques associated with ecological restoration, invasive species control, erosion prevention, seeding, and live planting. Specific recommendations along with more detailed descriptions of each management area are given in the Management Units chapter. The Toward Implementation chapter discusses coordinating work, the necessity of monitoring, a long-term outlook, and scheduling. The importance of

good data, documentation, thorough evaluation, use of best management practices, and an adaptive management approach is stressed throughout the report.

The study area was evaluated through geographic data analysis along with field evaluation. The field evaluation included the collection of over 10,000 data records associated with trees, invasive species, soil disturbance, erosion, restoration potential, significant features, photographs, and species occurrences. The tree data obtained included a tree inventory of over 6,000 trees along with tree care and risk evaluation for all trees along the Trail and in high public use areas. Data taken for each tree was consistent with City of Austin standards, including species, diameter at breast height, and information about the tree's condition. Data on invasive species included over 1,300 points tracking species, size of the invasion, and percent cover. Data on soil disturbance and erosion included 280 points tracking the type of disturbance, size, and probable cause. Data on restoration potential documented areas where the ecological context makes restoration feasible. Areas with particularly diverse or intact plant communities, good wildlife habitat, good views, or significant trees were recorded as significant features.

The study area was documented with photographs in addition to data points, and photo points were set up for long-term monitoring as explained in Toward Implementation and seen in Appendix 3. Field evaluation also included a plant survey that found over 360 species in the site as described in greater detail in the Site Ecology and Characteristics chapter. Though a wildlife survey was not part of this project, information from area species lists from the City, Brackenridge Field Laboratory, eBird, iNaturalist, Odonates of Texas, and other sources where used to compile a list of over 400 wildlife species that could be found in the study area.

Geographic data used to evaluate the site included aerial imagery, geology and soil layers, historic imagery, and City of Austin geographic data layers associated with tree canopy, critical water quality zones, elevation, park boundaries, and Grow Zones. Examination of these data sets shows that the site has topographic relief at the pedestrian level but has relatively little variation overall, with a 60 ft change in elevation throughout the site (Figure 2.2). The site is dominated by alluvial soils, and all but a small area near the Boardwalk is within the 100 or 500 year floodplain (Figures 2.4 and 2.6). Historic images show major changes associated with the creation of upriver dams that control flooding, the grading and impoundment of Lady Bird Lake in 1960, and management practices dominated by mowing all but a thin ribbon of our central urban forest from 1960 to present.

The primary threats to the natural areas are excessive mowing in areas with little recreational traffic, invasive plant species, soil compaction from heavy off-trail recreation, and erosion of soil and trail material. While some areas should continue to be mowed for recreation, there are numerous underutilized lawn areas that are recommended for woodland expansion. Restoring these underutilized lawn areas to woodland is the best way to increase the myriad benefits we receive from the natural areas, reduce long-term maintenance costs, return the site to a more natural state, and work towards numerous City initiatives.

Invasive plant species are found throughout the study area and pose a threat because of their ability to take over areas and crowd out native species that form the aesthetic of Central Texas and provide wildlife habitat. While it is not practical to rid the natural areas of invasive species, the guidelines aim to sustainably manage their impacts in the natural areas while increasing the resistance of the natural areas to invasion in the future. Thirty one plants are identified in the Ecology chapter as having invasive behavior within the natural areas, including giant reed (Figure 1.7), elephant ear, Chinaberry, Ligustrum, Chinese tallow, Chinese lacebark elm, and golden rain tree. Best management practices for these and other problematic species are laid out in the Natural Area Management Guidelines chapter, with recommended treatment areas laid out in the

Figure 1.6: More intact woodlands, such as this area between the Trail and Lake along Zilker Park, consist of understory and herbaceous species along with canopy trees.

Figure 1.7: Invasive species, like the giant reed pictured here, are one of the largest threats to the ecological health of the natural areas around Lady Bird Lake.

Management Units chapter. In addition, ongoing monitoring practices are recommended in the Toward Implementation chapter to ensure new invasive species problems are dealt with quickly.

There are numerous erosion and soil issues throughout the study area that are degrading the value of the urban forest and natural areas and negatively impacting the user experience. One major erosion issue is decomposed granite from the Trail eroding into the natural areas and the Lake. Where this is affecting sensitive parts of the natural areas, particularly slopes and areas within 50 ft of the water, it should be minimized through trail stabilization. Other issues include off-trail trampling in high use areas and gully erosion due to storm water. Areas in need of trail stabilization, trail realignments, restoration from trampling, and stormwater management improvements are pointed out in the Management Units chapter.

Recommended restoration activities include woodland enhancement, woodland expansion, savanna restoration, and aquatic plantings as seen in Figure 3.9. Woodland enhancement is recommended for all 60 acres that are currently woodland. Enhancement often includes controlling degradation factors, followed in some cases by additional plantings and seeding to supplement natural regeneration. Woodland expansion is recommended for over 80 acres, most of which is currently managed as lawn but not heavily used for recreation. Recommendations in these areas include soil treatment and planting of woody species to significantly increase the canopy cover of the study area. The results of restoration activities will be reduced maintenance time and cost, a shadier trail, more aesthetically pleasing natural areas, a higher canopy with a cathedral feel over the Trail, a more ecologically functional natural area, and an overall better user experience.

Just under 12 acres are recommended for savanna restoration. These areas are primarily chosen for their Gaddy soils, which can sustain a savanna vegetation type not found in the protected natural areas of Travis County. These soils offer an opportunity for savanna restoration that includes some unique species specifically suited to these alluvial soils (shown in Table 3.1).

Aquatic restoration areas were chosen based on the depth of the Lake and protection from flood flows. The aquatic plantings build on work already being taken on by the City of Austin to enhance the diversity of species within Lady Bird Lake.

Management recommendations are further broken down into 16 management units in the Management Units chapter. These management units are defined by their topography, use patterns, and vegetation. Management units are used to organize needs, best management practices, and priorities into implementable tasks with measurable results.

The Toward Implementation chapter focuses on how the project can be completed. It discusses a four-year schedule, long-term management, coordination, monitoring, documentation, and metrics to evaluate the success of implementation. The task orientation of the recommendations here can be used by professionals and/or trained volunteers to complete numerous objectives. It is likely that this work will be completed by numerous entities, with Texas Conservation Corps taking on a substantial amount. Monitoring is a vital component of successful implementation. Monitoring protocols are

recommended for annual evaluations, identifying new invasive species issues, tracking management activities, and incorporating citizen science to observe wildlife in the study area. While coordinating efforts of all departments and organizations doing work in the study area is complex, documentation is the first and most critical component. Documentation, through the use of electronic field data acquisition with shared access for all entities doing work, will go a long way towards strategic and effective coordination and ensure that successful management practices are being used.

Metrics are used to track the cumulative success of implementation over many years. The metrics are designed to represent measurable aspects of the goals and to be relatively easy to measure for evaluation. Metrics include a percent increase in canopy cover, increased shade over the trail, thousands of additional trees in the study area in the coming years, and decreased invasive species infestations.

Lady Bird Lake and its natural areas substantially influence the character of the City and provide numerous cultural and ecological benefits. Since the initiation of the Town Lake beautification project in 1971, Austin has recognized the importance of this area and sought to protect, enhance, and restore it. This report fits well with the City's goals and recommends ways to move the study area to higher levels of ecological function and user enjoyment. The implementation of the recommendations here will result in the enhancement and expansion of the woodlands around Lady Bird Lake, increased canopy cover, increased wildlife habitat, improved aesthetics, more diverse plant communities, more user access to the water, a more sustainable trail system, and a healthier urban forest.

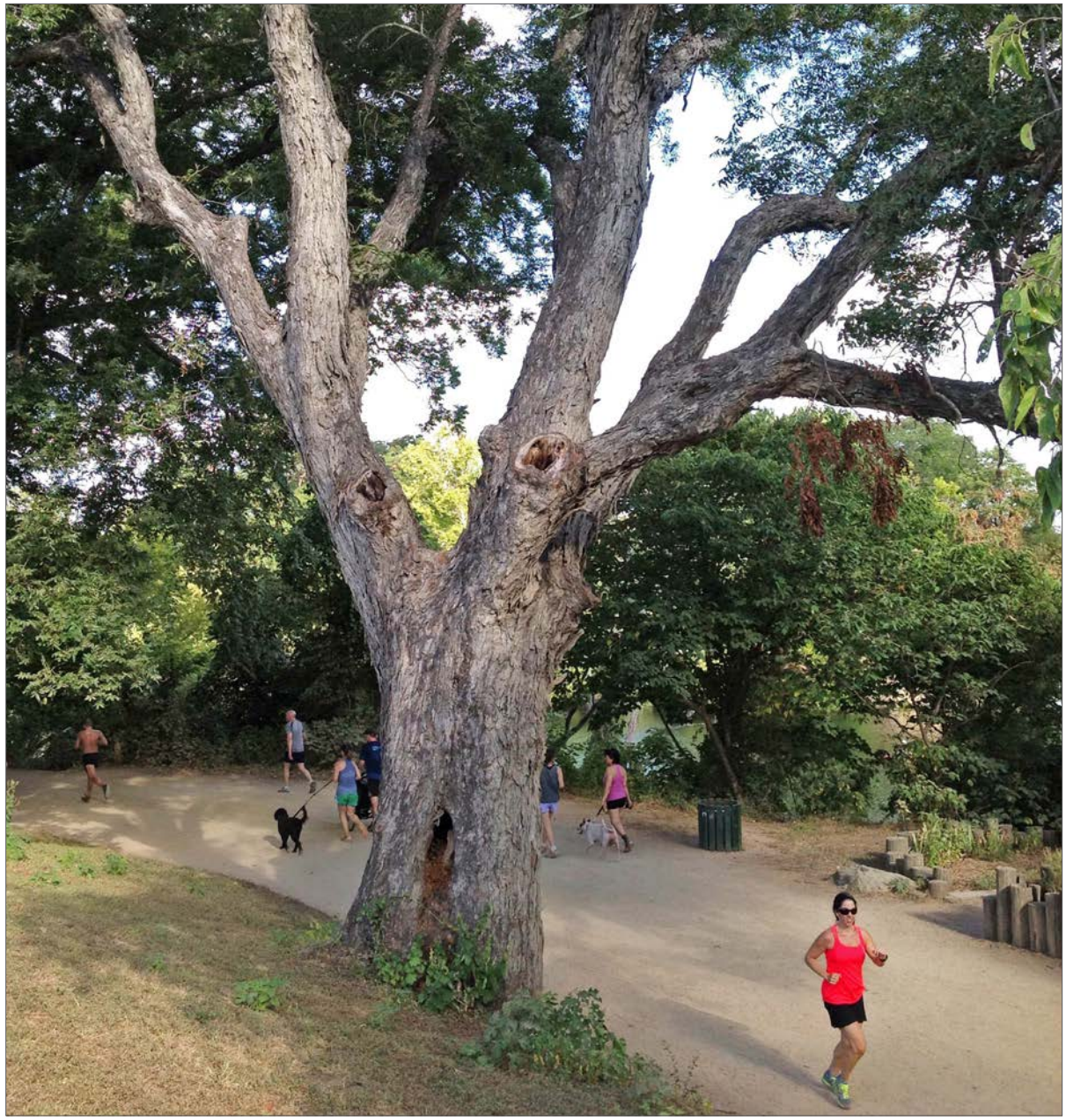
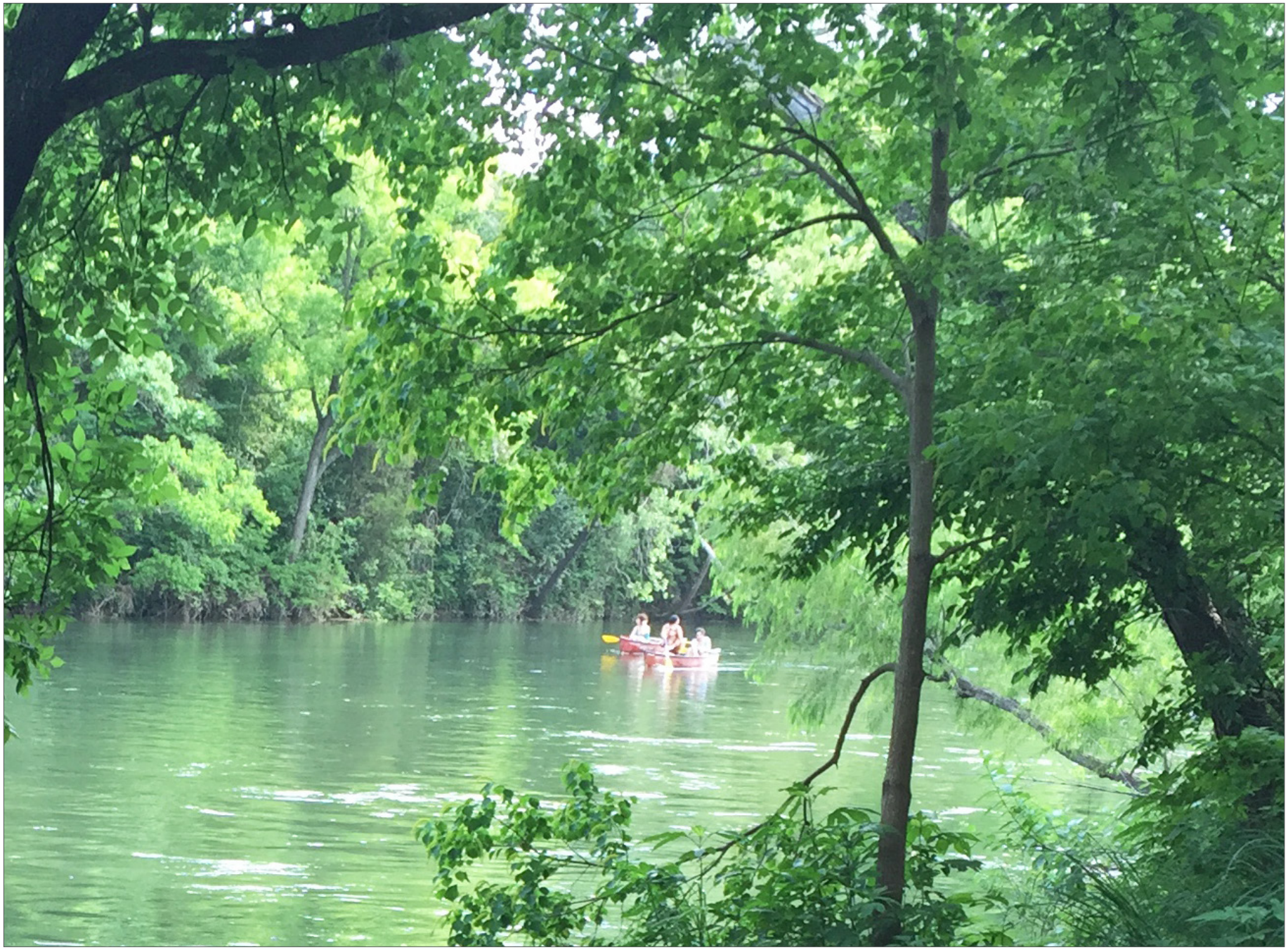


Figure 1.8: Lady Bird Lake, the Butler Trail, and the surrounding natural areas are central to Austin's character and appeal.



Site Ecology and Characteristics

The urban forest and natural areas of Lady Bird Lake and the Butler Trail form a linear park in the heart of Austin consisting of approximately 200 acres. The study area is in the transition zone from the Edwards Plateau and Hill Country in the west to the plains and Blackland Prairie in the east. It is part of the Colorado River Watershed and the riparian corridor that stretches from New Mexico to the Gulf Coast. The site has been heavily manipulated in the past and is substantially influenced by both hydrology and human use today. The urban forest and natural areas seen today are relatively young, with most areas established after the grading and impoundment of the Lake in 1960.

The study area is relatively flat, with a vertical change of only 60 ft along the ten mile loop of trail. The site is heavily influenced by the Colorado River and its tributaries through small but impactful changes in topography and the saturation of soils. The diverse flora and fauna is representative of central Texas, but is compromised by the effects of urbanization. There are some larger patches of natural area within the study area, but much of the site is characterized by long-established management practices of mowing to near the water's edge. A thin, often fragmented canopy surrounds the Lake, along with numerous underutilized lawns and active recreation areas.

TOPOGRAPHY

The topography around Lady Bird Lake varies from low, flat floodplains near Austin High to steep cliffs just west of I-35 on the southern shore, as seen in Figure 2.2. The average water level of the Lake is

Figure 2.1 (Left): The ecology of the study area is profoundly influenced by Lady Bird Lake and the many urban streams flowing into it, such as Barton Creek shown here.
Figure 2.2 (Below): Elevation and bathymetry of Lady Bird Lake and surrounding natural areas. Sources: COA, NAIP.

429 ft above mean sea level (msl), and the lowest points of land within the study area are just above the water line. The highest point in the study area is 489 ft above msl, found on the cliffs near the Boardwalk. Changes in topography (slope) are most substantial at the cliffs on the southern shore near I-35, along the edges of Zilker Park, near the mouths of many creeks, and near the Mexican American Cultural Center. In contrast, the area near Austin High, Festival Beach, and the southeastern shore of the Lake are comparatively flat. The slopes of the site can be seen in Figure 2.3.

The topography of the site affects its current condition in numerous ways. Steep slopes often contain the most intact woodlands, whereas most areas accessible to lawnmowers are regularly mowed. While the elevation gain throughout the site is relatively small, it does allow for a greater variety of views of the Lake, the natural areas, and Austin. The slope also has an effect on the flow and accumulation of water on the site.

The depth of the Lake has implications for the surrounding natural areas, including opportunities for aquatic habitat expansion. The deepest parts of the Lake can be found directly south of the baseball fields at Holly Shores, directly under and slightly east of the I-35 bridge, and in several small pockets of the southeastern corner of the Lake, with depths of approximately 34, 29, and 29 ft respectively (Figure 2.2). Shallow areas can be found at numerous points along the shore, with substantial shallow areas around the low peninsulas west of Austin High, between the mouth of Shoal Creek and Congress Avenue, the area surrounding the Austin Rowing Club near Waller Creek, the far eastern extent of the southern shoreline, the western portion of the Boardwalk, and the mouth of West Bouldin Creek.

HYDROLOGY

As a thin ribbon of land wrapping around Lady Bird Lake, the study area is defined by hydrology. The Colorado River's historical paths shape the site as well as the surrounding area. Major factors contributing to conditions we see today include historic flooding, the construction of the Highland Lakes dams, the impoundment of Lady Bird Lake, soil saturation levels along the shoreline that influence vegetative communities, highly urbanized tributaries flowing across the study area, and weather patterns defined by major rain events resulting in flashy creek flows and large amounts of storm water entering the site.

The Colorado River flowing into Lady Bird Lake has a catchment area of 25 million acres. The watershed begins in eastern New Mexico and flows across the High Plains and the Rolling Plains of the Texas Pan-

Figure 2.3: Steepness of slopes surrounding Lady Bird Lake. Sources: COA, NAIP.

handle before entering the Edwards Plateau. Flows from the River are used for agriculture, energy production, and the City of Austin's drinking supply. Downstream flows feed into Matagorda Bay and its estuaries, with substantial amounts of water taken out seasonally for agriculture in the coastal areas.

Weather patterns within the study area and upstream are defined by major rain events. Central Texas has received some of the highest amounts of water falling in both a 2 hr period and a 24 hr period recorded in the United States (Caran and Baker 1986). While the average annual rainfall in the study area is 33" (NOAA 2013), it is highly variable, as evidenced by the heavy spring rains of 2015 and the drought conditions of 2011 and 2012. Seasonal rains, along with upstream lake releases for downstream agriculture, generally translate into higher seasonal flows and river-like conditions in late spring and summer and lower flows in the fall and winter.

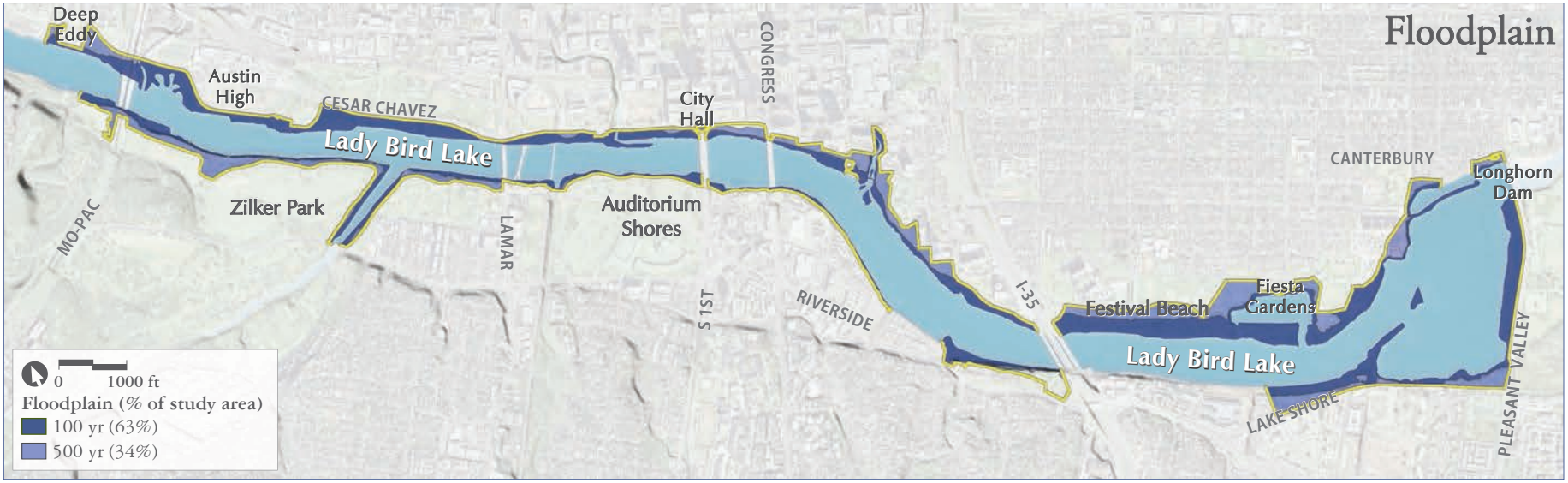
Massive flood events were a regular part of life in Austin until the Highland Lakes were created. The impoundment of the upstream Highland Lakes in the 1930s and 1940s minimized the naturally occurring floodwaters that shaped the floodplain and surrounding areas. The upstream dams stopped natural cycles of flow, flooding, and soil deposition that historically scoured and supported the regeneration of vegetation on the floodplain terrace. Substantial changes occurred again as the construction of Longhorn Dam in 1960 formed Lady Bird Lake, formerly known as Town Lake. The creation of Lady Bird Lake only 55 years ago has resulted in a less dynamic, constant-level lake surrounded by saturated shoreline soils.

Even with the dams and flood controls, periodic flooding occurs in low lying areas of the study area, such as those found at the peninsula near Longhorn Dam and the areas near Johnson Creek. The 100 year floodplain continues to encompass 63% of the study area, and the 500 year floodplain covers an additional 34%, as seen in Figure 2.4.

Tributaries within the study area contribute another 94,000 acres to the watershed. Major creeks flowing into Lady Bird Lake within the study area include Johnson, Shoal, Waller, Barton, West Bouldin, East Bouldin, and Blunn creeks. These creeks substantially impact the local hydrology, topography, and ecology as they bisect the study area to meet Lady Bird Lake. Their flows can be extremely flashy and destructive due to high impervious cover levels associated with urban creeks and the sporadic but heavy rainfall patterns that characterize our area. The creeks also carry a great deal of trash and debris into the Lake and onto the shoreline.

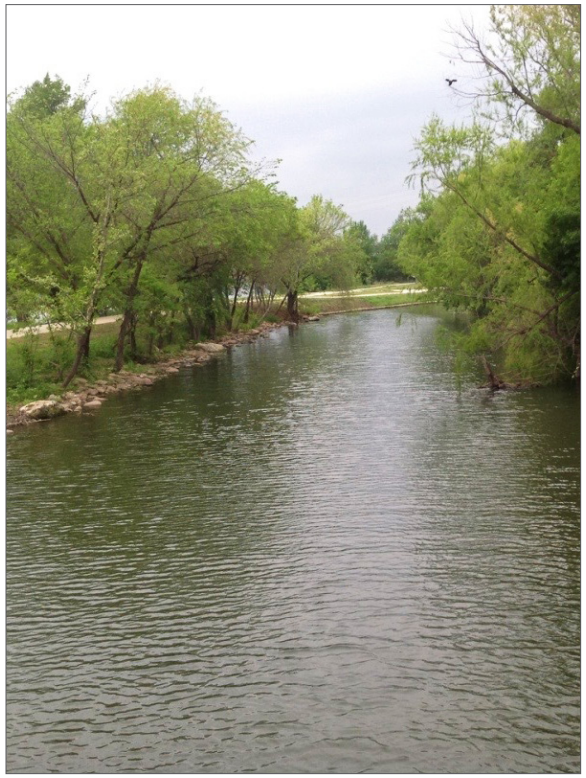
Shoal Creek and Waller Creek are the most impacted watersheds due to urban development and

Figure 2.4: 100 and 500 year floodplains for Lady Bird Lake. Sources: COA, NAIP.



its associated high levels of impervious cover. The flashiness of Waller Creek's flows and the desire to reclaim floodplain for development have resulted in the Waller Creek Tunnel Project that is substantially altering the shoreline just west of the creek and will alter the impacts of flashy flows on the mouth of the creek. Shoal Creek does not have an equivalent project, but the problem of flashy flows and the impacts on the watershed and the mouth of the creek as it enters the study area are known (Figure 2.5). Both of these watersheds contribute substantial amounts of trash to Lady Bird Lake.

Figure 2.5: Shoal Creek is one of the most impacted creeks in the study area and is subject to flashy flows.



Barton Creek is another prominent waterway coming into the river. It has the largest persistent flow of any of the tributaries as a result of Barton Springs, which is just upstream of the study area and is home to the endangered Barton Springs Salamander. Other documented springs in the study area include: Gazebo Spring and Zilker Park Spring in the western portion of Zilker Park and Cold Springs (now under the Lake) near Deep Eddy pool.

The control of Longhorn Dam, and thereby the control of Lady Bird Lake water levels, has entered an interesting stage. The Lake was initially used as a cooling pond for the Holly Power Plant, which has now been decommissioned. This may have implications for natural areas management associated with bank stability, varying water levels, invasive species control, and germination of aquatic and shoreline plants.

Overall water quality within the Lake is considered fair, with high scores for vegetation, marginal scores for water chemistry, and fair scores for sediment quality, eutrophication, habitat, and aquatic life. The natural areas and associated vegetation contribute to better water quality, while the influx of stormwater from urban streams generally lowers overall water quality (COA-WPD, 2015).

The recent decline in flows associated with the drought that began in 2011 has resulted in pockets of slower moving water that cause changes in aquatic vegetation and aesthetics. These types of conditions should be acknowledged and evaluated both as an anomaly and as a potential new steady state that will have impacts on the study area associated with deposition of new material, clearing of debris, establishment of plants, and effects on numerous water quality indicators.

GEOLOGY AND SOILS

The geology and soils of the natural areas are defined by the Colorado River and its historical movement along with the inundation that created Lady Bird Lake. The result is a mix of loamy and sandy soils in most areas. Three bedrock types underlie the study area based on the 15-minute GAT from Bureau of Economic Geology (2002):

- Qal: Quaternary Alluvium
- Qt: Fluviate terrace deposits
- Kau: Austin Chalk

The majority of the site is underlain by the alluvium deposits of the Qal and Qt layers. These are not bedrock at all, but deposits made by the Colorado River during flood events over millions of years. They are highly variable. Some areas are dominated by sand and others by loamy clay or gravel deposits. The limestone bluffs near the Boardwalk are an exception with substrate composed of Austin Chalk rather than alluvium. This thick limestone layer is composed of late Cretaceous mud and lime deposits and forms relatively shallow silty clay soils.

The soils on the Qal and Qt geologic layers reflect both the parent material and the scope of human impact upon the site (Figure 2.6). The most abundant map unit is the combined Ur, CF, and GP unit, or Urban soils—a miscellaneous category for soils that have been heavily manipulated by urban activity. Within the study area, the Urban soils mostly resemble the Hardeman and Bergstrom soils, appearing to be silty clay loams or fine sandy loams at the surface. These contrast with the next most abundant soil series, the Gaddy soils, which are found

on approximately a quarter of the study site. The Gaddy soils are typically a loamy fine sand. While the overstory trees found in all of these soils are similar, the sandy nature of the Gaddy soils should be reflected in a distinct herbaceous layer that contains species not found in the loamier Bergstrom and Hardeman soils. Currently, the herbaceous layer is disturbed to the extent that almost all species present are generalists.

The Eddy soils are located over the Austin Chalk. They are very shallow, with bedrock typically occurring within 14 to 20" of the surface. These rocky, limestone-derived soils are well drained and will support xeric plants. They will be vulnerable to erosion on steeper slopes if disturbed.

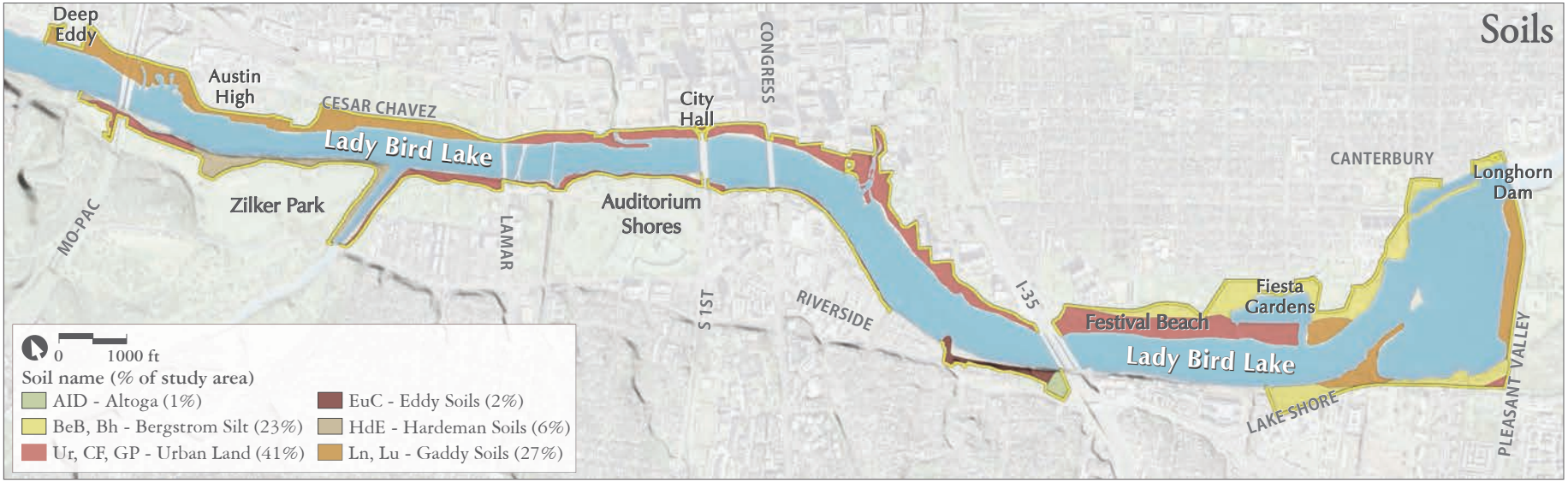
HISTORIC AND CURRENT LAND USE

The town of Waterloo on the banks of the Colorado River was selected as the new national capital for Texas in 1839. It was selected for its central location, clean water, views, and natural resources. The original parcels contained three miles of Colorado River shoreline with a 30 to 40 ft bluff down to the River. The River's prominence in the selection was complemented by the two creeks bordering the claim—Shoal to the west and Waller to the east. The original 735-acre tract was "heavily timbered" and included cottonwood, ash, burr oak, sugar hackberry, post oak and cedar, with bald cypress found sporadically along the shores farther upstream (Horton et al. 1839).

From that time forward, the City grew and took advantage of what was seen as an endless supply of natural resources (Doughty 1983). Immigrants claimed cheap land, fertile soils, and good hunting grounds. The abundance of wildlife and beauty of the landscape compelled many early explorers to describe the grandeur and bounty in the Austin area. Their stories suggest there were plentiful bison, black bear, panthers, and deer (Doughty 1983; Olmsted 1857). In addition to game mammals, explorers encountered large expanses of riparian and upland woodlands (Weniger 1984).

The idea of an endless supply of natural resources held claim until the 1850s, when people began to see marked decreases in game and issues such as erosion. This substantial land transformation, much of which occurred by 1860, impacted the study area in the form of steep declines in the riparian woodland, eroding shores, and the loss of flora and fauna from the area. Evidence can be seen in the photo from 1860 of the pontoon bridge crossing the Colorado—likely at the terminus of Blanco Street looking south over the River—which shows a stark lack of vegetation on the southern shore (Figure 2.7). A photo taken in 1910 looking towards the Capitol from the

Figure 2.6: Soil units surrounding Lady Bird Lake. Sources: COA, NAIP, USDA-NRCS.



Congress Avenue Bridge shows a growing city with a running river below, lacking vegetation on the southern shore but still containing a vegetated slope on the northern shore (Figure 2.8). A couple of decades later, Figure 2.9 from 1930 shows a view of the Capitol with the southern shore in riparian woodland and the area on the north shore east of Congress Avenue in lawn. Periodic flooding of the River since the inception of the City continued to plague Austin in the early 1900s, as seen by the rising floodwater and the preparations to sandbag in 1935 (Figure 2.10).

An aerial image from 1940 (Figure 2.11) shows a landscape with sparse canopy and an expansive floodplain terrace across much of the study area. Evidence of gravel mining can be seen on the south shore near Congress Avenue. Identifiable woodlands in the 1940 image include those around Zilker Park, Barton Creek, near Blunn Creek, and the cliffs just west of I-35's current location. Numerous areas are without woodland, including the Austin High area, Festival Beach, and the Southeast Shore.

The 1951 aerial image shows a rapidly growing city with a new crossing at Lamar Boulevard and substantial changes at the shoreline around Congress Avenue (Figure 2.12). The floodplain terrace appears less scoured, likely due to more consistent flows as a result of upstream dams. Evidence of gravel mining can still be seen around Congress Avenue on the south shore and additional gravel operations and/or construction activities can be seen at Holly Shores and around the current Longhorn Dam area. The riparian areas around Auditorium Shores and the Seaholm Power Plant (shown in Figure 2.13 from approximately 1950) lack vegetation. The riparian woodland is more robust in other areas, like the south shore of the River near Congress, now the grounds of the Hyatt hotel, as seen in Figure 2.14 from 1950.

In the late 1950s, the river was graded and prepared for impoundment. The construction of the Holly Power Plant complex can be seen in Figure 2.15 from 1959, with the River in the background. The aerial image in Figure 2.16 from 1959, looking east across the study area, shows the construction of the I-35 Bridge, construction around the Holly Power Plant, and a study area generally without trees except along the cliffs just west of I-35.

The completion of Longhorn Dam in 1960 created Lady Bird Lake, then known as Town Lake, leading to the shoreline we know today. The aerial photo in Fig-

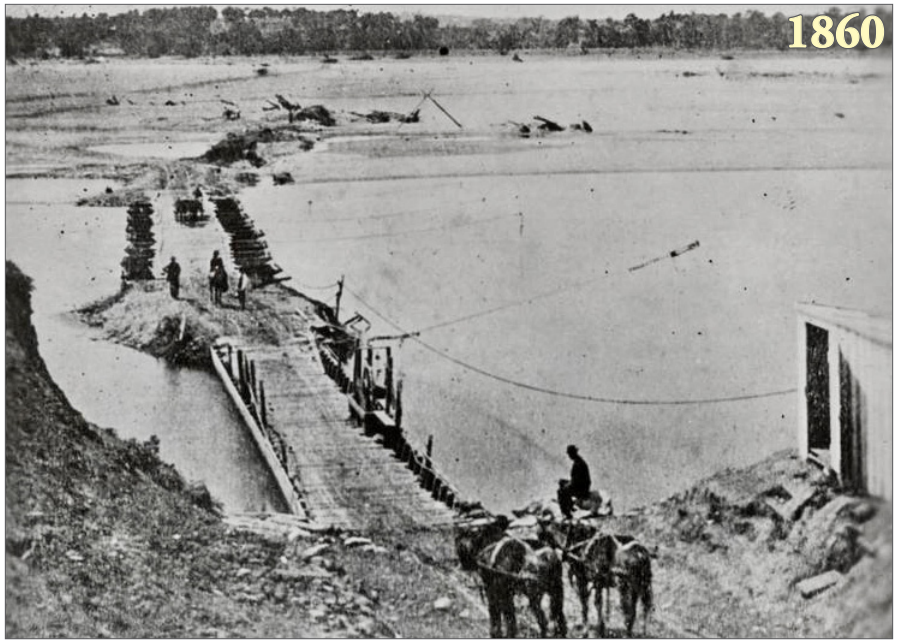
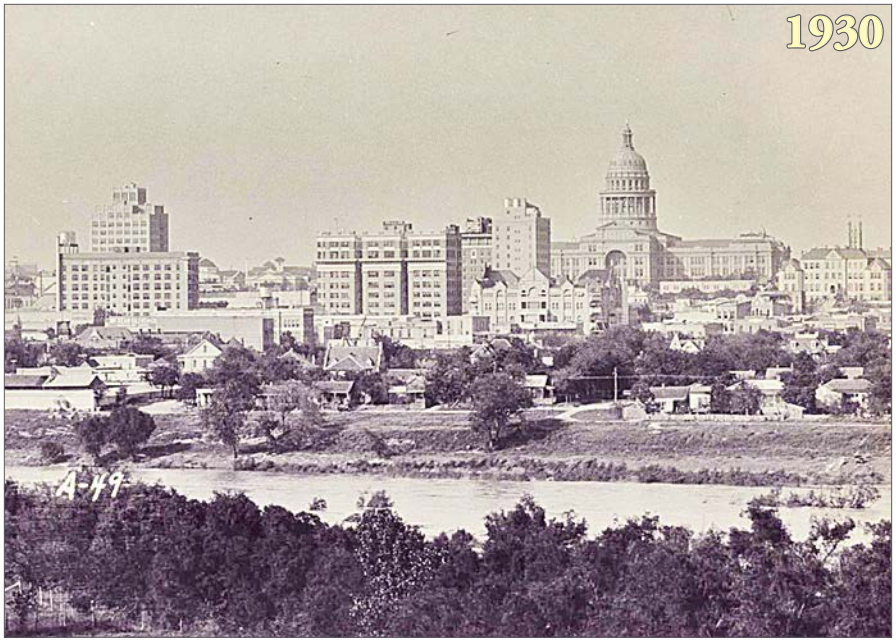
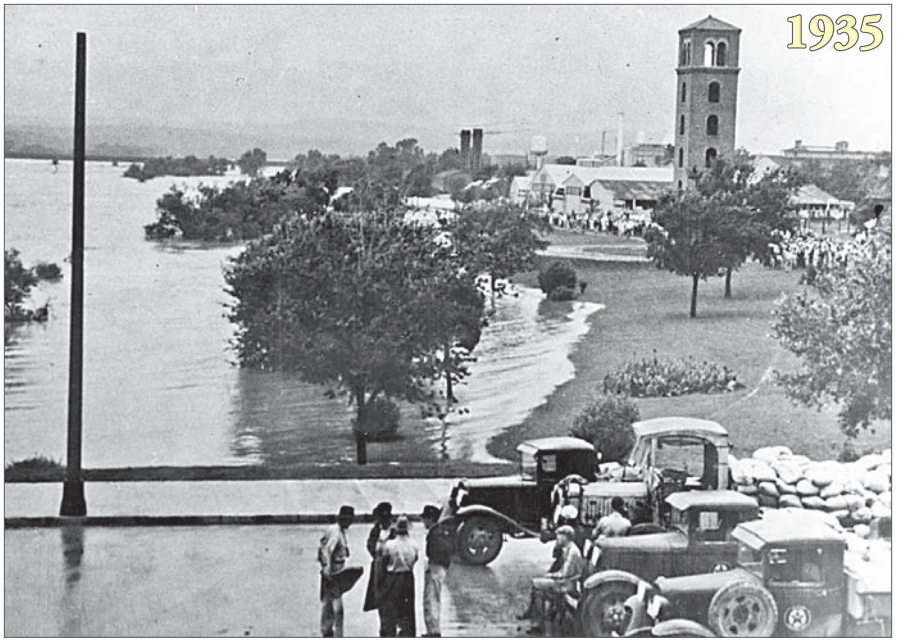


Figure 2.7 (Above): Pontoon bridge crossing the Colorado River, 1860. Source: The Portal to Texas History (PTH). Figure 2.8 (Below): View towards the Capitol from Congress Bridge, 1910. Source: Portal to Texas History. Source: Ellison Photo Co. via PTH.





Figures 2.9 (Above, Left): View of the Capitol showing riparian woodland on southern shore, 1930. Source: PTH. Figure 2.10 (Above, Right): Rising floodwaters, 1935. Source: Ellison Photo Co. via PTH. Figure 2.11 (Below): 1940 aerial image of the study area. Source: CAPCOG.

ure 2.17 from 1962 shows that major portions of the shoreline were still undefined, including the southern shore east of Lamar Boulevard and the northern shore down to the Austin High area. It also shows substantial woodlands on the south shore west of Lamar Boulevard and some areas near the mouth of Johnson Creek on the northern shore. The grading for the Lake's edge and the very sparse beginnings of the urban forest can be seen in Figure 2.18 from 1968, in which Festival Beach is nearly devoid of trees. The 1969 aerial image shows, generally, the outline of the Lake we have become familiar with today with the addition of Longhorn Dam, the island, and peninsulas at Holly Shores, Shoal Creek, Johnson Creek, and the Southeast Shore (Figure 2.19). By 1975, infrastructure improvements were added to enhance recreation along the Lake, as seen in Figure 2.20 of a runner passing a park bench facing the Zilker Park woods across the Lake. By 1986, the urban forest began to develop more strongly around Johnson Creek, Zilker Park, the peninsula at the southeast shore, the island, the peninsula at Holly Shores, the cliffs west of I-35, and the mouth of Waller Creek, as seen in Figure 2.21.

Today, the study area has become a central focus of the Austin community and is a highly used natural area, with over 1.5 million visits per year (COA 2003). People come to the site because of its convenient location within Austin, beauty, natural aesthetic, and recreational opportunities. Land management practices in the study area today and for the past 75 years have been dominated by mowing, allowing for specimen trees but generally leaving woodlands only where steep slopes made mowing impractical. In the past few years, 13 acres of the study area have been designated as Grow Zones—areas that are not mowed so that passive woodland regeneration can occur. These changes (discussed in greater detail on page 27 and shown in Figure 2.26) have had mixed results due to slow adoption of new management practices, lack of consensus on desired outcomes, and a meager seedbank impairing regeneration of native woodland species.

URBAN FOREST AND PLANT COMMUNITIES

The defining influences on the vegetation are the riparian corridor created by the Colorado River and the highly urbanized landscape surrounding the site. Despite the massive changes in vegetation, use, and habitat quality over the many decades since Austin's founding along the Colorado River in 1839, the natural areas are still an essential part of the riparian corridor that extends from the rolling hills in the west to the relatively flat woodlands and savannas in the east. Since the 1970s, extent and health of the urban forest has improved immensely, but there is still great need to build upon previous work to increase the urban forest's robustness, resilience, and

Figure 2.12: 1951 aerial image of the study area. Source: CAPCOG.

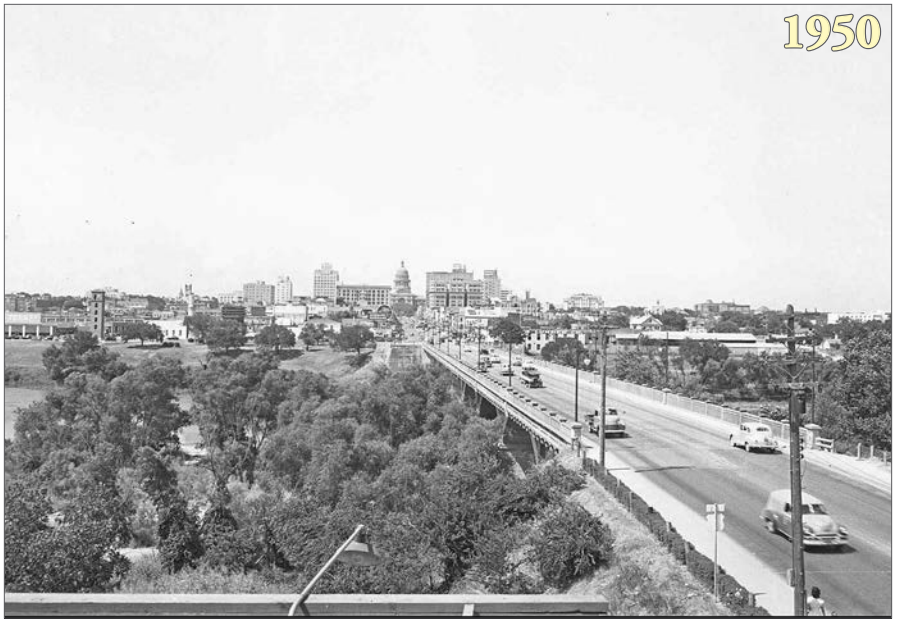
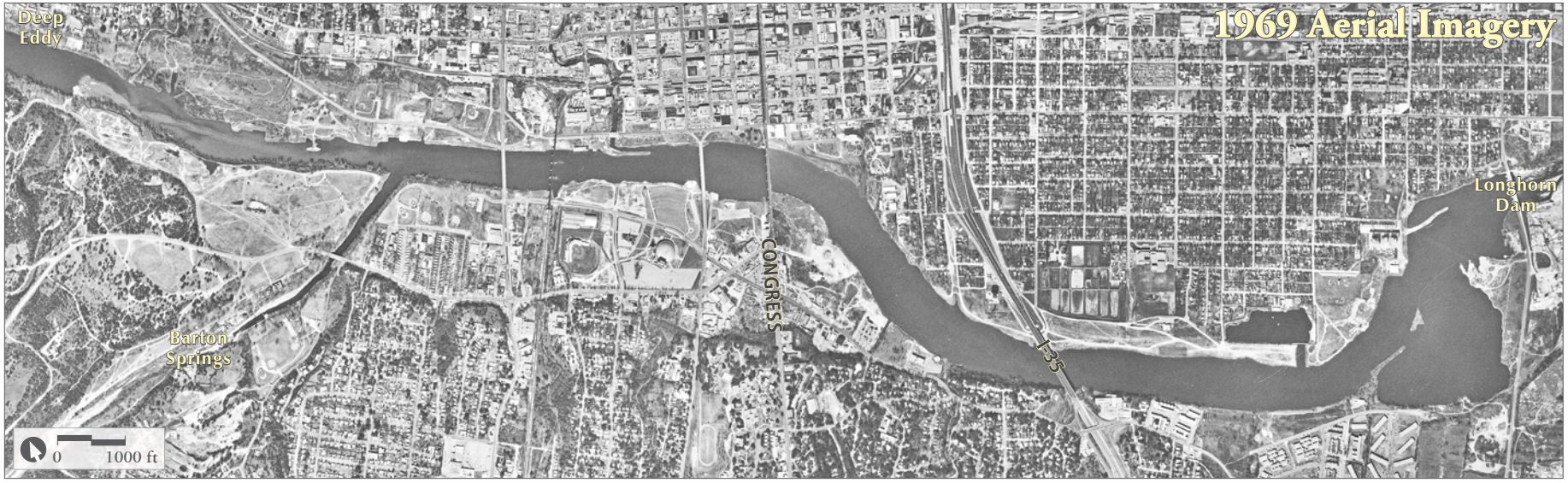


Figure 2.13 (Above, left): Auditorium Shores and Seaholm Power Plant, circa 1950. Source: City of Austin via PTH. Figure 2.14 (Above, right): More robust riparian woodland near Congress Bridge, 1950. Source: Neal Douglass via PTH. Figure 2.15 (Below, Left): Construction of the Holly Power Plant 1959. Source: Neal Douglass via PTH. Figure 2.16 (Below, right): Aerial image of the study area from Lamar looking east shows construction of I-35, 1959. Source: Neal Douglass via PTH.

Figure 2.17 (Above, left): Aerial image from 1962 shows undefined shorelines of Southcentral Shore and Auditorium Shores. Source: Neal Douglass via PTH. Figure 2.18 Figure (Above, right): Aerial image from 1968 shows graded lakeshore and beginnings of shoreline woodlands. Source: Neal Douglass via PTH. Figure 2.19 (Below): 1969 aerial image of the study area. Source: CAPCOG.

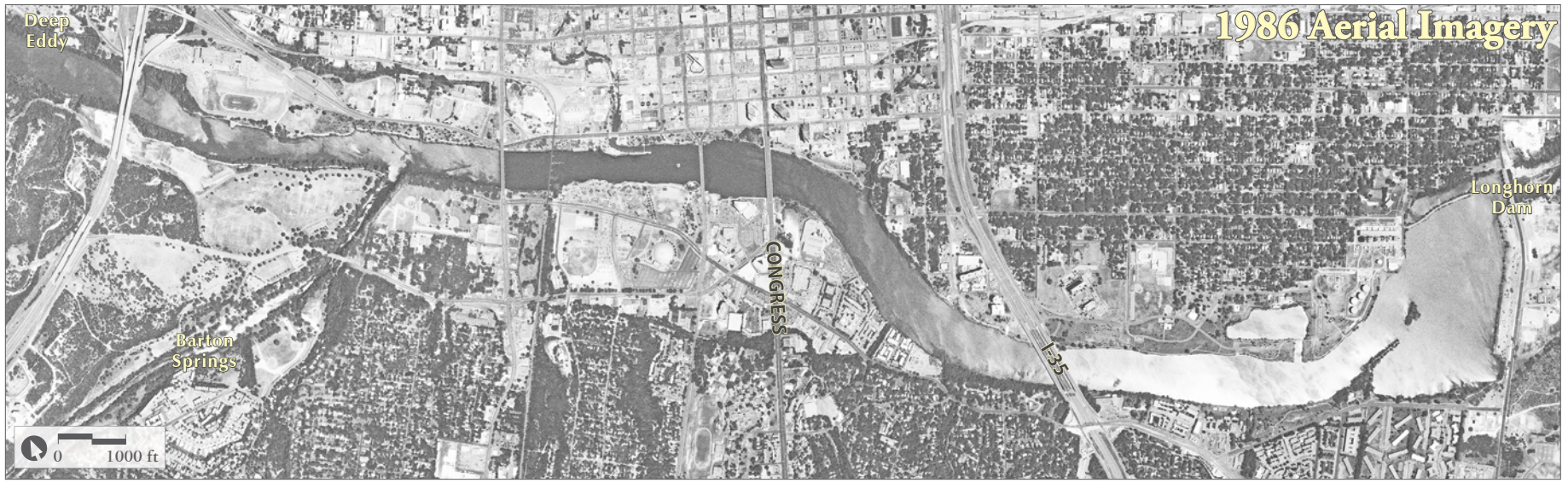


appeal as a recreational amenity.

The majestic trees of Lady Bird Lake and the Butler Trail are a significant part of the aesthetic and recreational appeal of the site, providing shade, visual screening, and natural beauty. In addition, the forest and natural areas provide an array of irreplaceable services to the city including: cleaning the air, reducing noise pollution, enhancing water quality, sequestering carbon, intercepting rainfall, mitigating flooding, reducing erosion, decreasing urban temperatures, shading our recreation areas, protecting the shoreline, building soil, providing wildlife habitat, increasing public health, increasing property values, reducing infrastructure costs, and making people happy (COA Urban Forest Plan 2014).

The composition, structure, and health of the natural areas and urban forest around Lady Bird Lake affect those important functions, as well as the aesthetic appeal of the site. Almost the entire study area is floodplain terrace and would naturally be wooded except for areas recently disturbed by floodwater, which would be in a dynamic transition from savanna to forest. Within the mature woodland there would be towering canopy trees with smaller trees, understory, and groundcover below. Tree mortality, small disturbance events, or flooding of

Figure 2.20 (Above): By 1975, park infrastructure helped draw users to the Trail and Lake. Source: The Trail Foundation. Figure 2.21 (Below): 1986 aerial image of the study area. Source: CAPCOG.



the area would cause openings in the canopy. To better understand the current condition of the natural areas and potential management recommendations, this project included an inventory of over 6,000 trees paired with existing tree data, a botanical survey, an assessment of tree health and risk, and an overall evaluation of densities, diversity, and age classes.

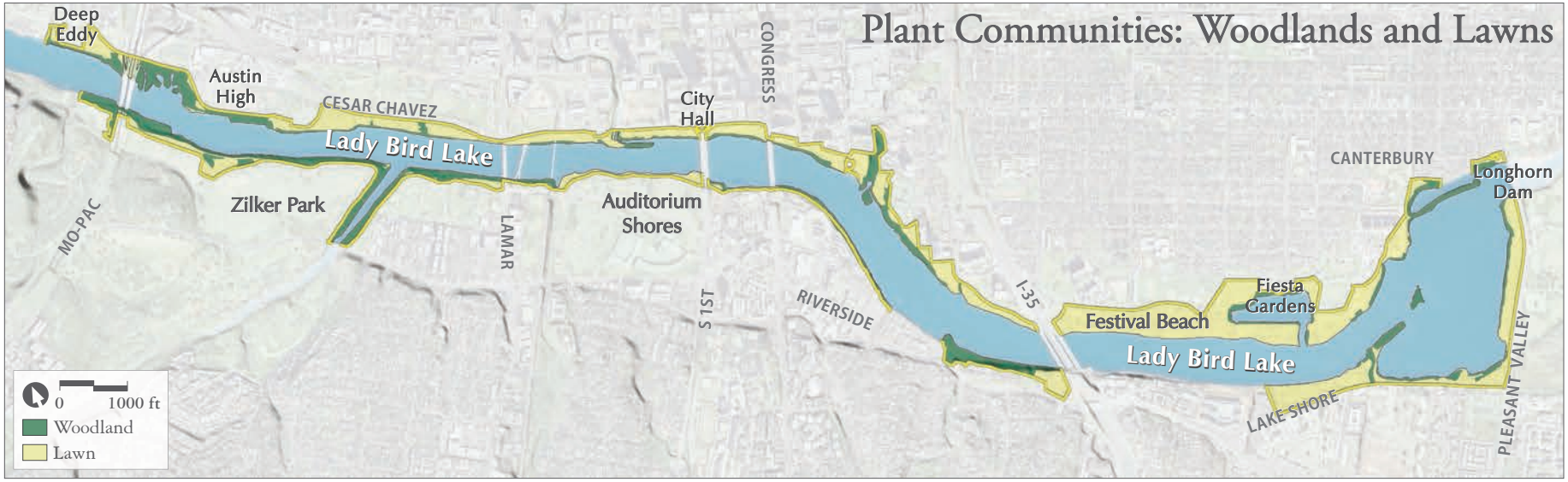
Plant Species and Communities

During the botanical survey, botanist Bill Carr encountered 365 plant species (Table 2.1) and defined three existing plant communities in the study area. The survey included natural areas as well as maintained open spaces and planted landscapes. In addition to 245 native species, 120 exotic species not historically found in Texas were observed. This number is higher due to the inclusion of planted landscapes in the study area than it would be for a survey of the natural areas alone. The majority of the exotic species are not considered harmful, but some pose a threat to the natural systems and are discussed in the invasive plant species section below. The three plant communities observed in the study area are: Shoreline Woodland, Floodplain Terrace Woodland, and Lawn. Figure 2.22 shows areas classified as Lawn and Woodland. Shoreline Woodland and Floodplain Terrace Woodland are combined in the map because the Shoreline Woodland is so narrow in most areas that it would not be visible on its own. These communities are described generally below, with variation across the study area discussed in greater detail in the Management Units chapter.

Shoreline Woodland

The Shoreline Woodland is highly influenced by the saturation of the soil. It is characterized by bald cypress (*Taxodium distichum*) along the shoreline of the Lake, as shown in Figure 2.23. In most places this community is a very narrow band, often only a few feet wide, directly along the shore. In a few areas where low-lying land extends father from the shoreline, the Shoreline Woodland is more expansive. Other characteristic trees in this community are black willow (*Salix nigra*), green ash (*Fraxinus pennsylvanica*), Chinese tallow (*Triadica sebifera*), and eastern sycamore (*Platanus occidentalis*). Buttonbush (*Cephalanthus occidentalis*) and roughleaf dogwood (*Cornus drummondii*) are the most consistent components of the sparse shrub layer. The herbaceous layer is generally lacking diversity, composed almost entirely of Emory sedge (*Carex emoryi*), false nettle (*Boehmeria cylindrica*) and elephant ear (*Colocasia esculenta*). The herbaceous layer is more diverse in areas with flatter banks. Such areas are, however, quite un-

Figure 2.22: Woodland and lawn areas in the natural areas around Lady Bird Lake. Sources COA, NAIP.



common within the study area.

Floodplain Terrace Woodland

The Floodplain Terrace Woodland is found immediately upslope from the Shoreline Woodland. Characteristic trees of this community include sugar hackberry (*Celtis laevigata*), American elm (*Ulmus americana*), pecan (*Carya illinoinensis*), cedar elm (*Ulmus crassifolia*), white mulberry (*Morus alba*), and Chinaberry (*Melia azedarach*) (Figure 2.24). Shrubs are often sparse, though some areas have dense cover of young cherry laurel (*Prunus caroliniana*). Mexican sabal palm (*Sabal mexicana*) has recently become naturalized in the study area and is locally common on the lower parts of Floodplain Terrace Woodlands. Texas persimmon (*Diospyros texana*), and Ashe juniper (*Juniperus ashei*) occur in small numbers in steep areas. Vines are often abundant in the understory. Poison ivy (*Toxicodendron radicans*) is abundant throughout and is often joined by mustang grape (*Vitis mustangensis*) and peppervine (*Ampelopsis arborea*). The ground layer is sparse in the fall (the time of the botanical survey), with characteristic species including inland sea oats (*Chasmanthium latifolium*), Virginia wildrye (*Elymus virginicus*), Turk's cap (*Malvaviscus arboreus*), and a white-rayed aster, most likely *Symphyotrichum lanceolatum*. Two warm-season shade-tolerant perennial grasses, rustyseed (*Paspalum langei*) and southwestern bristlegrass (*Setaria scheelei*), are present but not as common here as in similar woodlands in less heavily altered parts of the region.

Figure 2.23: The Shoreline Woodland is characterized by large bald cypress and is generally only one tree wide, as seen here just east of 1st Street on the south shore

Lawn

The third major plant community, Lawn, begins at the point where the slope becomes flat enough to mow (Figure 2.25). With the exception of the Johnson Creek area, the wildflower meadow areas near Cesar Chavez, and the recently instituted Grow Zone areas discussed below, the majority of the land in the study area that is flat enough to mow is frequently mowed. In the majority of lawn areas, Bermudagrass (*Cynodon dactylon*) is the dominant lawn grass. Other herbaceous plants are either absent or difficult to identify due to mowing. Exceptions occur along the very edge of the woodland, where mowers do not reach the stems of a few species such as giant ragweed (*Ambrosia trifida*), the most conspicuous herbaceous plant along edges and in Grow Zones during the fall of 2014. Many of the lawn areas have shade trees, most often pecan (*Carya illinoinensis*) and live

Figure 2.24: Sugar hackberry is the most abundant tree in the Floodplain Terrace Woodland, and the community often lacks a dense shrub layer, as seen here just west of MoPac on the south shore.

oak (*Quercus fusiformis*), some of which occur on these valley flats naturally and some of which have been planted. The most common ornamental planting on lawns throughout the project area is crepe myrtle (*Lagerstroemia indica*). More recent plantings in the lawn areas by the Trail Foundation and the City have included numerous native trees and shrubs.

The Grow Zones are riparian areas designated by the City's Watershed Protection Department and PARD to be converted from mowed lawn to woodland. The goal of the program is to create healthier riparian habitats by allowing woodland species to naturally regenerate in the absence of mowing. There are 13 acres designated as Grow Zone within the study area (Figure 2.26), though at the time of this study mowing was still occurring in some of the areas.

The full botanical survey report has been provided to The Trail Foundation and the City of Austin. It is important to note that the botanical survey was conducted in the fall and therefore only captured species that are identifiable during that time of year. For comparison, the species list of the nearby Brackenridge Field Laboratory contains 479 species, 354 of which are native. Conducting regular plant surveys, ideally at various times of year, would make the species list for the study area more complete and help capture changes in species composi-

Figure 2.25: Much of the study area is mowed lawn punctuated by shade trees, like this section of the Southeast Shore near the eastern extent of the Boardwalk.

Figure 2.26: Areas designated as Grow Zones in the natural areas around Lady Bird Lake. Sources COA, NAIP.

Table 2.1: Plant species recorded by Bill Carr during a botanical survey of the study area, Fall 2014.

Nativity Codes:
- *N: Native to Texas*
- *N-I: Native to Texas but introduced on site*
- *E: Exotic*
- *I: Invasive exotic*

Form Codes:
- *AQ: Aquatic forb*
- *FA: Annual forb*
- *FAV: Annual vine forb*
- *FP: Perennial forb*
- *FPV: Perennial vine forb*
- *GA: Annual grass or grass-like plant*
- *GP: Perennial grass or grass-like plant*
- *PP: Perennial fern or fern ally*
- *S: Shrub*
- *T: Tree*
- *WV: Woody vine*

Botanical Survey Results

Common Name	Scientific Name	Nativity	Form
Agarita	*Berberis trifoliolata*	N	S
Agave	*Agave sp.*	E	S
Alamo vine	*Merremia dissecta*	N	FPV
Alligatorweed	*Alternanthera philoxeroides*	E	FP
Allium	*Allium sp.*	E	FP
Amberique-bean	*Strophostyles helvola*	N	FPV
American beautyberry	*Callicarpa americana*	N-I	S
American bulrush	*Schoenoplectus pungens*	N	GP
American Elm	*Ulmus americana*	N	T
American sycamore	*Platanus occidentalis*	N	T
American water-willow	*Justicia americana*	N	FP
Anacacho orchid tree	*Bauhinia lunarioides*	N-I	S
Anacua	*Ehretia anacua*	N	T
Annual bluegrass	*Poa annua*	E	GA
Annual march elder	*Iva annua*	N	FA
Arizona walnut	*Juglans major var. major*	N	T
Ashe juniper	*Juniperus ashei*	N	S
Asiatic jasmine	*Trachelospermum asiaticum*	I	WV
Asparagus	*Asparagus sp.*	E	FP
Autumn sage	*Salvia greggii*	N-I	S
Baby jump-up	*Mecardonia procumbens*	N	FA
Bald cypress	*Taxodium distichum*	N	T
Ball moss	*Tillandsia recurvata*	N	FP
Balloon vine	*Cardiospermum halicacabum*	N	FAV
Banana	*Musa sp.*	E	T
Bastard cabbage	*Rapistrum rugosum*	E	FA
Bermuda grass	*Cynodon dactylon*	I	GP
Big blue lilyturf	*Liriope muscari*	E	FP
Bigpod sesbania	*Sesbania herbacea*	N	FA
Bigtooth maple	*Acer grandidentatum*	N-I	T

Common Name	Scientific Name	Nativity	Form
Bindii	*Tribulus terrestris*	E	FA
Bindweed	*Convolvulus equitans*	N	FPV
Black willow	*Salix nigra*	N	T
Blackbristle greenbriar	*Smilax tamnoides var. hispida*	N	WV
Black-eyed Susan	*Rudbeckia hirta {horticultural form}*	N-I	FP
Bladderpod	*Glottidium vesicaria*	N	FA
Bladderpod sida	*Rhynchosida physocalyx*	N	FP
Blind prickly- pear	*Opuntia sp.*	E	S
Blue mudplantain	*Heteranthera limosa*	N	FP
Box elder	*Acer negundo*	N	T
Boxwood	*Buxus sp.*	E	S
Bradford pear	*Pyrus calleryana*	I	S
Brazilian vervain	*Verbena brasiliensis*	E	FP
Broadleaf plantain	*Plantago major*	E	FA
Brown mustard	*Brassica juncea*	E	FA
Buffalobur nightshade	*Solanum rostratum*	N	FA
Buffalograss	*Bouteloua dactyloides*	N-I	GP
Bulbine	*Bulbine sp.*	E	FP
Bur oak	*Quercus macrocarpa*	N-I	T
Bushy bluestem	*Andropogon glomeratus*	N-I	GP
Buttonweed	*Diodia virginiana*	N	FP
California bulrush	*Schoenoplectus californicus*	N	GP
Camphorweed	*Heterotheca subaxillaris var. latifolia*	N	FA
Canada germander	*Teucrium canadense*	N	FP
Canada spikegrass	*Eleocharis geniculata*	N	GA
Candle bush	*Senna alata*	E	S
Carelessweed	*Amaranthus palmeri*	N	FA
Carolina bristlemallow	*Modiola caroliniana*	N	FP
Carolina buckthorn	*Frangula caroliniana*	N-I	S
Carolina dayflower	*Commelina caroliniana*	E	FA

Botanical Survey Results (*continued*)

Common Name	Scientific Name	Nativity	Form
Carolina fanwort	*Cabomba caroliniana*	N	AQ
Carolina ponysfoot	*Dichondra caroliniensis*	N	FP
Carolina snailseed	*Cocculus carolinus*	N	FPV
Catclaw vine	*Macfadyena unguis-cati*	I	WV
Cayenne pepper	*Capsicum annuum*	N	S
Cedar Elm	*Ulmus crassifolia*	N	T
Cenizo	*Leucophyllum frutescens*	N-I	S
Cheeseweed mallow	*Malva parviflora*	E	FA
Cherry laurel	*Prunus caroliniana*	N	T
Chinaberry	*Melia azedarach*	E	T
Chinese fringe flower	*Loropetalum chinense*	E	S
Chinese lacebark elm	*Ulmus parvifolia*	I	T
Chinese parasolotree	*Firmiana simplex*	I	T
Chinese photinia	*Photinia sp.*	I	S
Chinese pistache	*Pistacia chinensis*	E	T
Chinese tallow	*Triadica sebifera*	I	T
Chinquapin oak	*Quercus muehlenbergii*	N-I	T
Chisme	*Portulaca pilosa*	N	FA
Citrus sp.	*Citrus sp.*	E	T
Climbing dayflower	*Commelina diffusa*	N	FA
Climbing hempvine	*Mikania scandens*	N	FPV
Climbing milkweed vine	*Funastrum cynanchoides var. cynanchoides*	N	FPV
Coastal sandbur	*Cenchrus spinifex*	N	GP
Common buttonbush	*Cephalanthus occidentalis*	N	S
Common chaste tree	*Vitex agnus-castus*	I	S
Common chickweed	*Stellaria media*	E	FA
Common dandelion	*Taraxacum officinale*	E	FA
Common elderberry	*Sambucus nigra ssp. canadensis*	N	S
Common fig	*Ficus carica*	E	S
Common purslane	*Portulaca oleracea*	E	FA
Common ragweed	*Ambrosia psilostachya*	N	FP
Common sunflower	*Helianthus annuus*	N	FA
Confederate jasmine	*Trachelospermum jasminoides*	I	WV
Coral vine	*Antigonon leptopus*	E	FPV
Correll's false dragonhead	*Physostegia correllii*	N	FP
Cowpen daisy	*Verbesina encelioides*	N	FA

Common Name	Scientific Name	Nativity	Form
Crabgrass	*Digitaria sp.*	E	GA
Creeping fig	*Ficus pumila*	E	WV
Creeping primrose-willow	*Ludwigia repens*	N	FA
Creeping water-primrose	*Ludwigia peploides subsp. peploides*	N	AQ
Crepe myrtle	*Lagerstroemia indica*	E	S
Cretanweed	*Hedypnois cretica*	E	FA
Crinum	*Crinum sp.*	E	FP
Crossvine	*Bignonia capreolata*	N-I	WV
Cutleaf evening-primrose	*Oenothera laciniata*	N	FP
Dallisgrass	*Paspalum dilatatum*	E	GP
Dasylirion	*Dasylirion sp.*	N	S
Desert Christmas cactus	*Opuntia leptocaulis*	N	S
Desert willow	*Chilopsis linearis*	N-I	S
Dewberry	*Rubus trivialis*	N	S
Doctorbush	*Plumbago scandens*	E	FP
Drummond's aster	*Symphyotrichum drummondii var. texanum*	N	FP
Drummond's wood-sorrel	*Oxalis drummondii*	N	FP
Duckweed	*Lemna sp.*	N	AQ
Eared redstem	*Ammannia auriculata*	N	FA
Eastern black nightshade	*Solanum ptycanthum*	N	FP
Eastern cottonwood	*Populus deltoides subsp. deltoides*	N	T
Eastern gamagrass	*Tripsacum dactyloides*	N	GP
Eastern redbud	*Cercis canadensis var. texensis*	N	T
Elbow bush	*Forestiera pubescens*	N	S
Elephant ear	*Colocasia esculenta*	I	AQ
Emory sedge	*Carex emoryi*	N	GP
English Ivy	*Hedera helix*	I	WV
Entireleaf indian paintbrush	*Castilleja indivisa*	N	FA
Erect spadeleaf	*Centella erecta*	N	AQ
Erect spiderling	*Boerhavia erecta*	N	FP
Erythrina	*Erythrina sp.*	E	S
Evening rain lily	*Cooperia drummondii*	N	FP
Evergreen sumac	*Rhus virens var. virens*	N-I	S
Eve's necklace	*Styphnolobium affine*	N	T
False daisy	*Eclipta prostrata*	N	FP
False dayflower	*Tinantia anomala*	N	FA

Common Name	Scientific Name	Nativity	Form
False indigo-bush	*Amorpha fruticosa*	N	S
False nettle	*Boehmeria cylindrica*	N	FP
False willow	*Baccharis neglecta*	N	S
Fan palm	*Washingtonia sp.*	E	GP
Firebush	*Hamelia patens*	E	S
Flame acanthus	*Anisacanthus quadrifidus*	N-I	S
Four o'clocks	*Mirabilis jalapa*	E	FP
Fourleaf manyseed	*Polycarpon tetraphyllum*	E	FA
Fragrant flatsedge	*Cyperus odoratus*	N	GA
Frostweed	*Verbesina virginica*	N	FP
Giant goldenrod	*Solidago gigantea*	N	FP
Giant ragweed	*Ambrosia trifida*	N	FA
Giant reed	*Arundo donax*	I	GP
Ginko	*Ginkgo biloba*	E	T
Glossy privet	*Ligustrum lucidum*	I	S
Golden Bamboo	*Phyllostachys aurea*	I	GP
Golden rain tree	*Koelreuteria paniculata*	I	T
Goosefoot	*Chenopodium sp.*	E	FA
Grape ivy	*Cissus trifoliata*	N	FPV
Green ash	*Fraxinus pensylvanica*	N	T
Green carpetweed	*Mollugo verticillata*	N	FA
Green sprangletop	*Leptochloa dubia*	N	FP
Guadeloupe cucumber	*Melothria pendula*	N	FPV
Guara	*Gaura sp. {horticultural selection}*	E	FP
Gum bumelia	*Sideroxylon lanuginosum subsp. oblongifolium*	N	T
Gummy lovegrass	*Eragrostis curtipedicellata*	N	GP
Hairyfruit chervil	*Chaerophyllum taintur ieri var. taintur ieri*	N	FA
Hairyseed paspalum	*Paspalum pubiflorum*	N	GP
Hall's panicgrass	*Panicum hallii*	N	GP
Heartleaf peppervine	*Ampelopsis cordata*	N	WV
Heavenly bamboo	*Nandina domestica*	I	S
Hedge parsley	*Torilis arvensis*	I	FA
Honey locust	*Robinia pseudoacacia*	N-I	T
Honey mesquite	*Prosopis glandulosa var. glandulosa*	N	T
Hooded windmill grass	*Chloris cucullata*	N	GP

Common Name	Scientific Name	Nativity	Form
Horsemint	*Monarda citriodora var. citriodora*	N	FA
Horsetail	*Equisetum sp.*	N	PP
Horseweed	*Conyza canadensis*	N	FA
Huisache	*Acacia farnesiana*	N	T
Illinois bundleflower	*Desmanthus illinoensis*	N-I	FP
Indian goosegrass	*Eleusine indica*	E	GA
Indiangrass	*Sorghastrum nutans*	N-I	GP
Inland seaoats	*Chasmanthium latifolium*	N	GP
Jamaicanweed	*Nama jamaicense*	N	FA
Japanese brome	*Bromus japonicus*	E	GA
Japanese holly fern	*Cyrtomium falcatum*	E	PP
Japanese honeysuckle	*Lonicera japonica*	I	WV
Johnson Grass	*Sorghum halepense*	I	GA
Jungle rice	*Echinochloa colona*	E	GA
Lamb's quarters	*Chenopodium berlandieri var. berlandieri*	N	FA
Lantana	*Lantana camara*	E	S
Late boneset	*Eupatorium serotinum*	N	FP
Lax hornpod	*Mitreola petiolata*	N	FA
Least snoutbean	*Rhynchosia minima*	N	FPV
Lepidium sp.	*Lepidium sp.*	N	FA
Ligustrum	*Ligustrum japonicum*	I	S
Ligustrum	*Ligustrum quihoui*	I	S
Lindheimer's muhly	*Muhlenbergia lindheimeri*	N-I	GP
Loquat	*Eriobotrya japonica*	I	S
Maximilian sunflower	*Helianthus maximiliani*	N-I	FP
Mediterranean lovegrass	*Eragrostis barrelieri*	E	GA
Mexican buckeye	*Ungnadia speciosa*	N	S
Mexican fan palm	*Washingtonia robusta*	E	T
Mexican hat	*Ratibida columnifera*	N	FP
Mexican holdback	*Caesalpinia mexicana*	E	S
Mexican olive	*Cordia boissieri*	N-I	S
Mexican petunia	*Ruellia caerulea*	I	FP
Mexican pistachio	*Pistacia mexicana*	E	T
Mexican plum	*Prunus mexicana*	N-I	T
Mexican primrose-willow	*Ludwigia octovalvis subsp. octovalvis*	N	FA
Mexican sabal	*Sabal mexicana*	N	T

Botanical Survey Results (*continued*)

Common Name	Scientific Name	Nativity	Form
Mexican tea	*Chenopodium ambrosioides*	N	FA
Mimosa	*Albizia julibrissin*	I	S
Mistletoe	*Phoradendron tomentosum*	N	S
Monterrey Oak	*Quercus polymorpha*	N-I	T
Mustang grape	*Vitis mustangensis*	N	WV
Nealley's globe amaranth	*Gomphrena nealleyi*	N	FP
Northern catalpa	*Catalpa speciosa*	N-I	T
Nutgrass	*Cyperus rotundus*	E	GP
Okra	*Abelmoschus esculentus*	E	FA
Old-man's-beard	*Clematis drummondii*	N	FPV
Oneflower flatsedge	*Cyperus retroflexus*	N	GP
Oppositeleaf spotflower	*Acmella oppositifolia var. repens*	N	FP
Panicledleaf ticktrefoil	*Desmodium paniculatum*	N	FP
Paper mulberry	*Broussonetia papyrifera*	I	T
Pearl milkweed vine	*Matelea reticulata*	N	FPV
Pecan	*Carya illinoinensis*	N	T
Pennsylvania pellitory	*Parietaria pensylvanica*	N	FA
Pennywort	*Hydrocotyle verticillata var. verticillata*	N	FP
Peppervine	*Ampelopsis arborea*	N	WV
Perennial ryegrass	*Lolium perenne*	E	GP
Phoenix palm	*Phoenix sp.*	E	T
Pickerelweed	*Pontederia cordata*	N-I	AQ
Pigeonberry	*Rivina humilis*	N	FP
Pine	*Pinus sp.*	E	T
Pineland threeseed mercury	*Acalypha ostryifolia*	N	FA
Pink evening primrose	*Oenothera speciosa*	N	FA
Pittosporum	*Pittosporum sp.*	E	S
Plains lovegrass	*Eragrostis intermedia*	N	GP
Poison ivy	*Toxicodendron radicans*	N	WV
Pomegranate	*Punica granatum*	E	S
Pond flatsedge	*Cyperus ochraceus*	N	GP
Possumhaw	*Ilex decidua*	N	S
Prairie cupgrass	*Eriochloa contracta*	N	GA
Prairie flameleaf sumac	*Rhus lanceolata*	N-I	S
Prairie lily	*Cooperia pedunculata*	N	FP
Prairie tea	*Croton monanthogynus*	N	FA
Primrose Jasmine	*Jasminum mesnyi*	I	S
Prostrate sandmat	*Chamaesyce prostrata*	N	FA
Purple clematis	*Clematis pitcheri var. pitcheri*	N	FPV
Purple prairie verbena	*Glandularia bipinnatifida*	N	FA
Purple threeawn	*Aristida purpurea var. purpurea*	N	GP
Rattlebush	*Sesbania drummondii*	N	FA
Red lovegrass	*Eragrostis secundiflora subsp. Oxylepis*	N	GP
Red yucca	*Hesperaloe parviflora*	N-I	S
Redroot flatsedge	*Cyperus erythrorhizos*	N	GA
Redseed plantain	*Plantago rhodosperma*	N	FA
Rescuegrass	*Bromus catharticus*	E	GA
Retama	*Parkinsonia aculeata*	N	S
Rock rose	*Pavonia lasiopetala*	N-I	S
Rose	*Rosa sp.*	E	S
Rosemary	*Rosmarinus officinalis*	E	S
Roughleaf dogwood	*Cornus drummondii*	N	S
Rumex	*Rumex sp.*	N	FP
Russian olive	*Elaeagnus macrophylla*	E	S
Rustyseed paspalum	*Paspalum langei*	N	GP
Sand dropseed	*Sporobolus cryptandrus*	N	GP
Santa Maria feverfew	*Parthenium hysterophorus*	N	FA
Saw greenbrier	*Smilax bona-nox*	N	WV
Scarlet Sage	*Salvia coccinea*	N	FA
Scarlet spiderling	*Boerhavia coccinea*	N	FP
Senna	*Senna sp.*	E	S
Shepherd's purse	*Capsella bursa-pastoris*	E	FA
Shortspike windmill grass	*Chloris subdolichostachya*	N	GP
Shrubby boneset	*Ageratina havanense*	N	S
Shrubby copperleaf	*Acalypha phleoides*	N	FP
Shumard red oak	*Quercus shumardii*	N	T
Sideoats grama	*Bouteloua curtipendula*	N	GP
Silver beardgrass	*Bothriochloa laguroides subsp. torreyana*	N	GP
Silver ponysfoot	*Dichondra argentea*	N-I	FP
Silverleaf nightshade	*Solanum elaeagnifolium*	N	FP
Singlewhorl burrobrush	*Hymenoclea monogyra*	N	S
Slender amaranth	*Amaranthus viridis*	N	FA
Slender snakecotton	*Froelichia gracilis*	N	FP
Slender yellow woodsorrel	*Oxalis dillenii*	N	FP

Common Name	Scientific Name	Nativity	Form
Smallflower groundcherry	*Physalis cinerascens var. cinerascens*	N	FP
Small-flowered carpetweed	*Kallstroemia parviflora*	N	FA
Smooth horsetail	*Equisetum laevigatum*	N	PP
Soft-hair marbleseed	*Onosmodium bejariense var. bejariense*	N	FP
Southern annual saltmarsh aster	*Symphyotrichum divaricatum*	N	FP
Southern cattail	*Typha domingensis*	N	GP
Southern magnolia	*Magnolia grandiflora*	N-I	T
Southwestern bristlegrass	*Setaria scheelei*	N	GP
Spiderwort	*Tradescantia sp.*	N	FP
Spiny chloracantha	*Chloracantha spinosa*	N	FP
Spiny sowthistle	*Sonchus asper*	E	FA
Spotted water hemlock	*Cicuta maculata*	N	FA
Spreading fanpetals	*Sida abutifolia*	N	FP
St. Augustine Grass	*Stenotaphrum secundatum*	E	GP
Stiff greenthread	*Thelesperma filifolium*	N	FP
Stinking gourd	*Cucurbita foetidissima*	N	FAV
Straggler daisy	*Calyptocarpus vialis*	N	FP
Sugar hackberry	*Celtis laevigata var. laevigata*	N	T
Sugar hackberry	*Celtis laevigata var. reticulata*	N	T
Sunflower goldeneye	*Viguiera dentata*	N	FA
Swamp sawgrass	*Cladium mariscus subsp. jamaicense*	N	GP
Swamp smartweed	*Polygonum hydropiperoides*	N	FA
Sweet autumn clematis	*Clematis terniflora*	I	WV
Sweetscent	*Pluchea odorata*	N	FA
Switchgrass	*Panicum virgatum*	N	GP
Talayote	*Cynanchum racemosum var. unifarium*	N	FPV
Tall goldenrod	*Solidago altissima var. altissima*	N	FP
Tall morning glory	*Ipomoea purpurea*	I	FPV
Texas bluebonnet	*Lupinus texensis*	N	FA
Texas bullnettle	*Cnidoscolus texanus*	N	FP
Texas frogfruit	*Phyla nodiflora*	N	FP
Texas kidneywood	*Eysenhardtia texana*	N	S
Texas lantana	*Lantana urticoides*	N	S
Texas live oak	*Quercus fusiformis*	N	T
Texas mountain laurel	*Sophora secundiflora*	N	S
Texas nightshade	*Solanum triquetrum*	N	FP
Texas persimmon	*Diospyros texana*	N	S

Common Name	Scientific Name	Nativity	Form
Texas prickly ash	*Zanthoxylum hirsutum*	N	S
Texas pricklypear	*Opuntia engelmannii var. lindheimeri*	N	S
Texas red oak	*Quercus buckleyi*	N	T
Texas snakeweed	*Gutierrezia texana*	N	FA
Texas stork's bill	*Erodium texanum*	N	FA
Texas vervain	*Verbena halei*	N	FP
Thorn-crested agave	*Agave lophantha*	N-I	S
Threelobe false mallow	*Malvastrum coromandelianum*	N	FP
thymeleaf sandwort	*Arenaria serpyllifolia*	E	FA
Tievine	*Ipomoea cordatotriloba var. cordatotriloba*	N	FPV
Toothed spurge	*Euphorbia dentata*	N	FA
Trailing lantana	*Lantana montevidensis*	E	S
Tree of heaven	*Ailanthus altissima*	I	T
Tree tobacco	*Nicotiana glauca*	E	S
Tropical amaranth	*Amaranthus polygonoides*	N	FA
Tropical puff	*Neptunia pubescens*	N	FP
Trumpet vine	*Campsis radicans*	N	WV
Turk's cap	*Malvaviscus arboreus var. drummondii*	N	FP
Twistleaf yucca	*Yucca rupicola*	N	S
Twoleaf watermilfoil	*Myriophyllum heterophyllum*	N	AQ
Vasey grass	*Paspalum urvillei*	I	GP
Velvetweed	*Oenothera curtiflora*	N	FA
Violet ruellia	*Ruellia nudiflora var. nudiflora*	N	FP
Virginia creeper	*Parthenocissus quinquefolia*	N	WV
Virginia wildrye	*Elymus virginicus*	N	GP
Wafer ash	*Ptelea trifoliata*	N	T
Washerwoman	*Alternanthera caracasana*	E	FP
Water hyssop	*Bacopa monnieri*	N	FP
Water oak	*Quercus nigra*	N-I	T
Waterlily	*Nymphaea sp.*	E	AQ
Watermeal	*Wolffia sp.*	N	AQ
Weakleaf bur ragweed	*Ambrosia confertiflora*	N	FP
Western horsenettle	*Solanum dimidiatum*	N	FP
Western soapberry	*Sapindus saponaria var. drummondii*	N	T
Western wild petunia	*Ruellia occidentalis*	N	FP
White avens	*Geum canadense*	N	FP

Botanical Survey Results (*continued*)

Common Name	Scientific Name	Nativity	Form
White mulberry	*Morus alba*	E	T
White panicle aster	*Symphyotrichum lanceolatum var. lanceolatum*	N	FP
White sweetclover	*Melilotus albus*	E	FA
Whitemouth dayflower	*Commelina erecta*	N	FA
Whitemouth dayflower	*Commelina erecta var. angustifolia*	N	FP
Whitemouth dayflower	*Commelina erecta var. erecta*	N	FP
Whitestar	*Ipomoea lacunosa*	N	FPV
Wild poinsettia	*Euphorbia heterophylla*	N	FA
Wild tantan	*Desmanthus virgatus*	N	FP
Willowleaf aster	*Symphyotrichum praealtum*	N	FP
Winecup	*Callirhoe involucrata*	N	FP
Winter grape	*Vitis cinerea var. helleri*	N	WV
Woodland lettuce	*Lactuca floridana*	N	FA
Wood-sorrel	*Oxalis sp.*	E	FP
Woolly rose-mallow	*Hibiscus lasiocarpos*	N	FP
Yaupon holly	*Ilex vomitoria*	N	S
Yellow bells	*Tecoma stans*	N-I	S
Yellow bitterweed	*Helenium amarum var. amarum*	N	FP
Yellow bluestem	*Bothriochloa ischaemum var. songarica*	E	GP
Yellow flag iris	*Iris pseudacorus*	E	FP
Yucca	*Yucca spp.*	E	S
Zizotes milkweed	*Asclepias oenotheroides*	N	FP

tion following the restoration work and management changes recommended in the following chapters.

Tree Care and Safety

Arborist Don Gardner performed an assessment of tree health and risk along trails and other high-use recreation areas in the study area. The complete report, along with digital data points, has been given to the Trail Foundation and PARD. Overall, he found that PARD is doing a better job keeping up with tree maintenance compared to an assessment he completed five years ago over some of the same area. The report identifies 105 trees in need of maintenance, primarily because of large dead branches over the Trail. One tree in need of immediate removal was reported directly to PARD in September 2014 and has since been removed. An additional 19 trees were deemed extreme or high risk and were reported to PARD in December 2014. Many of the trees in need of maintenance or removal are hackberries with Ustulina—a fast-growing root rot—or mistletoe. The report also points out that dense grape vines are putting stress on trees on the edges of many of the natural areas, especially near Deep Eddy Pool, near the boat docks by Austin High, and near the boat launch at Festival Beach. The assessment did not reveal any significant disease or insect pests, but did find that many of the shade trees in mowed areas are in need of pruning and mulching, locations of which are provided in the Natural Area Management Guidelines chapter.

Measuring the Urban Forest

The tree inventory included collecting the following data for all trees 8" or more in diameter in woodlands, 3" or more in mowed areas, and 2" or more for planted trees in mowed areas:

- Tree species
- Tree ID number (corresponding to the tag applied to the tree)
- Diameter at breast height
- Multistemmed (Yes or No)
- Vigor (Good, Fair, Poor, Dead)
- Structure (Good, Fair, Poor, Dead)
- Overhead powerlines (Yes or No)
- Maintenance task (Crown Clean, Inspect, Install Stakes, None, Raise, Reduce, Remove, Remove hardware, Remove Stake, Remove Trunk Guard, or Structural Pruning)
- Maintenance priority
- Further inspection (Yes or No)
- Observations (Dead Wood, Decay, Lean, Poor Architecture, Previous fail-

ure, or Root Problems)

Measuring almost every tree over 8" in diameter at breast height in the natural areas and utilizing a variety of geographic data for the area enabled the evaluation of the canopy cover, size, density, and diversity of the urban forest around Lady Bird Lake, as summarized in Table 2.2. Based on 2014 aerial imagery, the study area has 49% canopy cover as seen in Figure 2.28. Sections of the study area with high canopy cover levels (over 70%) include those in Zilker Park, next to the Boardwalk, near PARD headquarters, and near Austin High. Areas with low canopy levels (below 40%) include all areas east of I-35 and Auditorium Shores. Trail shade, measured as canopy cover over the Trail along with shading from infrastructure such as overpasses, was also looked at as an important variable for Trail users in the natural areas. Overall trail shading along the Trail is 48%. The areas with low and high trail shading correspond with overall canopy with the exception of western parts of Zilker Park, where trail shading declines substantially. The canopy composition is shown in Table 2.3, with bald cypress making up almost a quarter of the canopy and both pecan and live oak each making up over 10%.

The density of trees varies substantially throughout the site and is, of course, densest in the 60 acres (nearly 30% of the site) defined as woodland, shown in Figure 2.22. Woodland, for this report, is defined as areas with continuous or nearly continuous canopy that contain 40 or more surveyed trees per acre along with understory and herbaceous plants. Overall, the mowed areas have an average of 14 trees per acre, whereas the woodlands average 76 trees per acre. The highest densities of trees were seen near Austin High, the Boardwalk, and Zilker

Tree Summary

Area	191* acres
Total trees	6273
Trees/acre	34
Basal area	56 ft^2/acre
Average diameter	16"
Protected tree count	1696
Heritage Tree count	772
Trees/100' of shoreline	5.4
Canopy cover	49%
Shaded trail	48%
Woodland area	60 acres
Trees/acre in woodland	80
Non-woodland area	131 acres
Trees/acre non-woodland	14

Canopy Composition

Bald cypress	22%
Pecan	14%
Live oak	12%
Hackberry	9%
American elm	7%
Black willow	5%
Cottonwood	3%
Box elder	3%
Green ash	3%
Spanish oak	3%
Sycamore	2%
Crepe myrtle	2%
Chinese tallow	2%
Chinaberry	2%
Other	12%

*Table 2.2 (Top): Summary of tree data for study area based on information collected during 2014 tree inventory by Siglo Group. Table 2.3 (Bottom): Approximate canopy composition by species. *Calculated excluding ~10 acres of woodland that were not included in the tree inventory and for which other data were not available.*

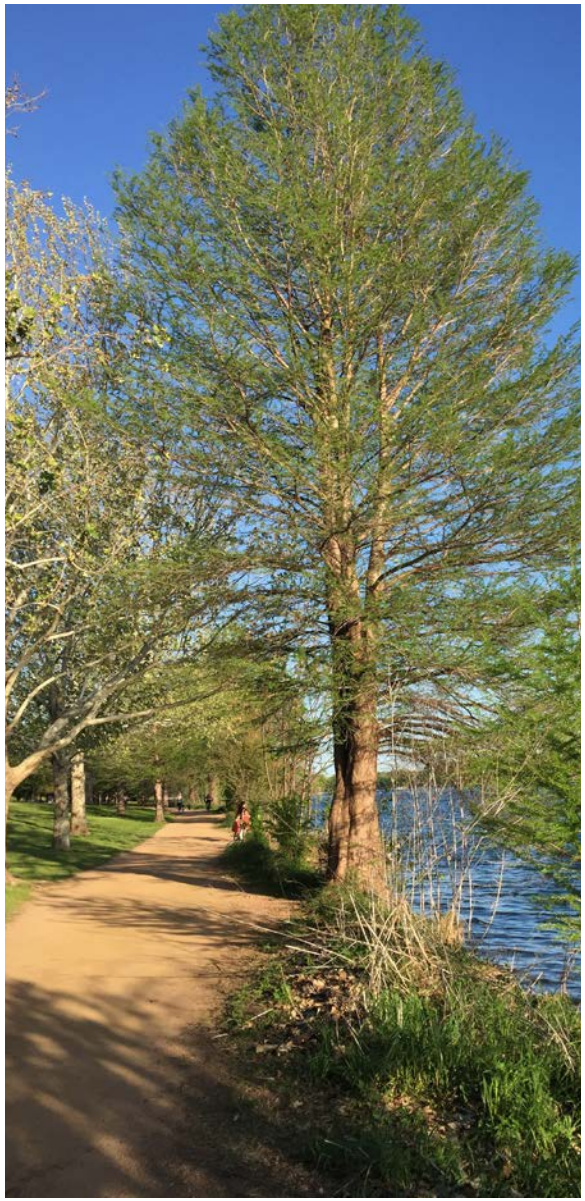


Figure 2.27: Bald cypress makes up over 20% of the canopy cover in the study area. The majestic trees are one of the defining characteristics of the shoreline of Lady Bird Lake.

Park. Areas with the lowest densities of trees include all areas east of I-35 and Auditorium Shores.

Shoreline trees are considered an integral part of the study area for aesthetic and ecological purposes. They perform the critical role of stabilizing the shoreline and create the aesthetic of a tree-lined Lake. For this report, trees within 4 ft of the shore, over 8" diameter breast height, and considered to play a role in shoreline stabilization are designated as shoreline trees. The entire site averages 5.3 trees per 100 ft of shoreline (approximately one tree every 20 ft) with a great deal of variation from area to area. Areas with over 7 trees per 100 ft include the areas near Austin High, the Boardwalk, and the western parts of Zilker Park. Areas with fewer than 4 trees per 100 ft include Festival Beach, areas just east of Congress on the northern shore, the Southeast Shore, and Auditorium Shores.

Within the site there are 1,696 protected trees (over 19" diameter at breast height), including 772 heritage trees (over 24" diameter at breast height of certain species), as defined by the City of Austin. Some of the largest trees in the study area are found along the shoreline of Zilker Park, parallel to Ceasar Chavez west of downtown, and in the lawn areas

Figure 2.28: Canopy covers 49% of the study area and 48% of the Trail is in shade. Sources: COA, NAIP.

of Festival Beach and the Southeast Shore. Areas with the fewest protected trees are Deep Eddy, the north shore near Congress Avenue, and Auditorium Shores. The three largest trees in the study area are bald cypresses found on the shoreline at Zilker Park with diameters of 100, 92, and 91" at breast height. To put this in perspective, of the over 40,000 trees inventoried by the City, only two have diameters over 90" at breast height, not including the 3 mentioned above (Halter 2015).

These numbers, the historic wooded condition of the site, and the vast amount of area currently managed as lawn in the study area suggest that there is ample opportunity to expand the existing woodlands and have a more equitable distribution of shade and canopy throughout the study area.

BIRDS, WILDLIFE, & HABITAT

The natural areas around Lady Bird Lake provide an important refuge for wildlife within the City and connect riparian corridors as well as numerous protected areas up- and downstream. Wildlife comes to the site for food, water, and shelter provided by the Lake and the surrounding natural areas. The natural areas serve both resident wildlife and numerous migratory birds and butterflies.

Wildlife encounters are part of what draws people to the Lake and natural areas. People enjoy watch-

ing American Coots bobbing along the water with their white bills contrasting against their black bodies, seeing awkward assemblies of red-eared slider turtles aligned on branches, watching a Great Blue Heron wade gracefully through shallow waters (as seen in Figure 2.29), or watching flocks of cormorants disappearing under the water only to emerge again and take flight just inches from the water's surface. One of the most popular attractions in Austin is the Mexican free-tailed bat population that makes its summer residence under the Congress Avenue Bridge. The nightly emergence of the largest urban bat colony in North America forms a cloud of small flying mammals that is watched by hundreds of onlookers every night.

The list of species found at the site is impressive and includes a wide variety of birds, fish, mammals, reptiles, amphibians, and invertebrates. Table 2.4 lists both likely and confirmed wildlife species for the Lady Bird Lake natural areas. 190 species of bird have been reported on eBird within 500 feet of the study area. An additional 42 bird species have been seen in nearby areas and are listed as "likely" in Table 2.4. Other records show at least 24 species of mammal, 11 amphibians, and 45 reptiles that are found in or just outside the study area. There are 36 species of fish known to inhabit the Lake (Farooqi and De Jesus 2011, De Jesus 2015, Labay 2015, and Linam 2015). Numerous invertebrates in various life stages are also found at the Lake, with some of the showiest being the dragonflies. Data from City of Austin, as well as Odonates of Texas and other sources, show 121 genera of invertebrates that have been identified in the study area.

Figure 2.29: A Great Blue Heron wades near the Boardwalk.

The City supports the enhancement, conservation, and creation of wildlife habitat through its Wildlife Austin Program, and the city became a certified Community Wildlife Habitat through the National Wildlife Federation in 2009. As part of National Wildlife Week 2015, the National Wildlife Federation named Austin the number one city for wildlife in the country (Miles 2015). NWF's reasons for bestowing the award on Austin included: the City's efforts to enhance wildlife habitat, the Mexican free-tailed bat population at the Congress Avenue Bridge, and the location of Austin within the migratory paths of numerous birds and monarch butterflies.

While there is a great deal of diversity and abundance in the study area, drawn by food, water, and shelter, the majority of the animals listed and ones not currently found at the site rely on intact plant

Bird Species

Common Name	Scientific Name	Confirmed
Acadian Flycatcher	*Empidonax virescens*	x
Alder Flycatcher	*Empidonax alnorum*	
American Bittern	*Botaurus lentiginosus*	x
American Coot	*Fulica americana*	x
American Crow	*Corvus brachyrhynchos*	x
American Goldfinch	*Carduelis tristis*	x
American Kestrel	*Falco sparverius*	x
American Redstart	*Setophaga ruticilla*	x
American Robin	*Turdus migratorius*	x
American White Pelican	*Pelecanus erythrorhynchos*	x
American Wigeon	*Anas americana*	x
Anhinga	*Anhinga anhinga*	x
Ash-throated Flycatcher	*Myiarchus cinerascens*	x
Baird's Sandpiper	*Calidris bairdii*	x
Baltimore Oriole	*Icterus galbula*	x
Bank Swallow	*Riparia riparia*	x
Barn Swallow	*Hirundo rustica*	x
Barred Owl	*Strix varia*	x
Bay-breasted Warbler	*Dendroica castanea*	
Bell's Vireo	*Vireo bellii*	
Belted Kingfisher	*Ceryle alcyon*	x
Bewick's Wren	*Thyromanes bewickii*	x
Black Vulture	*Coragyps atratus*	x
Black-and-white Warbler	*Mniotilta varia*	x
Black-bellied Whistling-Duck	*Dendrocygna autumnalis*	x
Black-billed Cuckoo	*Coccyzus erythrophthalmus*	
Blackburnian Warbler	*Dendroica fusca*	
Black-capped Vireo	*Vireo atricapilla*	x
Black-chinned Hummingbird	*Archilochus alexandri*	x
Black-crested Titmouse	*Titmouse Parus atricristatus*	x
Black-crowned Night-heron	*Nycticorax nycticorax*	x
Black-throated Green Warbler	*Dendroica virens*	
Blue Grosbeak	*Guiraca caerulea*	x
Blue Jay	*Cyanocitta cristata*	x
Blue-gray Gnatcatcher	*Polioptila caerulea*	x
Blue-headed Vireo	*Vireo solitarius*	x

Table 2.4a: Likely and confirmed bird species at Lady Bird Lake. Sources: eBird, Brackenridge Field Lab.

Common Name	Scientific Name	Confirmed
Blue-winged Teal	*Anas discors*	x
Bonaparte's Gull	*Chroicocephalus philadelphia*	x
Brewer's Blackbird	*Euphagus cyanocephalus*	x
Broad-winged Hawk	*Buteo platypterus*	x
Bronzed Cowbird	*Molothrus aeneus*	x
Brown Creeper	*Certhia americana*	x
Brown Thrasher	*Toxostoma rufum*	
Brown-headed Cowbird	*Molothrus ater*	x
Bufflehead	*Bucephala albeola*	x
Canada Warbler	*Wilsonia canadensis*	
Canvasback	*Aythya valisineria*	x
Canyon Towhee	*Melozone fusca*	x
Canyon Wren	*Catherpes mexicana*	x
Carolina Chickadee	*Parus carolinensis*	x
Carolina Wren	*Thyrothorus ludovicianus*	x
Cattle Egret	*Bubulcus ibis*	x
Cave Swallow	*Petrochelidon fulva*	x
Cedar Waxwing	*Bombycilla cedrorum*	x
Cerulean Warbler	*Setophaga cerulea*	
Chestnut-sided Warbler	*Setophaga pensylvanica*	
Chimney Swift	*Chaetura pelagica*	x
Chipping Sparrow	*Spizella passerina*	x
Chuck-wills-widow	*Caprimulgus carolinensis*	x
Cinnamon Teal	*Anas cyanoptera*	x
Clay-colored Sparrow	*Spizella pallida*	x
Cliff Swallow	*Petrochelidon pyrrhonota*	x
Common Grackle	*Quiscalus quiscala*	x
Common Loon	*Gavia immer*	x
Common Nighthawk	*Chordeiles minor*	x
Common Raven	*Coruvs corax*	
Common Snipe	*Gallinago gallinago*	
Common Yellowthroat	*Geothlypis trichas*	x
Cooper's Hawk	*Accipiter cooperii*	x
Couch's Kingbird	*Tyrannus couchii*	x
Crested Caracara	*Caracara cheriway*	x
Dark-eyed Junco	*Junco hyemalis*	x
Dickcissel	*Spiza americana*	x
Double-crested Cormorant	*Phalacrocorax auritus*	x
Downy Woodpecker	*Picoides pubescens*	x
Eared Grebe	*Podiceps nigricollis*	x
Eastern Bluebird	*Sialia sialis*	x
Eastern Kingbird	*Tyrannus tyrannus*	x
Eastern Meadowlark	*Sturnella magna*	x
Eastern Phoebe	*Sayornis phoebe*	x
Eastern Screech-Owl	*Megascops asio*	x
Eastern Towhee	*Pipilo erythrophthalmus*	x
Eastern Wood-Pewee	*Contopus virens*	x
Eurasian Collared-Dove	*Streptopelia decaocto*	x
European Starling	*Sturnus vulgaris*	x
Field Sparrow	*Spizella pusilla*	x
Forster's Tern	*Sterna forsteri*	x
Fox Sparrow	*Passerella iliaca*	x
Franklin's Gull	*Larus pipixcan*	
Gadwall	*Anas strepera*	x
Golden-cheeked Warbler	*Setophaga chrysoparia*	x
Golden-crowned Kinglet	*Regulus satrapa*	x
Golden-fronted Woodpecker	*Melanerpes aurifrons*	x
Golden-winged Warbler	*Vermivora chrysoptera*	
Grasshopper Sparrow	*Ammodramus savannarum*	
Gray Catbird	*Dumetella carolinensis*	x
Great Blue Heron	*Ardea herodia*	x
Great Crested Flycatcher	*Myiarchus crinitus*	x
Great Egret	*Casmerodius albus*	x
Great Horned Owl	*Bubo virginianus*	
Greater Scaup	*Aythya marila*	x
Greater Yellowlegs	*Tringa melanoleuca*	x
Great-tailed Grackle	*Quiscalus maxicanus*	x
Green Heron	*Butorides virescens*	x
Green Kingfisher	*Chloroceryle americana*	x
Green-winged Teal	*Anas crecca*	x
Harris's Sparrow	*Zonotrichia querula*	x
Hermit Thrush	*Catharus guttatus*	x
Herring Gull	*Larus argentatus*	x
Hooded Warbler	*Wilsonia citrina*	
House Finch	*Carpodacus mexicanus*	x
House Sparrow	*Passer domesticus*	x
House Wren	*Troglodytes aedon*	x
Inca Dove	*Columbina inca*	x
Indigo Bunting	*Passerina cyanea*	
Kentucky Warbler	*Oporornis formosus*	
Killdeer	*Charadrius vociferus*	x
Ladder-backed Woodpecker	*Dryobates scalaris*	x
Lark Sparrow	*Chondestes grammacus*	x
Least Flycatcher	*Empidonax minimus*	
Least Grebe	*Tachybaptus dominicus*	x
Least Sandpiper	*Calidris minutilla*	x
Lesser Goldfinch	*Spinus psaltria*	x
Lesser Scaup	*Aythya affinis*	x
Lesser Yellowlegs	*Tringa flavipes*	x
Lincoln's Sparrow	*Melospiza lincolnii*	x
Little Blue Heron	*Egretta caerulea*	x
Loggerhead Shrike	*Lanius ludovicianus*	x
Long-tailed Duck	*Clangula hyemalis*	x
Louisiana Waterthrush	*Parkesia motacilla*	
MacGillivray's Warbler	*Oporornis tolmiei*	
Magnolia Warbler	*Dendroica magnolia*	x
Mallard	*Anas platyrhynchos*	x
Marsh Wren	*Cistothorus palustris*	
Merlin	*Falco columbarius*	x
Mississippi Kite	*Ictinia mississippiensis*	x
Monk Parakeet	*Myiopsitta monachus*	x
Mourning Dove	*Zenaida macroura*	x
Mourning Warbler	*Oporornis philadelphia*	x
Mute Swan	*Cygnus olor*	x
Nashville Warbler	*Vermivora ruficapilla*	x
Neotropic Cormorant	*Phalacrocorax brasilianus*	x
Northern Bobwhite	*Colinus virginianus*	x
Northern Cardinal	*Cardinalis cardinalis*	x
Northern Flicker	*Colaptes auratus*	x
Northern Harrier	*Circus cyaneus*	x

Bird Species (*continued*)

Common Name	Scientific Name	Confirmed
Northern Mockingbird	*Mimus polyglottos*	x
Northern Oriole	*Icterus galbula*	
Northern Parula	*Parula americana*	
Northern Pintail	*Anas acuta*	x
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	x
Northern Shoveler	*Anas clypeata*	x
Northern Waterthrush	*Seiurus noveboracensis*	
Olive-sided Flycatcher	*Contopus borealis*	
Orange-crowned Warbler	*Vermivora celata*	x
Orchard Oriole	*Icterus spurius*	x
Osprey	*Pandion haliaetus*	x
Ovenbird	*Seiurus aurocapillus*	
Painted Bunting	*Passerina ciris*	x
Palm Warbler	*Setophaga palmarum*	
Pectoral Sandpiper	*Calidris melanotos*	x
Peregrine Falcon	*Falco peregrinus*	x
Philadelphia Vireo	*Vireo philadelphicus*	
Pied-billed Grebe	*Podilymbus podiceps*	x
Pine Siskin	*Carduelis pinus*	
Pine Warbler	*Setophaga pinus*	x
Purple Martin	*Progne subis*	x
Red-bellied Woodpecker	*Melanerpes carolinus*	x
Reddish Egret	*Egretta rufescens*	x
Red-eyed Vireo	*Vireo olivaceus*	x
Redhead	*Aythya americana*	x
Red-necked Grebe	*Podiceps grisegena*	x
Red-shouldered Hawk	*Buteo lineatus*	x
Red-tailed Hawk	*Buteo jamaicensis*	x
Red-winged Blackbird	*Agelaius phoeniceus*	x
Ring-billed Gull	*Larus delawarensis*	x
Ringed Kingfisher	*Megaceryle torquata*	x
Ring-necked Duck	*Aythya collaris*	x
Rock Pigeon	*Columba livia*	x
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	
Ruby-crowned Kinglet	*Regulus calendula*	x
Ruby-throated Hummingbird	*Archilochus colubris*	x
Ruddy Duck	*Oxyura jamaicensis*	x
Rufous-crowned Sparrow	*Aimophila ruficeps*	x
Sandhill Crane	*Grus canadensis*	x
Savannah Sparrow	*Passerculus sandwichensis*	x
Scarlet Tanager	*Piranga olivacea*	x
Scissor-tailed Flycatcher	*Tyrannus fortificata*	x
Sharp-shinned Hawk	*Accipiter striatus*	x
Short-billed Dowitcher	*Limnodromus griseus*	x
Snow Goose	*Chen caerulescens*	x
Snowy Egret	*Egretta thula*	x
Solitary Vireo	*Vireo solitarius*	
Song Sparrow	*Melospiza melodia*	x
Sora	*Porzana carolina*	x
Spotted Sandpiper	*Actitis macularia*	x
Spotted Towhee	*Pipilo erythrophthalmus*	x
Stilt Sandpiper	*Calidris himantopus*	x
Summer Tanager	*Piranga rubra*	x
Swainson's Hawk	*Buteo swainsoni*	x
Swainson's Thrush	*Catharus ustulatus*	x
Swamp Sparrow	*Melospiza georgiana*	
Tennessee Warbler	*Vermivora peregrina*	x
Tree swallow	*Tachycineta bicolor*	x
Turkey Vulture	*Cathartes aura*	x
Upland Sandpiper	*Bartramia longicauda*	
Veery	*Catharus fuscescens*	
Vesper Sparrow	*Pooecetes gramineus*	
Warbling Vireo	*Vireo gilvus*	
Western Kingbird	*Tyrannus verticalis*	x
Western Scrub-Jay	*Aphelocoma californica*	x
White-crowned Sparrow	*Zonotrichia leucophrys*	x
White-eyed Vireo	*Vireo griseus*	x
White-rumped Sandpiper	*Calidris fuscicollis*	x
White-throated Sparrow	*Zonotrichia albicollis*	x
White-winged Dove	*Zenaida asiatica*	x
White-winged Scoter	*Melanitta fusca*	x
Wild Turkey	*Meleagris gallopavo*	
Willow Flycatcher	*Empidonax traillii*	
Wilson's Phalarope	*Phalaropus tricolor*	x
Wilson's Warbler	*Wilsonia pusilla*	x
Winter Wren	*Troglodytes troglodytes*	x
Wood Duck	*Aix sponsa*	x
Worm-eating Warbler	*Helmitheros vermivorus*	
Yellow Warbler	*Dendroica petechia*	x
Yellow-bellied Flycatcher	*Empidonax flaviventris*	
Yellow-bellied Sapsucker	*Sphyrapicus varius*	x
Yellow-billed Cuckoo	*Coccyzus americanus*	x
Yellow-breasted Chat	*Icteria virens*	x
Yellow-crowned Night-Heron	*Nyctanassa violacea*	x
Yellow-rumped Warbler	*Dendroica coronata*	x
Yellow-throated Vireo	*Vireo flavifrons*	x

Reptile Species

Common Name	Scientific Name	Confirmed
Black-necked Gartersnake	*Thamnophis cyrtopsis*	
Blotched Watersnake	*Nerodia erythrogaster*	
Broad-banded Watersnake	*Nerodia fasciata*	
Checkered Garter Snake	*Thamnophis marcianus*	
Common Five-lined Skink	*Plestiodon fasciatus*	
Common Spotted Whiptail	*Aspidoscelis gularis*	
Diamondback Watersnake	*Nerodia rhombifer*	x
Eastern Box Turtle	*Terrapene carolina*	
Eastern Hog-nosed Snake	*Heterodon platirhinos*	
Eastern Spiny Softshell	*Apalone spinifera*	
Flat-headed Snake	*Tantilla gracilis*	
Four-lined Skink	*Plestiodon tetragrammus*	
Green Anole	*Anolis carolinensis*	
Groundsnake	*Sonora semiannulata*	
Little Brown Skink	*Scincella lateralis*	
Mediterranean House Gecko	*Hemidactylus turcicus*	
Ornate Box Turtle	*Terrapene ornate*	
Prairie Lizard	*Sceloporus consobrinus*	
Red-eared Slider	*Trachemys scripta*	x
Rough Earthsnake	*Virginia striatula*	
Rough Green Snake	*Opheodrys aestivus*	
Short-lined Skink	*Eumeces brevilineatus*	
Six-lined Racerunner	*Cnemidophorus sexlineatus*	
Slender Glass Lizard	*Ophisaurus attenuatus*	
Snapping Turtle	*Chelydra serpentina*	x
Sonora Kingsnake	*Lampropeltis getula*	
Stinkpot	*Sternotherus odoratus*	
Texas Alligator Lizard	*Gerrhonotus infernalis*	
Texas Blind Snake	*Rena dulcis*	
Texas Brown Snake	*Storeria dekayi*	
Texas Cooter	*Pseudemys texana*	
Texas Coral Snake	*Micrurus tener*	
Texas Map Turtle	*Graptemys versa*	x
Texas Patch-nosed Snake	*Salvadora grahamiae*	
Texas Rat Snake	*Pantherophis obsoletus*	
Texas Slider	*Chrysemys concinna*	
Texas Spiny Lizard	*Sceloporus olivaceus*	
Texas Threadsnake	*Leptotyphlops dulcis*	
Texas Tortoise	*Gopherus berlandieri*	
Three-toed Box Turtle	*Terrapene carolina triunguis*	
Western Cottonmouth	*Agkistrodon piscivorus*	
Western Diamonback Rattlesnake	*Crotalus atrox*	
Western Ribbon Snake	*Thamnophis proximus*	
Yellow Mud Turtle	*Kinosternon flavescens*	
Yellow-bellied Racer	*Coluber constrictor*	

Table 2.4b (Above): Likely and confirmed reptile species at Lady Bird Lake. Sources: Brackenridge Field Lab and Travis LaDuc. Table 2.4c (Below): Confirmed fish species at Lady Bird Lake. Sources: TPWD, Fishes of Texas website.

Fish Species

Common Name	Scientific Name
American eel	*Anguilla rostrata*
Blackstripe topminnow	*Fundulus notatus*
Blacktail shiner	*Cyprinella venusta*
Blue catfish	*Ictalurus furcatus*
Blue Tilapia	*Oreochromis aureus*
Bluegill	*Lepomis macrochirus*
Bullhead minnow	*Pimephales vigilax*
Central stoneroller	*Campostoma anomalum*
Channel catfish	*Ictalurus punctatus*
Common carp	*Cyprinus carpio*
Dusky darter	*Percina sciera*
Fathead minnow	*Pimephales promelas*
Flathead catfish	*Pylodictis olivaris*
Freshwater drum	*Aplodinotus grunniens*
Gizzard shad	*Dorosoma cepedianum*
Golden redhorse	*Moxostoma erythrurum*
Golden shiner	*Notemigonus crysoleucas*
Goldfish	*Carassius auratus*
Gray redhorse	*Moxostoma congestum*
Green sunfish	*Lepomis cyanellus*
Guadalupe bass	*Micropterus treculii*
Inland silverside	*Menidia beryllina*
Largemouth bass	*Micropterus salmoides*
Logperch	*Percina caprodes*
Longear sunfish	*Lepomis megalotis*
Longnose gar	*Lepisosteus osseus*
Mexican tetra	*Astyanax mexicanus*
Mosquitofish	*Gambusia affinis*
Northern pike	*Esox lucius*
Orangethroat darter	*Etheostoma spectabile*
Redbreast sunfish	*Lepomis auritus*
Redear sunfish	*Lepomis microlophus*
Redspotted sunfish	*Lepomis miniatus*
Rio Grande cichlid	*Herichthys cyanoguttatus*
River carpsucker	*Carpiodes carpio*
Smallmouth bass	*Micropterus dolomieu*
Smallmouth buffalo	*Ictiobus bubalus*
Spotted gar	*Lepisosteus oculatus*
Striped bass	*Morone saxatilis*
Suckermouth catfish	*Hypostomus plecostomus*
Texas logperch	*Percina carbonaria*
Triploid grass carp	*Ctenopharyngodon idella*
Warmouth	*Lepomis gulosus*
White bass	*Morone chrysops*
White crappie	*Pomoxis annularis*
Yellow bullhead	*Ameiurus natalis*

Macroinvertebrates

Table 2.4d: Confirmed families and genera of macroinvertebrates at Lady Bird Lake, arranged by order. Sources: COA.

Amphipoda	
Gammaridae	*Gammarus*
Hyalellidae	*Hyalella*
Basommatophora	
Ancylidae	*Ferrissia*
Lymnaeidae	*Fossaria*
Physidae	*Physa*
Pisidiidae	*Sphaerium*
Planorbidae	*Gyraulus*
Planorbidae	*Helisoma*
Planorbidae	*Helisoma*
Cladocera	
Daphniidae	*Ceriodaphnia*
Daphniidae	*Daphnia*
Coleoptera	
Dryopidae	*Helichus*
Dytiscidae	*Agabus*
Dytiscidae	*Anodocheilus*
Dytiscidae	*Berosus*
Dytiscidae	*Celina*
Dytiscidae	*Laccophilus*
Dytiscidae	*Liodessus*
Dytiscidae	*Neoporus*
Dytiscidae	*Uvarus*
Elmidae	*Dubiraphia*
Elmidae	*Hexacylloepus*
Elmidae	*Neolmis*
Elmidae	*Stenelmis*
Haliplidae	*Peltodytes*
Hydrochidae	*Hydrochus*
Hydrophilidae	*Enochrus*
Hydrophilidae	*Tropisternus*
Scirtidae	*Scirtes*
Decapoda	
Cambaridae	*Procambarus*
Palaemonidae	*Palaemonetes*
Diplostraca	
Chydoridae	*Eurycercus*
Sididae	*Sida*
Diptera	
Ceratopognidae	*Bezzia*
Ceratopognidae	*Ceratopogon*
Ceratopognidae	*Culicoides*
Ceratopognidae	*Dasyhelea*
Ceratopognidae	*Probezzia*
Ceratopognidae	*Serromyia*
Chironomidae	*Chironominae*
Chironomidae	*Orthocladiinae*
Chironomidae	*Tanypodinae*
Chironomidae	*Tanytarsini*
Chironomidae	*Xestochironomus*
Culicidae	*Aedes*
Ephydridae	
Stratiomyidae	*Caloparyphus*
Ephemeroptera	
Baetidae	*Apobaetis*
Baetidae	*Callibaetis*
Baetidae	*Camelobaetidius*
Baetidae	*Centroptilum*
Baetidae	*Fallceon*
Caenidae	*Caenis*
Ephemeridae	*Hexagenia*
Heptageniidae	*Stenacron*
Heptageniidae	*Stenonema*
Leptohyphidae	*Tricorythodes*
Leptophlebiidae	*Thraulodes*
Hemiptera	
Belostomatidae	*Belostoma*
Corixidae	*Trichocorixa*
Gerridae	*Metrobates*
Gerridae	*Rheumatobates*
Gerridae	*Trepobates*
Mesoveliidae	*Mesovelia*
Hemiptera (continued)	
Naucoridae	*Pelocoris*
Nepidae	*Ranatra*
Pleidae	*Neoplea*
Veliidae	*Macrovelia*
Veliidae	*Microvelia*
Isopoda	
Asellidae	*Caecidota*
Megaloptera	
Sialidae	*Sialis*
Neotaeniglossa	
Hydrobiidae	*Cincinnatia*
Pleuroceridae	*Elimia*
Thiaridae	*Melanoides*
Odonata	
Aeshnidae	*Anax*
Aeshnidae	*Boyeria*
Aeshnidae	*Nasiaeschna*
Coenagrionidae	*Argia*
Coenagrionidae	*Enallagma*
Coenagrionidae	*Ischnura*
Corduliidae	*Epitheca*
Corduliidae	*Macromia*
Gomphidae	*Aphylla*
Lestidae	*Lestes*
Libellulidae	*Brachymesia*
Libellulidae	*Brechmorhoga*
Libellulidae	*Dythemis*
Libellulidae	*Dythemis*
Libellulidae	*Erythemis*
Libellulidae	*Libellula*
Libellulidae	*Pachydiplax*
Libellulidae	*Pantala*
Libellulidae	*Perithemis*
Libellulidae	*Plathemis*
Libellulidae	*Tramea*
Trichoptera	
Helicopsychidae	*Helicopsyche*
Hydropsychidae	*Cheumatopsyche*
Hydropsychidae	*Nectopsyche*
Hydroptilidae	*Hydroptila*
Hydroptilidae	*Orthotrichia*
Hydroptilidae	*Oxyethira*
Leptoceridae	*Oecetis*
Leptoceridae	*Triaenodes*
Philopotamidae	*Chimarra*
Polycentropoidae	*Cernotina*
Polycentropoidae	*Polycentropus*
Tricladida	
Planariidae	*Dugesia*
Unionoida	
Unionidae	*Amblema*
Unionidae	*Anodonta*
Unionidae	*Arcidens*
Unionidae	*Cyrtonaias*
Unionidae	*Lampsilis*
Unionidae	*Leptodea*
Unionidae	*Potamilus*
Unionidae	*Pyganodon*
Unionidae	*Quadrula*
Unionidae	*Tritogonia*
Unionidae	*Utterbackia*
Veneroida	
Corbiculidae	*Corbicula*
Sphaeriidae	*Musculium*
Sphaeriidae	*Pisidium*

Mammal Species

Common Name	Scientific Name	Confirmed
American Beaver	*Castor canadensis*	
Bobcat	*Lynx rufus*	
Cave Myotis (Cave Bat)	*Myotis velifer*	
Common Gray Fox	*Urocyon cinereoargenteus*	
Common Porcupine	*Erethizon dorsatum*	
Common Raccoon	*Procyon lotor*	x
Coyote	*Canis latrans*	
Deer Mice	*Peromyscus*	
Domestic Cat*	*Felis domesticus*	x
Eastern Cottontail	*Sylvilagus floridanus*	
Eastern Wood Rat	*Neotoma floridana*	
Fox Squirrel	*Sciurus niger*	x
Hispid Cotton Rat	*Sigmodon hispidus*	
House Mouse	*Mus musculus*	
Mexican Free-tailed Bat	*Tadarida brasiliensis*	x
Nine-banded Armadillo	*Dasypus novemcinctus*	
Nutria*	*Myocastor coypus*	x
Red Fox	*Vulpes vulpes*	
Rock Squirrel	*Spermophilus variegates*	
Striped Skunk	*Mephistes mephistes*	
Swamp Rabbit	*Sylvilagus aquaticus*	
Virginia Opossum	*Didelphis virginiana*	x
White-tailed Deer	*Odocoileus virginianus*	

Amphibian Species

Common Name	Scientific Name	Confirmed
American Bullfrog	*Lithobates catesbeianus*	
Blanchard's Cricket Frog	*Acris blanchardi*	
Cliff Chirping Frog	*Eleutherodactylus marnockii*	
Cricket Frog	*Acris crepitans*	
Gray Tree Frog	*Hyla versicolor*	
Green Tree Frog	*Hyla cinerea*	
Gulf Coast Toad	*Incilius nebulifer*	
Hurter's Spadefoot Toad	*Scaphiopus hurteri*	
Red-spotted Toad*	*Anaxyrus punctatus*	
Rio Grande Leopard Frog	*Lithobates berlandieri*	
Western Slimy Salamander	*Plethodon albagula*	

*Table 2.4e (Left, top): Likely and confirmed mammal species at Lady Bird Lake. Sources: Brackenridge Field Lab. Table 2.4f (Left, bottom): Likely and confirmed amphibians species at Lady Bird Lake. Sources: Brackenridge Field Lab. *Introduced species*

communities. Improvements in the urban forest and the quality of habitat will increase the number and types of species found at the site.

SIGNIFICANT ENVIRONMENTAL FEATURES

The natural areas surrounding Lady Bird Lake contain numerous significant environmental features, including uncommon plants and habitats, features covered by specific regulations, features of exemplary quality, and areas with the potential for restoration. These areas were documented through field observation and geographic analysis. Features documented include:

Gaddy Soils

Just over 25% of the study area is classified as Gaddy soils. The savanna plant community that would naturally grow within the Gaddy soils is not currently represented within any protected lands in Travis County. Even without restoration, one area with Gaddy soils is currently home to the only occurrence of burrobrush (Hymenoclea monogyra) recorded in Travis County since 1937.

Austin Chalk

While it is not rare within the county, the Austin Chalk outcrop just west of I-35 on the south shore is unique within the study area itself and hosts a plant community similar to those characteristic of the Edwards Plateau ecoregion.

Gravel Bars

Although they are not globally or locally uncommon, gravel bars are considered significant environmental features because they are now rare within the study area due to the inundation of the Lake.

Rare and Unique Plants

One globally rare plant, the Correll's false dragonhead (Physostegia correllii) (G2S2), is found within the study area. This wetland-obligate perennial is known to occur in urban ditches and irrigation canals, suggesting it may do well in newly created wetlands around Lady Bird Lake. This plant can be found in the wetland area near the mouth of Blunn Creek. Several plants at the western edge of their range were also found within the study area. Though not rare plants, it is notable to find blackbristle greenbriar (Smilax tamnoides var. hispida) and anglefruit milkvine (Matelea gonocarpos) in this location.

Protected and Heritage Trees

1,696 protected trees, including 772 heritage trees, were found in the site as mentioned earlier in the urban forest section.

Ecological Value

Areas with a combination of high diversity, intact plant communities, and/or good wildlife habitat were recorded.

Features designated as Critical Environmental Features in Title 25, section 8 of the City of Austin Code of Ordinances were also documented through field observation and geographic analysis (COA, Municipal Code § 25.8). The Code of Ordinances requires a buffer of 150 ft around Critical Environmental

Features, within which natural vegetative cover must be retained as much as is practicable and construction, wastewater disposal, and irrigation are prohibited. Hiking trails are allowed within the buffer as long as they are at least 50 ft from the Critical Environmental Feature. Critical Environmental Features found within the study area include:

Bluffs

Defined as areas with vertical change of elevation greater than 40 ft, Bluffs are present west of I-35 on the south shore of the Lake.

Canyon Rimrocks

Canyon Rimrocks, areas with a gradient over 60% for a vertical distance of at least 4 ft and exposed 50 ft horizontally, are found west of I-35 on the south shore of the Lake (Shown in Figure 2.30).

Springs

Two locations where groundwater flows onto land or into a body of water are identified within the study area, both within Zilker Park.

Figure 2.30 (Above): Canyon rimrock next to the Boardwalk. Figure 2.31 (Below): Critical Water Quality Zone extending 100 ft inland from the 429 ft contour line around Lady Bird Lake. Sources: COA, NAIP.

In addition to Critical Environmental Features, the Code designates Critical Water Quality Zones around water ways. For Lady Bird Lake the Critical Water Quality Zone, shown in Figure 2.31, extends 100 horizontal ft inland from the 429 foot contour line in general but 75 horizontal ft where there is single family residential development (COA, Municipal Code § 25.8).

THREATS TO NATURAL AREAS OF LADY BIRD LAKE

Natural areas are dynamic, living systems that change over time. These changes occur with or without active management. Threats are anything causing or with the potential to cause impairment or degradation to the size or condition of a natural area (TNC 2003). We look here at the threats created by invasive species and erosion within the study area as issues that can be addressed by The Trail Foundation and the City of Austin.

Invasive Plant Species

Invasive plants are one of the primary threats to the natural communities surrounding Lady Bird Lake. To maintain and restore ecological function, invasive plants will need to be reduced and, where feasible, removed to allow for thriving native plant communities. Invasive species are those that did not evolve in the ecosystem where they are found and cause economic and/or ecological harm. Their aggressive growth and spread can crowd out and replace native plants and can disrupt natural processes. The impact of invasive species can be very dramatic and ranks second only to direct habitat destruction as the principal threat to rare species globally, with 49% of imperiled species being negatively impacted (Wilcove 1998). The ways invasive plants threaten native communities include:

- Altering soil or water chemistry
- Altering natural processes such as fire and flooding
- Direct displacement through competition ("crowding out" native plants)
- Changing the amount of light in or below the canopy or sub-canopy

Invasive plants also impact native animals and insects by crowding out the native flora they rely on for shelter, protection, and food. A 2006 study in Austin found that sites with intact native plant communities had higher bird species richness and abundance than sites dominated by non-natives (Kalmbach 2006).

Field data were collected for 31 species (or groups of species) listed in Table 2.5

Invasive Plants

Scientific Name	Common Name	COA Ranking	TTF Ranking
Arundo donax	Giant reed	High	High
Colocasia esculenta	Elephant ear	Moderate	High
Koelreuteria paniculata	Golden rain tree	not listed	High
Macfadyena unguis-cati	Catclaw vine	Moderate	High
Melia azedarach	Chinaberry tree	High	High
Sorghum halepense	Johnson grass	High	High
Triadica sebifera	Chinese tallow	Moderate	High
Ulmus parvifolia	Chinese lacebark elm	not listed	High
Ailanthus altissima	Tree of Heaven	Moderate	Moderate
Broussonetia papyfera	Paper mulberry	Moderate	Moderate
Clematis terniflora	Sweet autumn clematis	not listed	Moderate
Cynodon dactylon	Bermuda grass	Moderate	Moderate
Hedera helix	English Ivy	not listed	Moderate
Ligustrum spp.	Ligustrum	High	Moderate
Lonicera japonica	Japanese honeysuckle	Moderate	Moderate
Phyllostachys aurea	Golden bamboo	High	Moderate
Ruellia caerulea	Mexican petunia	not listed	Moderate
Vitex agnus-castus	Common chaste tree	not listed	Moderate
Albizia julibrissin	Mimosa tree	not listed	Low
Alternanthera philoxeroides	Alligator weed	not listed	Low
Eriobotrya japonica	Loquat	not listed	Low
Firmiana simplex	Chinese parasoltree	Moderate	Low
Ipomoea purpurea	Morning glory vine	not listed	Low
Iris pseudacorus	Yellow Iris	not listed	Low
Jasminum mesnyi	Primrose Jasmine	not listed	Low
Nandina domestica	Heavenly bamboo	Moderate	Low
Paspalum urvillei	Vasey grass	not listed	Low
Photinia serratifolia	Chinese photinia	not listed	Low
Pyrus calleryana	Bradford Pear	not listed	Low
Torillis arvensis	Tall sockbane	not listed	Low
Trachelospermum jasminoides	Confederate jasmine	not listed	Low

Table 2.5: Invasive plants found in the study area. COA Ranking is from the Top 24 Invasive Species in Austin list in the City's Invasive Species Management Plan (2012). TTF Ranking is based on apparent threat posed in the study area.

because of their invasive behavior within the study area. Fourteen of these are listed in the Top 24 Invasive Species list in the City of Austin Invasive Species Management Plan. An additional 74 non-native species where found in the study area during the botanical survey but are not currently exhibiting substantial invasive behavior. Over 1,350 data points were taken on invasive species during field work from July to December 2014. Data included:

- Species name
- Patch size: <100ft2, 100-625ft2, 625ft2-0.25acres, or > 0.25acres
- Invasive percent cover (of total vegetation): less than 5%, 5 to 25%, 25 to 50%, 50 to 75%, or 75% or more
- Invasive treatment priority: Immediate response, regular management, or low

While all these species should be watched and treated as needed, further descriptions are given here for 13 species that make up over 60% of the invasive species occurrences recorded on the site. The species include: tree of heaven (*Ailanthus altissima*), giant reed (*Arundo donax*), paper mulberry (*Broussonetia papyfera*), sweet autumn clematis (*Clematis terniflora*), elephant ear (*Colocasia esculenta*), golden rain tree (*Koelreuteria paniculata*), catclaw vine (*Macfadyena unguis-cati*), Chinaberry (*Melia azedarach*), Chinese tallow (*Triadica sebifera*), Chinese lacebark elm (*Ulmus parvifolia*), Ligustrum (*Ligustrum* spp.), Johnsongrass (*Sorghum halepense*), and common chaste tree (*Vitex agnus-castus*). Each one is discussed in more detail below.

Tree of Heaven

Tree of heaven (*Ailanthus altissima*) is a fast-growing tree that produces abundant seeds and can quickly form dense stands, crowding out native vegetation. It is currently found in fewer than 10 locations within the study area and is not yet growing densely in any of those locations (Figure 2.32). It is ranked Moderate by the City of Austin and is also ranked Moderate for the study area because it is likely to spread and become denser if the isolated populations are not controlled.

Giant Reed

Giant reed (*Arundo donax*) is a tall, thick grass that forms nearly-impenetrable monocultures in moist areas. Giant reed is not a new problem within the study area, as can be seen in a photo from 1925 (Figure 2.33). In the study area it is found primarily in gaps within the Shoreline Woodland. It often forms dense patches like the one seen in Figure 2.34. In addition to dense above-ground growth, giant reed has large rhizomes that form a dense mat, making revegetation by native species difficult even when above-ground vegetation has been treated and removed. Many patches have been previously treated, but are now growing back. These areas will receive on-going treatment from the City of Austin Watershed Protection Department. In many treated areas, the rhizome mat is not only preventing revegetation but also causing erosion issues. This species is ranked High both by the City of Austin and within the study area.

Paper Mulberry

Paper mulberry (*Broussonetia papyrifera*) is a small deciduous tree ranked Moderate both by the City of Austin and for the study area. Growing very aggressively, it can quickly form monocultures blocking out native vegetation, as shown in Figure 2.35.

Figure 2.32: Tree of heaven is found in only a few locations in the study area but is capable of forming dense stands.

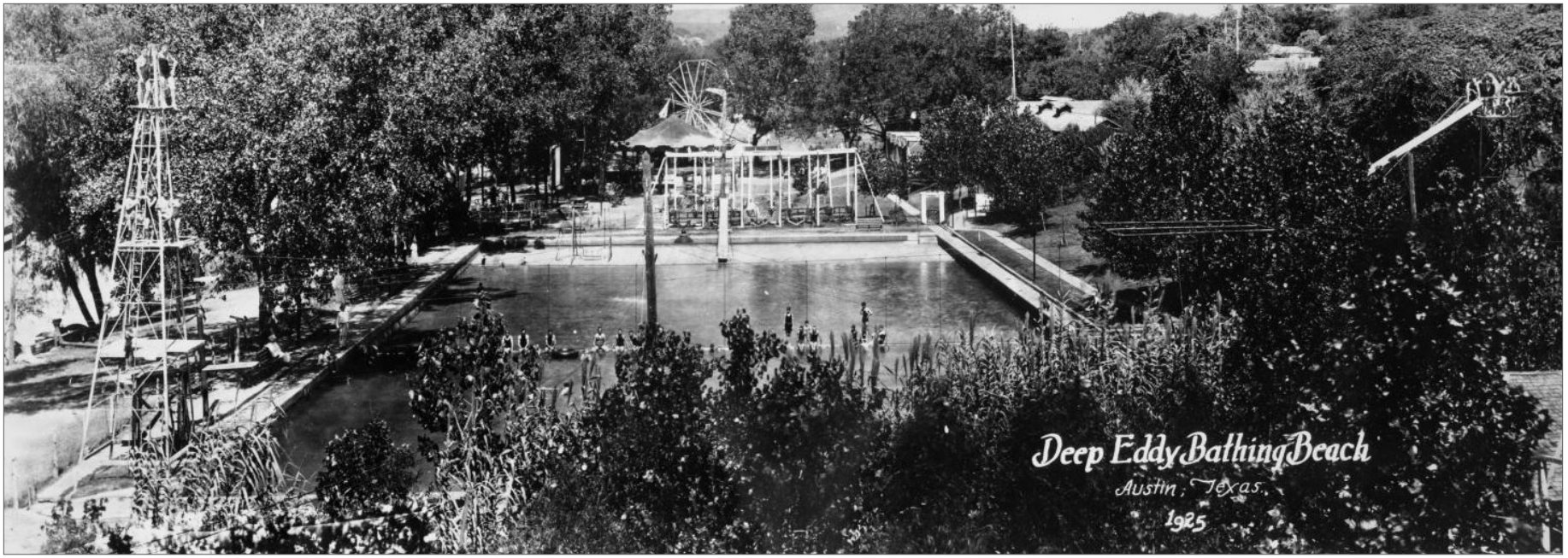


Figure 2.33 (Above): Giant reed can be seen in the foreground of this 1925 photo of Deep Eddy. Source: PTH. Figure 2.34 (Below, left): Giant reed forms dense monocultures along many sections of shoreline in the study area. Figure 2.35 (Below, right): Though not abundant in the study area, paper mulberry is highly problematic at Butler Shores Park.

Though it is only found in 3 locations in the study area, one of the patches—between the fields and the Trail at Butler Shores Park—is extremely dense and extensive, with very little native understory or herbaceous layer below.

Sweet Autumn Clematis

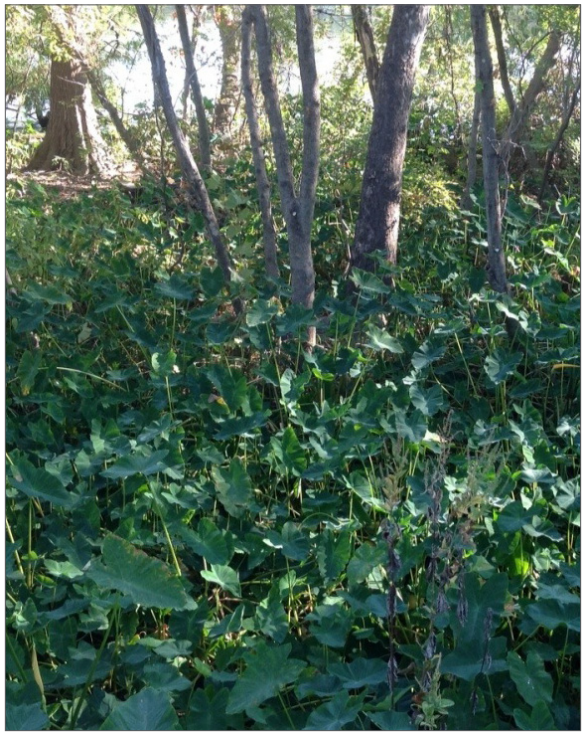
Sweet autumn clematis (*Clematis terniflora*) is a climbing vine that forms dense blankets over trees, shrubs, and other vegetation, blocking vital sunlight from reaching them, as shown in Figure 2.36. Dense patches are common throughout the entire study area. It is not listed as one of Austin's top 24 invasive species, but is ranked Moderate for the study area because it poses a serious threat to the natural areas.

Figure 2.36: Sweet autumn clematis forms a thick blanket over native vegetation.

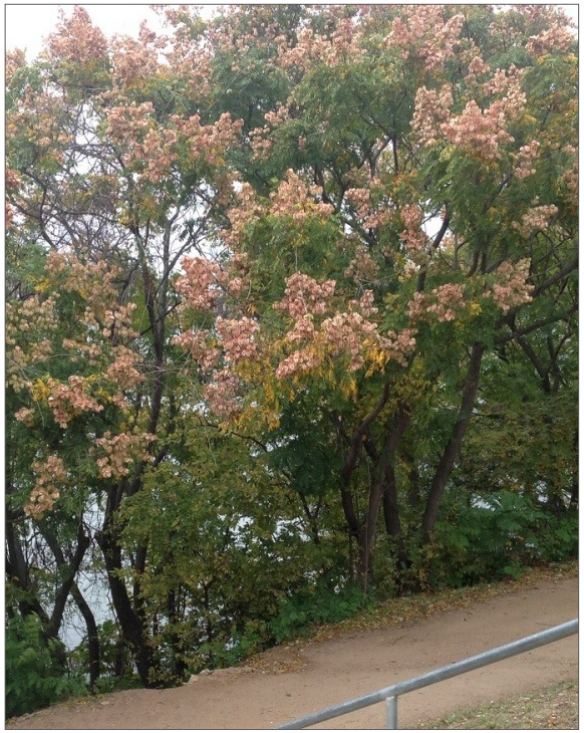
Elephant Ear

Elephant ear (*Colocasia esculenta*) is an aquatic plant present along the shoreline throughout the majority of the study area (Figure 2.37). As seen in Figure 2.38, elephant ear is not a new arrival in the study area. Large, dense monocultures of elephant ear crowd out native aquatic plants in many areas. Other sections of shoreline currently have more scattered, sparse instances of the species. This species is ranked as Moderate by the City of Austin and High for the study area.

Figure 2.37: Elephant ear grows densely on shorelines and low-lying areas.



Figures 2.38 (Above): Elephant ear at Barton Springs Pool in 1925. Source: Jordan Company via PTH.
Figure 2.39 (Below): Golden rain tree forms a near monoculture in the central north shore.



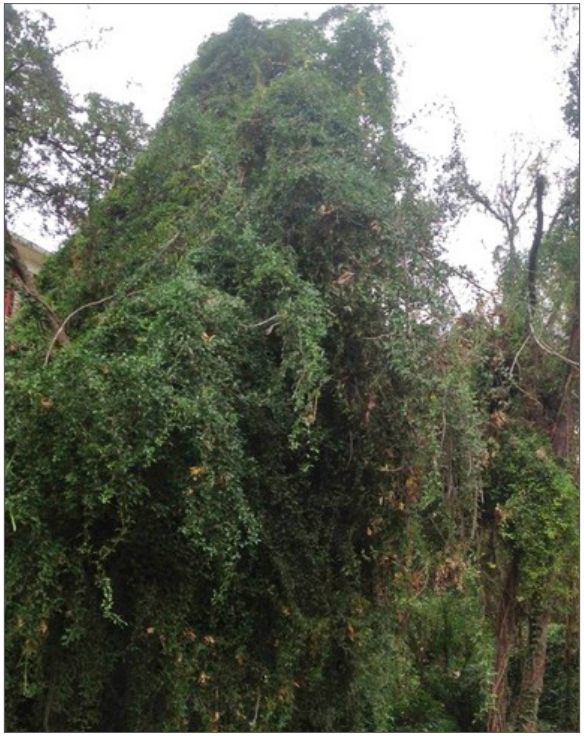
Golden Rain Tree

Golden rain tree (*Koelreuteria paniculata*) has formed a near monoculture along much of the central portion of the northern shore of the Lake, as seen in Figure 2.39. Fortunately, the species is currently primarily found along one stretch of the Trail, but it is highly problematic in that area. Though not included in the Top 24 Invasive Species in Austin list, golden rain tree is ranked High within the study area.

Catclaw Vine

Catclaw vine (*Macfadyena unguis-cati*) is an aggressive evergreen perennial that grows rapidly and can climb and overtop canopy trees, as shown in Figure 2.40. Difficult to control, it grows from underground tubers with vast stores of energy. It is currently found in only 5 parts of the study area, but is growing aggressively in those places. This species is given a Moderate ranking by the City of Austin, but a High ranking for the study area.

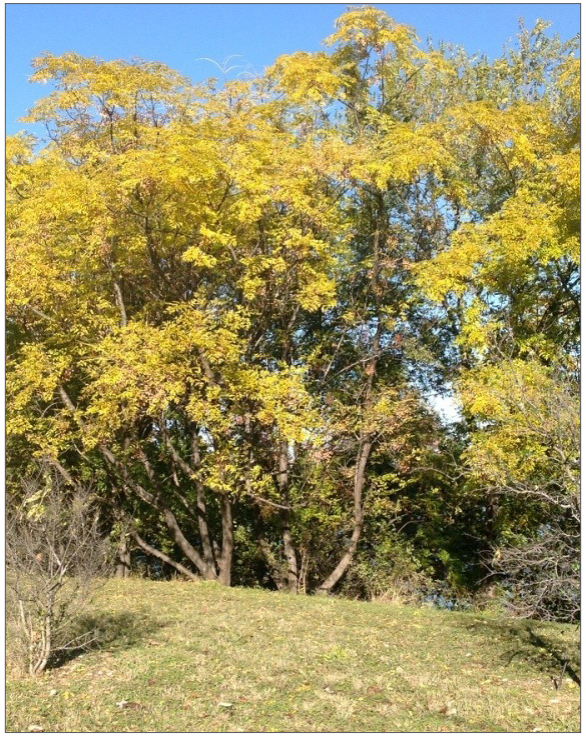
Figure 2.40 Catclaw vine smothers trees and other plants.



Chinaberry

Chinaberry (*Melia azedarach*) is a deciduous tree that can form dense stands and crowd out native vegetation, drastically reducing biodiversity. The tree's leaf litter can also alter soil chemistry, changing conditions for native plants. Chinaberry is common throughout the study area and has formed some dense stands, such as the one on the Southeast Shore shown in Figure 2.41. Both mature and young Chinaberry trees are abundant and could begin to form additional dense stands if left unchecked. This species is ranked High both by the City of Austin and within the study area.

Figure 2.41 : Dense stands of Chinaberry crowd out native plants.



Chinese Tallow

Chinese tallow (*Triadica sebifera*) is another deciduous tree that can form dense stands, crowding out native vegetation. Chinese tallow is common throughout the study area, especially within the Shoreline

Figure 2.42: Chinese tallow can quickly form thick stands.

Woodland. There are dense patches of Chinese tallow in several locations around the Lake, as shown in Figure 2.42. In areas where it is not yet dense, it is often abundant and poses the threat of becoming denser if not controlled. This species is ranked Moderate by the City of Austin, but High for the study area due to its abundance as well as the presence of several dense stands.

Chinese Lacebark Elm

Chinese lacebark elm (Ulmus parvifolia) appears to have been planted in several locations around the Lake, including a recent planting along the Boardwalk near the mouth of Blunn Creek. The species forms a near-monoculture along some sections of the northern shore of the Lake and is also abundant in limited portions of the south shore, as seen in Figure 2.43. These dense stands are less biodiverse than surrounding areas. Chinese lacebark elm is not included in the Top 24 Invasive Species in Austin list, but is ranked High for the study area.

Figure 2.43: Chinese lacebark elm is growing very densely on portions of the north shore.

Ligustrum

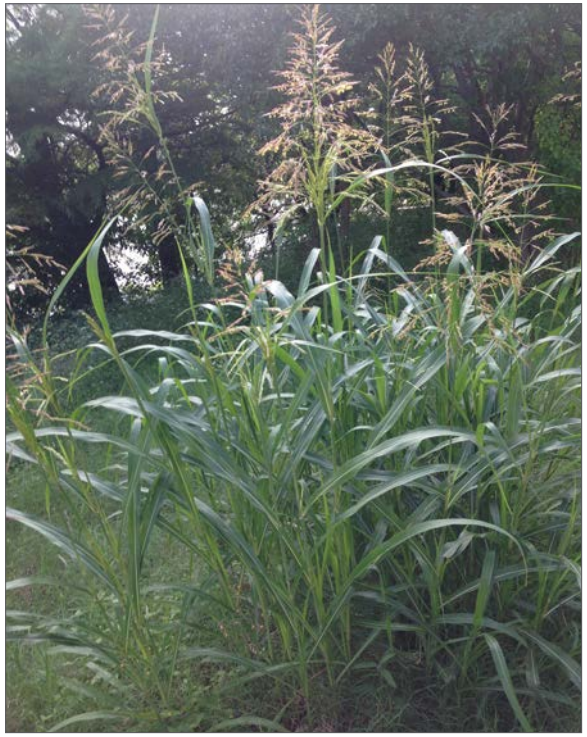
Ligustrum (*Ligustrum* spp.) is a genus of small evergreen trees, several species of which are capable of forming dense monocultures that crowd out native vegetation (Figure 2.44). Within the study area, it is primarily present as scattered individual plants. With the exception of several dense patches, Ligustrum is not currently having a substantial impact in the study area. Ligustrum is ranked High by the City of Austin, but Moderate within the study area.

Figure 2.44: Ligustrum grows densely and quickly resprouts when cut.

Johnsongrass

Johnsongrass (*Sorghum halepense*) is present along many streams and drainage areas throughout the study area as well as along sections of the lakeshore without overhead trees. Where Johnsongrass is present, it is generally growing in very dense patch-

Figure 2.45: Johnsongrass is abundant in many Grow Zones.



es that are crowding out native species, as shown in Figure 2.45. Many of the open spaces where Johnsongrass would likely thrive are currently mowed, limiting its growth. This species is particularly dominant in many Grow Zones and could become increasingly problematic as more areas are managed as Grow Zones or otherwise converted to more natural vegetation. It is ranked High by the City of Austin and in the study area.

Common Chaste Tree

Common chaste tree (*Vitex agnus-castus*) is an ornamental shrub that can grow densely, blocking out native vegetation below, as seen in Figure 2.46. It is present throughout much of the study area, particularly in the eastern half. In most cases, it is present as scattered individuals rather than dense stands. The majority of the plants seen were mature; limited seedlings and young plants suggests that the population is currently not dramatically increasing. There are, however, several areas of dense growth earning the species a Moderate ranking for the study area even though it is not included in the Top 24 Invasive Species in Austin list.

Figure 2.46: Common chaste tree is found along much of the shoreline and is growing densely in several locations.

A Note on Poison Ivy

Though it is native, poison ivy (*Toxicodendron radicans*) is problematic in certain parts of the study area. In areas without human recreation, poison ivy is a desirable plant; it provides good ground cover and erosion control, has lovely fall foliage, is a food source for wildlife, and can outcompete many invasive species. In some areas, however, the vines are so close to the Trail that people can easily brush against them, resulting in painful rashes. The current management practice used by PARD is to cut poison ivy back from the Trail but not completely remove it. These practices should continue as they enhance the user experience while protecting and restoring the natural systems.

Soil Disturbance: Erosion, Deposition, and Compaction

The soils and underlying geology are the foundation of the natural areas and urban forest around Lady Bird Lake. Any human action or infrastructure that removes, compacts, or covers the topsoil will have a profound impact on the site's ability to support a healthy plant community. The primary causes of soil disturbance in the study area include stormwater flow, poorly functioning or absent infrastructure, off-trail recreation, formal recreation without suitable supporting infrastructure, and the erosion of trail material. Soil disturbance is problematic in all areas, but is particularly concerning along the environmentally sensitive shoreline.

Field data and characteristics were taken on soil erosion issues at 280 points throughout the study area as seen in Figure 2.47 and shown in Table 2.6. The following characteristics were recorded:

- Erosion type (described below)
- Size of the disturbance (<100 ft^2, 100 to 650 ft^2, 650 ft^2 to 0.25 acres, and >0.25 acres)
- Disturbance stability (needs immediate attention, needs to be put into management plan, or stable and low priority)
- Probable cause of the disturbance (pet traffic, unauthorized or authorized human traffic, wildlife traffic, flood events along waterways, stormwater flow from infrastructure, habitat improvement project, or other)

Informal trails

Informal trails are pathways created by human and dog traffic that are not maintained by the Parks and Recreation Department. Informal trails have trampled vegetation and compacted soils, as shown in Figure 2.48, and may lead to sheet erosion or the development of rills and gullies over time.

Informal trails are found throughout the study area. They are most abundant in, but not limited to, level to moderately steep areas that are free of greenbrier, poison ivy, and dense woody vegetation. The three

Table 2.6: Number of data points collected for each type of erosion.

Erosion Types

Erosion Type	Count
Informal trail	123
Trampling, waterside	45
Gully erosion	32
Rill erosion	25
Erosion of formal trail	19
Bank erosion	16
Sheet erosion	11
Trampling, upland	2
Soil compaction	1
Other	6

main purposes of informal trails are:

- To access the Lake from the Butler Trail
- To access the Trail from parking areas and other parkland
- To access homeless sleeping areas—While no large homeless camps were found, several informal trails terminated in areas with clothing, cooking utensils, and bedrolls.

Trampling/Compaction

Trampling is a result of too much off-trail recreation traffic in an area compacting the soil, destroying vegetation, and preventing reestablishment of vegetation. One of the principal problems associated with trampling and compaction is the loss of surface porosity, which prevents water infiltration and seedling establishment, decreases organic matter, increases soil temperature, alters soil biota, and increases runoff, which may lead to erosion.

The impacts of trampling are seen over a wide area, unlike linear informal trails. Along the Butler Trail, trampling primarily occurs where people and dogs access the water without proper infrastructure, as seen in Figure 2.49. Though there are a number of established water access points around the Lake (Figure 2.50), their distribution has not kept up with the popularity or the number of users at the study area. Informal access to the water occurs in many areas where the Trail is close to the water and banks are not steep or wooded. People access the water for fishing, to touch the water, to get a good view, or just to be close to it. This has resulted in degradation of some of the most sensitive parts of the natural areas right at the water's edge. In some cases, the popularity of the established water access points has led to degradation as use exceeds the capacity of existing infrastructure. The areas with the most trampling are found near Auditorium Shores, the western bank of Barton Creek, along the shores

Figure 2.47: Erosion data points around Lady Bird Lake. Sources: COA, NAIP.

of Festival Beach, and the peninsula near Longhorn Dam. The City is currently addressing extensive trampling as part of the Auditorium Shores project.

Sheet erosion

Sheet erosion is the removal of thin layers of soil due to precipitation and shallow surface flow. Along Lady Bird Lake, it is closely associated with the trampling described above and steep slopes. In many areas, tree roots are the only things preventing the disturbance from progressing into rill erosion, as seen in Figure 2.51. There is high potential for these areas to become worse as continued erosion undermines tree roots.

There are a few areas experiencing sheet erosion without the presence of trampling, most notably along the steep banks of Waller Creek, just upland

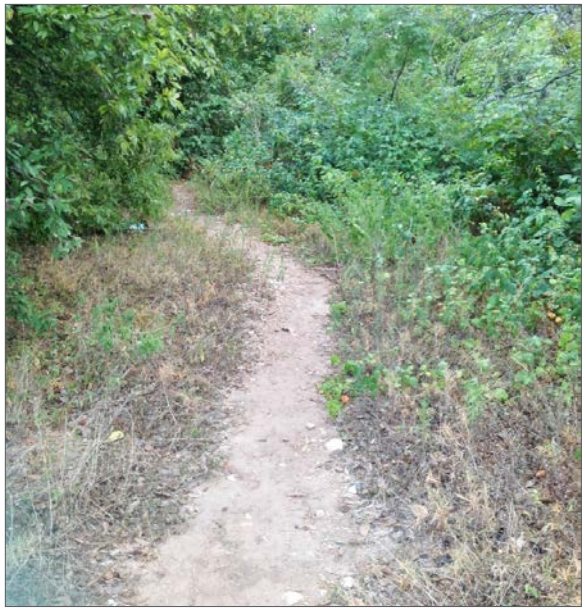
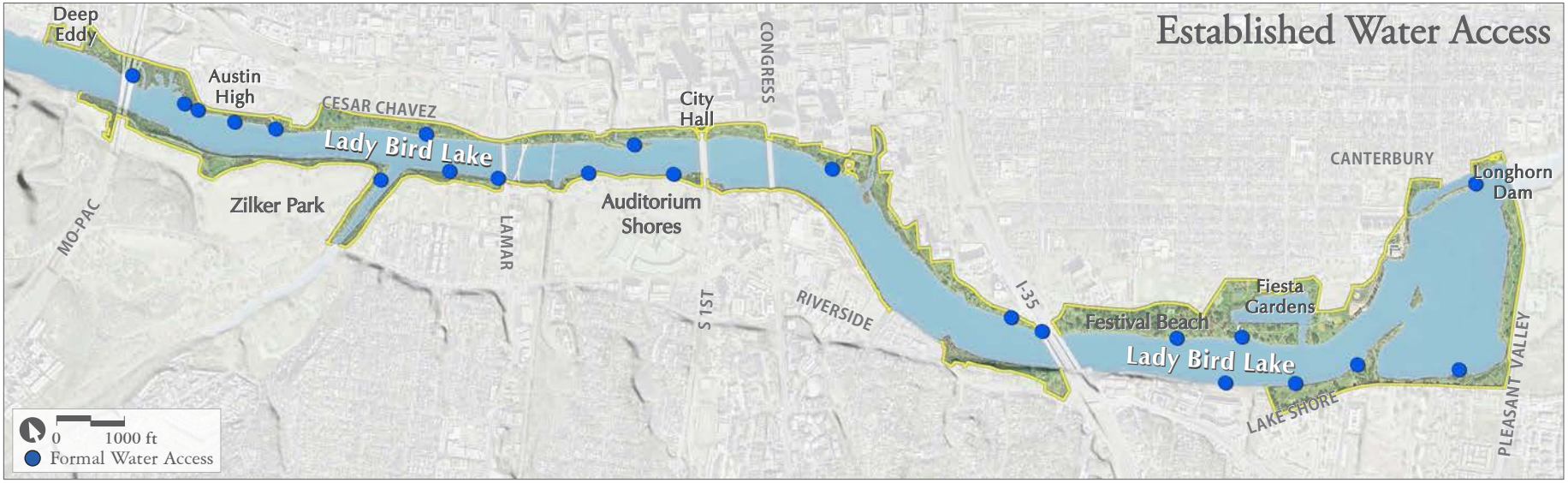


Figure 2.48: Informal trails have trampled vegetation and compacted soils.

Figure 2.49: This staircase near Rainey Street lacks infrastructure for water access, resulting in trampling.

Figure 2.50: Established water access points around Lady Bird Lake. Many of these points have sufficient infrastructure, though others lack proper infrastructure and are degraded as a result of heavy use. Sources: COA, NAIP.



of the western bank of Barton Creek, and along the south shore just east of the mouth of Barton Creek. These areas have extremely steep slopes and lack herbaceous cover. Vegetation re-establishment will be especially difficult in these areas where slopes prevent accumulation of organic matter.

Rill Erosion

Rill erosion is the formation of one or more small channels less than 1 ft deep, like the one shown in Figure 2.52. If the conditions that led to their formation continue unchecked, these channels may deepen. Rill erosion is not concentrated in any one location along the Butler Trail system. The causes and sources of rill erosion are numerous. Some examples include:

- Areas with high amounts of off-trail recreation—this includes informal trails and trampled areas on slopes, which become routes for runoff as the vegetation is removed and the soil begins to erode.
- Areas where water crosses the Trail without any infrastructural support—in some areas, water appears to run along the uphill side of the Trail before finding a low point. As it crosses the Trail (often eroding the decomposed granite), a large quantity of water flows onto the downhill side of the Trail. The concentration of runoff in these areas without any infrastructure to disperse or slow the water leads to the formation of rills.
- Infrastructure that does not take into account the natural areas or is having unintended consequences—examples of this include culverts that bring water under the Trail but are not armored below their outlet, retaining walls that have large amounts of water flowing around their edges (as shown in Figure 2.53), and designed dips in the Trail without armoring or flow dispersers below.

Figure 2.51: Sheet erosion is most common on steep slopes and can expose tree roots.

Figure 2.52: Rill erosion often occurs where culverts carry water under the Trail without armoring below.

Figure 2.53: Rills can form when proper dispersal mechanism are absent, like this ramp at Auditorium Shores.

Gully erosion

Gully erosion is a more advanced stage of rill erosion in which the incisions are 1 ft deep or more (Figure 2.54). It occurs most often in areas with long, steep slopes. Gullies that have not been armored or stabilized pose a threat to the Trail as they may eventually intercept and damage it.

Streambank and lakeshore erosion

Streambank erosion is found along all major creeks that enter the Lake. This is a result of the creeks' urban setting and the powerful force of Central Texas downpours. Waller Creek exhibits the greatest amount of streambank erosion. Plans are currently underway to address Waller's erosion issues. Recent restoration work at Shoal Creek has mitigated some of the bank erosion. Minor lakeshore erosion is taking place in many places along Lady Bird Lake, particularly in areas where giant reed has been treated, as shown in Figure 2.55.

Decomposed Granite Deposition

A tremendous volume of decomposed granite is leaving the Trail and entering the natural areas or the Lake itself (Figure 2.56). This material can bury the native herbaceous plants and soil, making the soil more susceptible to future erosion and lowering the quality of the natural area. Examples of deposition occur throughout the study area, but are most evident where the Trail is close to the Lake on the north shore near Austin High, at Festival Beach, just east of Congress Avenue on the south shore, and at the water access points between Barton Creek and the Lamar Bridge. Some of the steep slopes on the northern edge of Zilker Park are also being impacted by this process.

Figure 2.54: Gully erosion is a more advanced stage of rill erosion.

Figure 2.55: Bank erosion often occurs where giant reed has been removed, such as this area near Longhorn Dam.

Figure 2.56: Decomposed granite is sloughing off the Trail directly into the Lake.

Natural Area Management Guidelines

The natural area management guidelines recommended in this chapter stem from the great value placed by the community on vibrant, aesthetically pleasing, ecologically functional natural areas around the Butler Trail and Lady Bird Lake. The guidelines build on work started many decades ago to enhance the tree canopy and riparian areas around the Lake. Because of the study area's urban location and history of human impact, carefully planned, ongoing actions such as the ones outlined here will be necessary to maintain this community resource for future generations. In addition to ecological health, the immense draw of recreation within the study area was a core consideration in the creation of the guidelines. The guidelines look to enhance the user experience in all aspects of the project through aesthetic appeal and a more functional trail system.

The guidelines are organized within a process-oriented framework that seeks to initiate natural recovery and self-repair of damaged or diminished areas with realistic management objectives. When these techniques are applied in a steady, incremental, and adaptive manner, the outcomes will include:

- **Restored and enhanced plant communities:** native trees, understory, and groundcover create diverse and aesthetically appealing plant communities that provide rich wildlife habitat.
- **Repaired and improved ecological function:** landscape can better absorb and clean water, regenerate native flora, filter air, create and stabilize soil, reduce urban temperatures, and provide shade.
- **Enhanced resiliency:** landscape is better able to adapt to and withstand drought, heavy use, climate change, and other major disturbances.
- **Enhanced user experience:** the site provides aesthetically pleasing, compelling, comfortable, and intricate natural surroundings.
- **Improved stewardship: catalyze** opportunities to appreciate, observe, and care for the natural environment as an ongoing part of people's lives.

Figure 3.1: Trail bridge over Shoal Creek, the site of recent restoration work.

ADAPTIVE MANAGEMENT AND PROCESS APPROACH

The recommendations here are based on best practices established by the City, The Trail Foundation, Siglo Group, and other entities. They are the most appropriate, efficient, and effective treatments known for current and expected conditions. It is imperative to remember that the urban forest and natural areas of Lady Bird Lake are dynamic, ever-changing landscapes that will respond differently at different times to the same treatment. In addition, land management practices often take multiple steps over many years, and conditions may change midcourse. All information here should therefore be viewed through an adaptive management lens. Adaptive management is a process that allows land management practitioners to adjust methods according to existing conditions, previous successes, and unforeseen challenges. This approach is imperative in the face of potential climate change and prolonged drought.

To facilitate the implementation of the project, the study area has been divided into 16 management units based on current use, topography, needed management tasks, and plant communities as seen in figure 3.2. In the following chapter, the guidelines described below are applied to each management unit to create specific, implementable tasks that work towards the overall goals of these guidelines over a four year period.

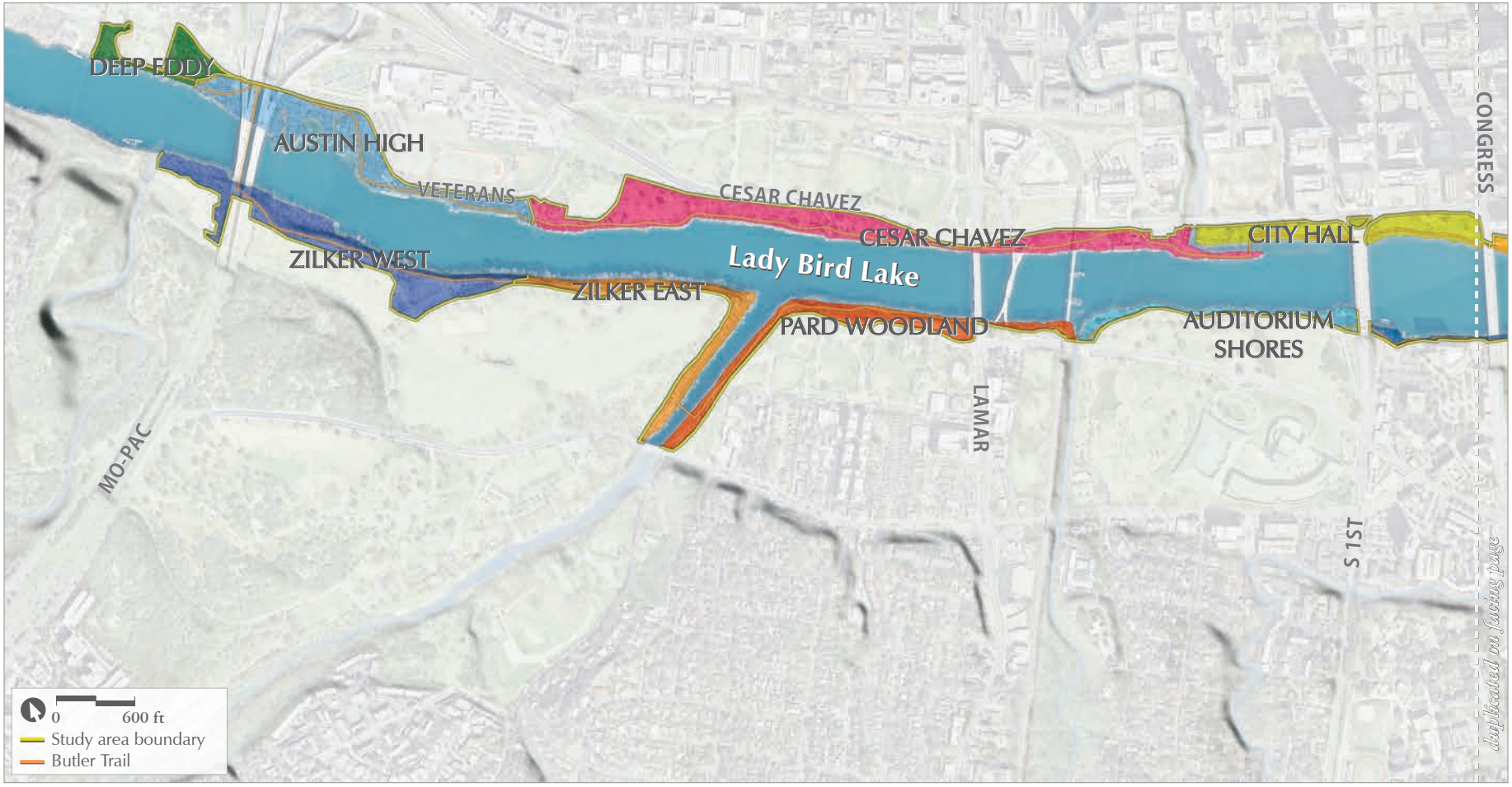
INTEGRATING MANAGEMENT WITH THE USER EXPERIENCE

As described earlier, the urban forest and natural areas around Lady Bird Lake house the highest-use trail in Central Texas, with over 1.5 million visits

per year (COA 2003). The natural areas management guidelines recognize the importance of the user experience and recommend ways to enhance that experience by increasing shade, reducing erosion hazards, creating more stable trails, increasing forest and tree health, enabling interaction with the flora and fauna of Central Texas, framing views, and enhancing aesthetic appeal.

Heavy use in recent decades, coupled with increased knowledge of erosion and compaction impacts, has created the need for some of the infrastructure to be altered or relocated. The proposed changes would reduce trampling, erosion, and compaction, allow for greater woodland areas at the shoreline, create more interesting and sustainable trail alignments, and formalize water access points to make it easier for users to enjoy the water's edge without causing damage. The integration of the user experience with natural area management is emphasized throughout this document.

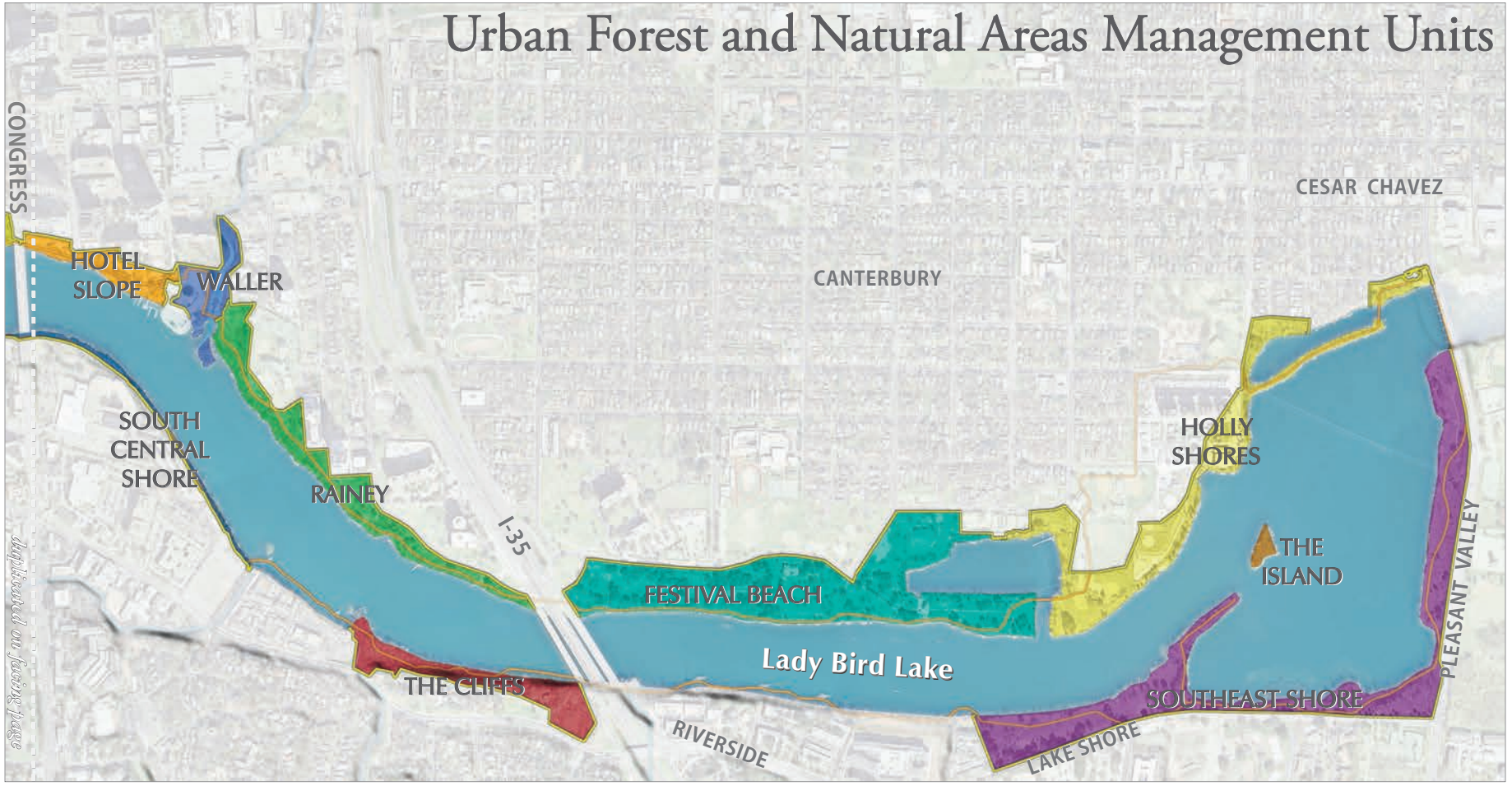
Figure 3.2: The study area of the Urban Forest and Natural Area Management Guidelines for Lady Bird Lake & the Butler Trail is split up into Management Units to facilitate implementation based on topography, existing use, and restoration potential.



NATURAL AREA MANAGEMENT AND ECOLOGICAL RESTORATION

Natural area management recognizes that people have a role to play in our natural areas. This is particularly true in urban areas that experience ongoing impacts and influences from surrounding areas, including stormwater flows, high recreational use, soil compaction, introduction of invasive species, and limited connection with other natural areas. The methods here work towards the ecological restoration of the site. Ecological restoration is the act of enhancing natural processes in a landscape where they may not exist, are impaired, or simply can be improved. We look at repairing environmental degradation as well as enhancing plant communities and habitat to create resilient, aesthetically pleasing, and ecologically functional natural areas. Resiliency of the site is heightened through:

- Reintroduction and restoration of plants and plant communities that evolved in and are adapted to this area.
- Increased plant diversity to endure substantial changes in weather conditions such as ongoing drought or climate change as some species and even some genotypes may do better than others as circumstances change.



REPAIRING ENVIRONMENTAL DEGRADATION

Environmental degradation can come from many factors, both natural and manmade. The major issues impacting an area must be addressed before or during restoration, or restoration efforts will be ineffective. Here we will discuss management of the main factors degrading the natural areas: invasive species and soil disturbances.

Invasive Species

Invasive species are components of our modern environment that require persistent management. The goal of the management practices outlined below is to remove and discourage the establishment of harmful non-natives while encouraging the establishment and health of native plants. The end goal is to have plant communities dominated primarily by native plants in one decade. We outline here the best management practices to control the major invasive species found throughout the site, and recommend additional practices that align with desired management outcomes of increased woodlands and increased native plant diversity.

The ideal defense against invasive species is a more robust native flora that weakens or prevents the establishment of invasives. Expanding the woodlands over the next four years can have a substantial impact on areas currently dominated by invasive species that have an affinity for full sun. This will not work in all areas, but in many areas expanding woodlands may weaken problematic species such as giant reed and Johnsongrass. In all cases, treatment of invasive species should also work toward the overall ecological goals of a particular area.

There are 31 invasive plant species found in the study area that are negatively impacting the property, as seen in Table 2.5 of the Ecology chapter. The invasive plants causing the largest impact in the study area or having the potential for a substantial impact in the near future are: tree of heaven, giant reed, paper mulberry, sweet autumn clematis, elephant ear, golden rain tree, catclaw vine, Chinaberry, Chinese tallow, Chinese lacebark elm, Ligustrum, Johnsongrass, and common chaste tree. Best management practices for each of these species are presented in the following pages as recommended by the City of Austin, Siglo Group, the National Parks Service, and TexasInvasives.org. As these practices are implemented, it is critical to remember that invasive species control is a multi-step process. After an initial treatment, follow up treatments are the only thing that will keep the situation from regressing (Texas Invasives 2015). For example, many of the giant reed patches throughout the study area have been previously treated by the City's Watershed Protection Department, but are growing back and are currently in need of follow up treatment and restoration planting (Figure 3.3).

Figure 3.3: Giant reed resprouting after treatment.

Invasive Species Control Guide

Paper Mulberry, Golden Rain Tree, Chinaberry, Chinese Tallow, Chinese Lacebark Elm, Ligustrum, and Common Chaste Tree (All invasive trees except Tree of Heaven)

Mechanical removal

Remove plants 2" or less in basal diameter using a Weed Wrench™ or other mechanical device. Hand pulling of new seedlings is required for multiple years until the seed bed is diminished and other plants can fill the niches. Provide for erosion control as needed. Leave as much of the pulled material as possible on site in low-use woodlands, taking care to remove any seed material, and leaving roots without soil contact. Slash from higher-use areas can be moved for use elsewhere on the site or removed altogether.

Where Appropriate: Areas with slopes <3:1
Optimal Time of Year: Any time
Plant size: ≤2" diameter
Effectiveness: High
Applicator Required: No
Labor Intensity: High

Cut stump

Cut tree down, providing for safety first. Paint the top of the stump with a triclopyr-based solution immediately, taking care to cover edges. Leave as much of the downed material as possible on site in low-use woodlands, taking care to remove any seed material. Slash or mulch from higher-use areas can be moved for use elsewhere on the site or removed altogether.

Where Appropriate: All areas
Optimal Time of Year: Fall
Plant size: >2" diameter
Effectiveness: Moderate
Applicator Required: Yes
Labor Intensity: Moderate

Basal spray

Spray the bottom 12–15" of the tree with a triclopyr and oil solution. The standing dead snag will be excellent habitat for many insects and birds. Only use when tree height is shorter than the distance to the nearest trail or recreational use area. Will not be as effective if bark is thick, a species dependent condition.

Where Appropriate: Away from trail
Optimal Time of Year: Slight fall preference
Plant size: >2" diameter
Effectiveness: Moderate
Applicator Required: Yes
Labor Intensity: Low

Tree of Heaven, *Ailanthus altissima*

Mechanical removal

Remove plants 2" or less in basal diameter using a Weed Wrench™ or other mechanical device. Hand pulling of new seedlings is required for multiple years until the seed bed is diminished and other plants can fill the niches. Provide for erosion control as needed. Leave as much of the pulled material as possible on site in low-use woodlands, taking care to remove any seed material, and leaving roots without soil contact. Slash from higher-use areas can be moved for use elsewhere on the site or removed altogether.

Where Appropriate: Areas with slopes <3:1
Optimal Time of Year: Any time
Plant size: ≤2" diameter
Effectiveness: High
Applicator Required: No
Labor Intensity: High

Hack and squirt

Tree of heaven will aggressively root sprout if cut completely. Instead, use a hatchet or girdling tool to create several wounds around the base of the tree. Do not completely girdle stem. Wound approximately 50% of diameter, with each wound 1 to 2" in height. Spray triclopyr-based solution onto wounds. This treatment is most suitable when tree height is shorter than the distance to the nearest trail or recreation areas. For trees closer to trails or recreational areas, a follow up removal of the tree should occur 6 months after the initial hack and squirt treatment.

Where Appropriate: Away from trail
Optimal Time of Year: Slight fall preference
Effectiveness: Moderate
Applicator Required: Yes
Labor Intensity: Moderate

Invasive Species Control Guide (*continued*)

Giant Reed, *Arundo donax*

Foliar spray	Apply foliar spray with imazamox solution. If not mixed with desirable vegetation, a combination of glyphosate and imazomox can be used. When stems die, cut and remove vegetation. Repeat as necessary. Erosion control efforts such as silt fences or erosion control fabric should be used and restoration plantings should be installed as soon as possible. Do not cut giant reed for at least a year before treatment, or effectiveness will be greatly reduced.	Where Appropriate: All areas Optimal Time of Year: Mid- to late summer Effectiveness: Moderate Applicator Required: Yes Labor Intensity: Moderate
Digging and root removal	Cut and remove tops of plants. Dig and remove as much of the roots as possible to minimize resprouting and dispose of all plant material off site. Wait for new sprouts to show and dig a second time. Digging will cause massive soil disturbance and open the area to erosion. Erosion control efforts such as silt fences or erosion control fabric should be used and restoration plantings should be installed as soon as possible.	Where Appropriate: For immediate removal Optimal Time of Year: Any time Effectiveness: Low Applicator Required: No Labor Intensity: High
Wick chemical application or cut and squirt	Use wick applicator to wipe the leaves with glyphosate/surfactant mix, allowing for application without harming nearby restoration plantings. Or cut individual stems and squirt a glyphosate solution into the stem cavity. Erosion control efforts such as silt fences or erosion control fabric should be used and restoration plantings should be installed as soon as possible.	Where Appropriate: Mowed/dug areas Optimal Time of Year: Summer Effectiveness: Uncertain Applicator Required: Yes Labor Intensity: High
Changing site conditions	Increase the tree canopy to shade out and weaken the establishment of giant reed. This can be done by planting riparian trees recommended in Table 3.1 directly around a treated area of giant reed, with particular focus on fast-growing trees such as box elder, hackberry, and black willow.	Where Appropriate: Treated areas Optimal Time of Year: Fall Effectiveness: Uncertain Applicator Required: No Labor Intensity: High

Sweet Autumn Clematis, *Clematis terniflora*

Mechanical removal	Seedlings can be pulled by hand or mowed. Mature plants can be cut or mowed, but the roots must also be dug up for effective removal. In areas with slopes greater than 3:1, erosion control fabric should be used and replacement planting should occur as soon as possible.	Where Appropriate: All areas Optimal Time of Year: Any time Effectiveness: Uncertain Applicator Required: No Labor Intensity: High

Elephant Ear, *Colocasia esculenta*

Mechanical removal	Carefully dig and dispose of tubers; even small fragments may re-root. This can cause severe soil disturbance, and coir logs can be installed to prevent erosion. Plant replacement species immediately.	Where Appropriate: Along shoreline Optimal Time of Year: Low lake level Effectiveness: Low Applicator Required: No Labor Intensity: High
Foliar spray	Spray foliage with an aquatic approved glyphosate or imazamox solution. Repeat treatment as recommended by herbicide manufacturer when needed. Plant replacement species in late fall.	Where Appropriate: Along shoreline Optimal time of year: April–October Effectiveness: Low Applicator Required: Yes Labor Intensity: High

Catclaw Vine, *Macfadyena unguis-cati*

Mechanical removal	Cut vines close to ground and dig up all root material.	Where Appropriate: All areas Optimal Time of Year: Any time Effectiveness: Moderate Applicator Required: No Labor Intensity: High
Combined cutting and foliar spray	Where catclaw is tangled in overstory trees and cannot be pulled down without damaging native tree branches, cut it at head height and allow vines in the upper branches to desiccate and fall on their own. On remaining vegetation, use a foliar spray with an herbicide solution that contains glyphosate and triclopyr.	Where Appropriate: Monocultures Optimal Time of Year: Non-drought Effectiveness: Uncertain Applicator Required: Yes Labor Intensity: Moderate
Cutting followed by foliar spray	Cut catclaw at ground level, and remove the aboveground biomass from the site. Where catclaw is tangled in overstory trees and cannot be pulled down without damaging tree branches, cut it at head height and allow the vine in the upper branches to desiccate and fall on its own. Allow catclaw to re-sprout from underground tubers. When it reaches 2 ft in height/spread, use foliar spray with an herbicide solution that contains glyphosate and triclopyr.	Where Appropriate: Non-monoculture Optimal Time of Year: Non-drought Effectiveness: Uncertain Applicator Required: Yes Labor Intensity: High

Johnsongrass, *Sorghum halepense*

Foliar spray	Foliar spray with glyphosate-based herbicide. Replant affected area with native vegetation.	Where Appropriate: Away from desirable plants Optimal Time of Year: September, October Effectiveness: High Applicator Required: Yes Labor Intensity: Moderate
Wick application	In areas with desirable groundcover underneath Johnsongrass, apply glyphosate-based herbicide with a wick applicator. This method tends to actually use more herbicide product, but avoids non-target kill.	Where Appropriate: Near desirable plants Optimal Time of Year: Spring or fall Effectiveness: High Applicator Required: Yes Labor Intensity: Moderate
Changing site conditions	Improve canopy cover of urban forest to reduce direct sunlight on herbaceous layer to decrease vitality of Johnsongrass and increase viability of competition by native species.	Where Appropriate: Where woodland is desired Optimal Time of Year: Fall Effectiveness: Uncertain Applicator Required: No Labor Intensity: High

Mitigating Soil Disturbance And Erosion

Healthy soils are the foundation of a healthy natural area. As discussed in the ecology chapter, human actions, infrastructure, and stream inflows have a great impact on the site's ability to support stable soils and healthy plant communities. The recommendations here focus on techniques to alleviate soil disturbance and erosion within the bounds of the study area. In some areas, due to the narrowness of the site or the size of the problem, additional actions may need to take place outside of the study area. The major issues addressed here include: informal trails, formal trail alignments, trail erosion, water access, soil compaction, and sheet, rill, and gully erosion. The solutions include green infrastructure, formalization of user access, redirection of storm water, regrading, soil amendments, soil decompaction, and infrastructure modification. Soil chemistry is another important component of healthy soil, but is not addressed here as a complete soil analysis was beyond the scope of this project.

User Impacts

Austinites love the Trail and the natural areas around Lady Bird Lake. Unfortunately, the site's heavy use is sometimes to the detriment of the very thing being enjoyed. Off-trail recreation, access to the water, and the general condition of our trails are impacting the natural areas. Numerous problems associated with user impacts can be alleviated by decommissioning informal trails, making sure there are adequate trails where needed, making sure there are sufficient formal water access points, realigning the trails away from the water's edge or steep slopes where possible, and stabilizing the trail surface to reduce the amount of trail material sloughing off into the natural areas and the Lake.

Formalizing access to the water

As discussed in the ecology chapter, there are numerous areas around the Lake where people access the water. Twenty-two established water access points with varying levels of supporting infrastructure can be seen in figure 2.50. There are, however, many more access points that are informal, with little to no supporting infrastructure. To protect the fragile ribbon of habitat at the water's edge, we propose the installation of formal water access points and upgrading of established access points where there is need and the topography allows. These areas will be clearly linked to the main trail, have appropriate amounts of space to accommodate users, and will have ample infrastructure to support appropriate activities such as sitting, fishing, putting in a boat, or viewing birds. In addition to accommodating the users' needs, these sites must be stabilized to withstand both floodwaters and foot traffic and must be designed in such a manner that discourages adjacent off-trail activities. An example formal water access location can be seen in Figure 3.4. As plans are further developed for these formal water access locations, they could become iconic pieces of architecture that complement the natural areas, much like the bathroom facilities that have been installed along the Trail by The Trail Foundation.

Formalizing Trails and Improving Infrastructure

There are numerous areas where paths created by recurring use make sense for the current configuration of the natural areas but are not maintained as a part of the trail system. In these areas, trails should be formalized and maintained per the criteria below. This directs the flow of users to these formalized areas, decreases informal use, and allows for reclamation of other areas previously being used informally. For example, this approach is recommended for the numerous trails running from Veteran's Drive behind Austin High and the Butler Trail. Formalizing two trails would allow other trails to be decommissioned and restored.

In many areas, structures such as docks, retaining walls, and gazebos have not been maintained over time. Repair and restoration of these structures offer the opportunity for design that fits into the sur-

Figure 3.4: Formal water access areas, like the "Northshore Overlook" installed by The Trail Foundation in 2006, allow visitors to engage with the water without causing damage to the sensitive lakeshore.

rounding area and functionally facilitates the user experience while moving people away from informal use of the natural areas that leads to degradation.

Trail Alignments and Surfacing

Two major trail issues throughout the study area are the placement of the Trail in sensitive areas and erosion of trail material. The narrowness of the site and steepness of the terrain often dictate the Trail's location. In these cases, stabilizing the trail surface (discussed below) and insuring proper drainage are critical to reducing the impacts of the Trail on the natural areas. In many places, however, there is room to adjust the trail position, which will reduce overall impacts on the natural area and thereby create a better user experience. Areas of note include the section along Cesar Chavez from Austin High to Lamar and Festival Beach. While this will initially seem like a large change, the inclusion of formal water access points, the aesthetic appeal of a more sinuous trail, and the realization that trail material has to be replaced (due to erosion) multiple times per year in some areas, makes these changes necessary, appealing, and cost effective. There are also areas where finer-scale changes in trail alignment are recommended. For instance, on the section paralleling Veteran's Drive, reducing the width of the Trail by a few feet and bringing it inland several feet will allow space for riparian vegetation. Another example of finer scale trail realignment that may involve cooperation with adjacent landowners is reducing the hardscape next to the Hyatt that creates one of the major bottlenecks in the trail system.

Figure 3.5: In areas where the Trail cannot be moved away from the shore, such as the Shoal Creek peninsula, the surface should be stabilized by paving or other means.

On portions of the Trail that either cannot be moved away from the water's edge or are bordered by a steep downhill slope, the crushed granite needs be stabilized or another material should be used. Using crushed granite as the surface of the Trail makes sense in terms of availability and softness. Unfortunately the Trail is washed out repeatedly throughout the study area, leading to ongoing maintenance challenges, a sprawling trail up to 25 ft wide in some areas, and deposition of granite material in the natural areas, which impacts both aquatic and terrestrial habitat. Potential guidelines for all trails moving forward are:

- 14 ft maximum Trail width in most areas—This recommendation is based on the recent improvements at Shoal Creek and other locations, as well as the AASHTO (1999) trail standards for multi-modal trails. This standard may not be valid in the most highly used Trail segments and should be evaluated in each segment based on user groups including: commuters, recreational bicyclists, runners, and pedestrians.
- Stabilize trails within 50 ft of the water's edge.
- Stabilize trails with a downslope side of 15% or greater within 2 ft of the trail.
- Stabilize trails in low-lying or frequently flooded areas.

These criteria are aligned with the City of Austin Environmental Criteria Manual, would considerably improve the Trail's function, and would substantially reduce the Trail's impacts on the natural areas.

Stabilization of trail material can come in numerous forms, including paving (as seen in Figure 3.5), geocell systems, spraying a polymer on the crushed granite, or a ribbon curb on the downslope side of the trail. In all cases, the reduction of trail material entering the natural areas should be the measurement of success. These Trail criteria and stabilization options will result in a better user experience and healthier natural areas.

Repairing Informal Trails, Retired Trails, Water Access, and Trampled Areas

Decommissioning informal water access points and trails and revegetating impacted areas are essential complements of creating formal access points and trails. Numerous informal trails are pointed out in the Management Units chapter, but monitoring and mitigating informal trails as they arise should be a

part of ongoing monitoring and management plans.

Brushing is a simple, effective way to reclaim informal trails. Brushing uses cut vegetation from pruning or invasive species removal to block the trail. Cut vegetation should be placed over impacted areas for at least 30 ft from intersections with formal trails. The cut pieces do not need to be large or tall, only difficult to walk through. Densely branched invasive species such as Ligustrum are especially good for brushing informal trails, though care must be taken to remove all seed material. Where the informal trail is in a relatively open area, the pieces should extend 3 to 5 ft beyond the edge to discourage visitors from widening the trail by walking beside the cut brush.

Brushing can be effective for small trampled areas as well. Larger downed material from invasive management or other maintenance in the area can be used to create additional obstacles to use.

Some of the larger trampled areas may be in need of additional soil amendments, decompaction, and planting. In high-use areas, temporary fencing, along with appropriate interpretation, may be necessary to allow areas to recover.

Stormwater

Stormwater runs downhill into the study area on its way to the Lake, causing numerous issues outlined in the Ecology chapter and shown in figure 2.47. Green infrastructure methods associated with slowing down flow are preferred for addressing stormwater issues within the study area. This can include swales, depressed areas within the landscape that retain stormwater, appropriate native plantings, and/ or simple grading changes. Where these solutions will not work, engineered solutions or solutions outside the study area are needed. In all cases, aesthetics should be taken into consideration when choosing solutions within and adjacent to the natural areas.

Trail Runoff

In numerous areas along the Trail, grade dips and small culverts are used to shunt water off of the Trail. In some areas, additional dips and small culverts should be installed to increase the number of locations where water moves across the Trail and reduce the volume for existing culverts. This may be especially necessary in areas where infrastructure diverts large amounts of fast-moving runoff onto the Trail, like the area shown in Figure 3.7.

Sheet erosion

Where sheet erosion is occurring, upslope solutions to reduce or slow flow should be considered. Possibilities include grading changes, swale installation, and rain capture areas. For minor sheet erosion issues, such as in the upper portions of Festival Beach, organic material can be added to cover exposed tree roots, along with the appropriate planting and seeding of understory plants to stabilize the soil and increase water uptake.

Figure 3.6: Brushing, as seen here on the Barton Creek Greenbelt, is an effective way to deter informal trail use.

Rill Erosion

As with sheet erosion, upslope solutions should be considered first. Where those can be installed, minor cases of rill erosion can be treated like sheet erosion with the addition of organic material to cover tree roots and create appropriate conditions for re-vegetation. Where upslope solutions are not feasible, erosion mats and additional plants to hold the soil may be adequate. Installing erosion mats will temporarily hold the soil until the new plants are firmly established.

Gully Erosion

Upslope solutions are preferred. Many of the gullies are caused by culvert discharges onto steep slopes. In these areas, water-dispersing armoring should be installed where feasible. A variety of materials may be used to disperse the water, including rip-rap, concrete, loose stones, and limestone block gabions. Native rock is the preferred material.

Where large culverts are causing erosion and it is not feasible to disperse the water due to the slope below or the volume of water, the most effective solution in some cases will be to extend the culvert to the Lake, thereby eliminating further erosion. Where this solution is employed, aesthetic considerations and restoration are critical to ensure that the new infrastructure does not negatively impact the user experience and that the previously impacted area can sustain native plantings.

Figure 3.7: Runoff from infrastructure is causing rill erosion and erosion of trail material at Auditorium Shores.

Figure 3.8: One of the locations where creation of streamlets is recommended in the Rainey management unit.

Creating Streamlets

Stormwater moving across the study area at regular intervals, when accommodated, is a useful resource. The recommendations above address areas where it is not currently being accommodated. In a few instances, it is possible to utilize the existing erosion channel to create a streamlet within the study area. A streamlet is simply a small drainage channel. Where they occur naturally in central Texas, they are filled with plants that do not require consistently wet soils but thrive in seasonally wetter soils, such as Lindheimer's muhly and seep muhly. Formalizing the existing channels by reinforcing the erosion bed with rock and gravel, planting appropriate plants, and reducing mowing frequencies to once a year or less will prevent erosion issues, accommodate the water flow, and create a more dynamic environment in the natural areas. There are two sites near Rainey Street (one is shown in Figure 3.8) and two sites in Festival Beach where this technique is recommended, as discussed in the Management Units chapter.

Streambank erosion

Mitigating the streambank erosion occurring along the major creeks such as Waller, Shoal, Johnson, and Blunn is outside the scope of this project. The City of Austin's Watershed Protection Department (WPD) has a process for evaluating and mitigating these issues. The recommendations in this document can complement the major infrastructure work associated with streambank restoration.

Soil restoration

As mentioned above, soils in impacted areas will need to be restored through decompaction and amendment. Unless issues of soil porosity/water infiltration and decreased organic matter content are addressed, these soils will not be able to support healthy plant communities. In heavily impacted areas—such as those where vehicles have driven, former trails, or infrastructure staging areas—decompaction will be necessary. This can be accomplished through tilling and/or aeration, though care must be taken to protect tree roots. In areas with bare soil or in existing lawns being converted to woodland or savanna, organic amendments are recommended. Native mulch or mulch from the site is recommended for areas under trees and areas being converted to woodlands to a depth of 4" the spring or summer before fall planting and as needed thereafter. In areas where seeding will take place in the next year, a mature stable compost approved by the City of Austin is recommended to be lightly mixed with the top 2" of weed-free soil.

In all cases, amendment material is only recommended in areas where it does not pose a risk of washing away during regular rain events and entering Lady Bird Lake. If amendments are needed in unstable areas, erosion blankets or equivalent structures should be used. While it is likely that the appropriate soil fauna will enter into treated soils from the surrounding landscape and from compost amendments, it may be necessary to move a small amount of healthy soil from a nearby natural area into areas that will be planted or seeded to ensure that the appropriate soil biota is present.

Use of downed material

Woody material from invasive plant removal, pruning, and other management activities can be used throughout the study area. Some of the woody material can be mulched to use in soil restoration efforts mentioned above, but the majority can be left in larger pieces and either left in place or moved to other woodland enhancement or woodland expansion areas. The large woody debris will eventually decompose, returning nutrients to the soil, but in the meantime it will provide cover for wildlife, discourage creation of new informal trails, and help slow down falling rain to reduce erosion. Leaving the debris intact will also save on time and equipment usage. In some cases, the Lake should be considered as a means for transporting woody debris from one area to another as some locations are most easily accessed via the water.

RESTORING AND ENHANCING PLANT COMMUNITIES AND HABITAT

Vegetation creates the ecological structure of the natural areas. Once degradation in an area has been controlled, native vegetation can be restored or enhanced to create habitat for wildlife as well as a beautiful setting for human enjoyment. Here we describe the basics of establishing and caring for native flora, restoring plant communities, and enhancing wildlife habitat. The implementation of these steps along with those listed above will result in restored aquatic, woodland, and savanna plant communities throughout the study area.

Restoration areas were defined by topography, existing and likely use, soils, infrastructure constraints, proximity to water, likely response to different management, and the likelihood of restoration success. The recommendations are shown in Figure 3.9 and include: woodland enhancement, woodland expansion, savanna restoration, and aquatic planting. Some areas have no recommendations as they are considered formal recreation areas or areas with infrastructure.

The 60 acres of the site currently defined as woodland are recommended for woodland enhancement. Enhancement recommendations include invasive species management or erosion control where there is degradation, and for areas in relatively good condition, increases in diversity.

Woodland expansion is recommended for areas that are currently—or were until very recently—managed as Lawn, but are not active recreation areas. These areas make up 80 acres of the study area and an additional 5 acres directly adjacent to the study area. Historically, these areas would be part of a floodplain terrace woodland with a nearly continuous, cathedral-like canopy along with thriving understory and herbaceous layers. In some areas, woodland expansion may be passive, simply changing management from mowed to Grow Zone and controlling for invasive species and erosion problems if they arise. In other areas, recommendations include native tree plantings to speed canopy establishment, followed by understory and groundcover establishment, while always controlling invasives and erosion.

Several smaller areas are dedicated to savanna restoration. The areas chosen have

Gaddy soils that can support a savanna plant community not found in any protected area in Travis County. While savanna restoration is an appropriate goal, the high level of preparation and ongoing maintenance makes it a lower priority than woodland expansion at this time.

Finally, the guidelines point to areas were emergent aquatic plantings would be appropriate based on bathemetry and existing aquatic plant colonization.

In all areas, whether woodland enhancement, woodland expansion, savanna restoration, or aquatic restoration, natural regeneration of plant material will be a crucial part of restoration activities. Natural regeneration will be most effective in areas with a sufficient native plant seedbank, proper soil conditions, time for recovery, ample water availability, and protection from degradation. Because it is rare for those conditions to coincide in this study area currently, and because of the high value placed on the study area, active restoration is recommended throughout much of the study area.

Plant Material, Planting, and Seeding

In all cases, seeds and plants sourced from Texas (preferably Central Texas) are recommended to ensure that plants are well adapted for the study area. In addition, planting, care, and seeding should be overseen by experienced professionals or volunteers to increase survivorship from initial planting and seeding to full establishment in 3 to 5 years.

A full list of recommended plants can be found in table 3.1. This list creates a substantial baseline for healthy plant communities in the study area. The plants are chosen based on the following criteria:

- Native to the Central Texas area;
- Available through the local nursery trade or native plant society groups;
- Successfully used in restoration projects within Central Texas;
- Add diversity to the plant palette around Lady Bird Lake;
- Included in the Texas Parks and Wildlife Department's Wildscapes list of plants that are beneficial for wildlife;
- Listed in the Texas Parks and Wildlife Department's descriptions of the vegetation types found in the study area; and/or
- Recommended for this or similar projects by arborists, ecologists, or land management professionals.

Live plantings work to quickly stabilize soils, increase diversity, shade out invasives, and better define the user experience. The next chapter highlights specific management units where canopy, understory, and groundcover plantings are recommended. Variables that help decide whether live planting is cost effective include: availability of irrigation, visibility of the site, whether invasive species may inhibit seeding, cost of labor and resources for planting and management during establishment, and whether natural recovery is an option.

Live plantings can consist of trees, understory, groundcover, or any combination of the three. In all cases, the following guidelines are critical:

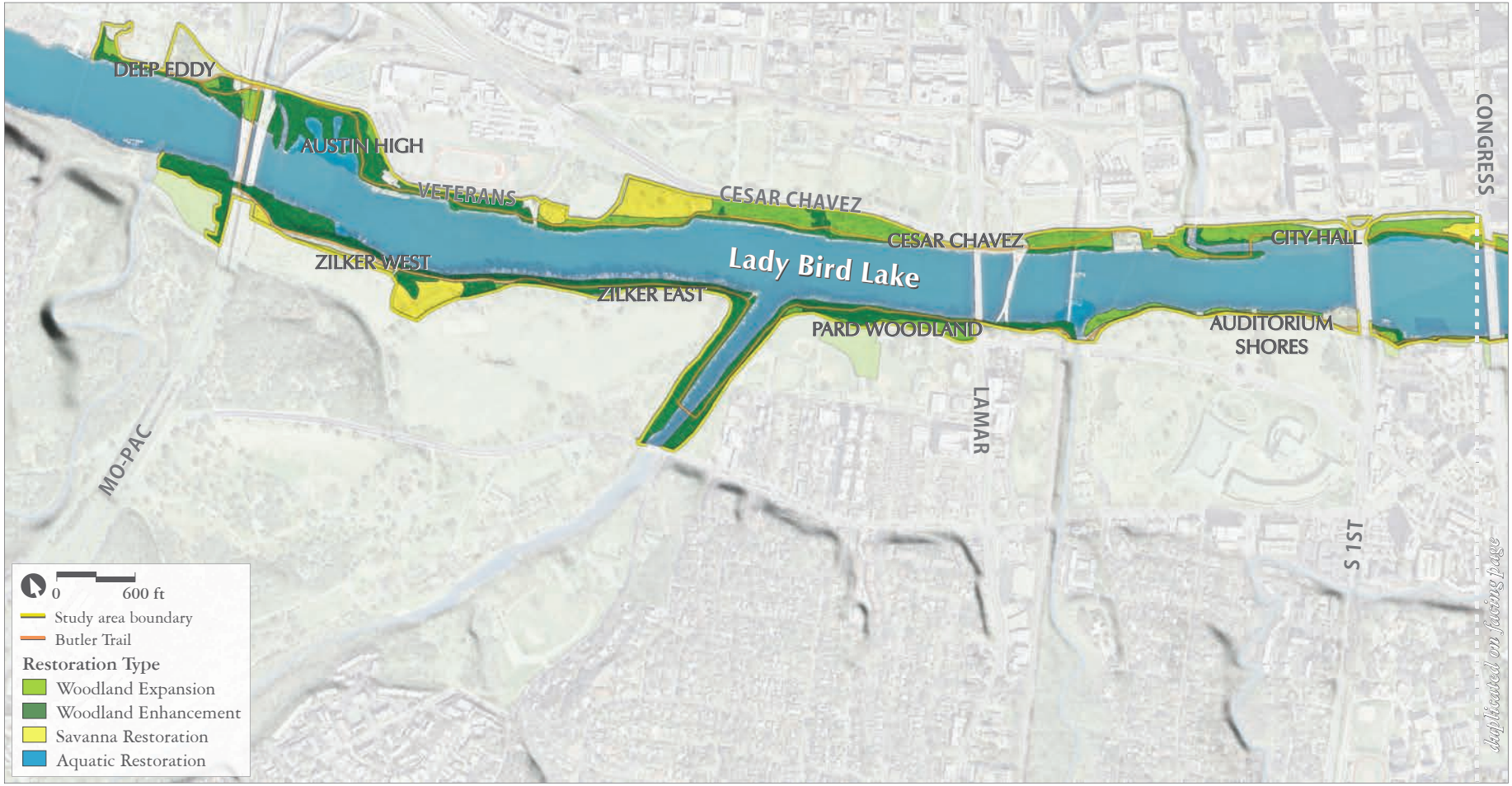
- Prepare for success: Ensure that trained individuals are part of all planting activities, make sure the area is prepared for planting and any degradation issues have been managed (such as invasive species, erosion, or soil compaction).
- Plant at the right time of year: To allow for initial establishment before the heat of the summer, most planting should occur October to February.
- Plant the right plant in the right place: The recommended plant list found in Table 3.1 includes appropriate locations for each species. Ensure shoreline trees are planted along the shoreline and upland trees are planted away from the shoreline, keeping in mind that some species may be appropriate for a variety of settings. Beyond the distinctions in the recommended plant list, an experienced professional and/or volunteer should facilitate decisions about where particular plants are placed.
- Size matters: Plants should be the smallest size suitable for the circumstances. For example, planting small caliper and bareroot trees allows resources to go much farther because the plant material and installation costs are substantially reduced (Duncan and Richter 2012). That said, in areas where trampling or aesthetics are of immediate concern, larger plants may be appropriate.
- Irrigation: Temporary irrigation during the summer months is critical in the first three to five years of establishment after planting. Irrigation is available through much of the study area and creative, cost-effective means of utilizing it in all restoration activities will substantially increase plant survivability.
- Continued care: Whether trees, understory, or groundcover, planting is only the first step. Ensuring that the new plants have sufficient water, are not being outcompeted by invasives, and are not being negatively impacted by erosion issues are all critical to a project's success.

When planting trees, it is also important to use a naturalistic planting design. Planting trees in clumps rather than spacing them evenly will create a more natural aesthetic. These trees will grow up to form groves, which is often how trees are encountered in central Texas.

Seeding can be used independently or as a complement to live plantings in areas where trampling is unlikely, for particular species that grow best from seed, where immediate results are not as critical, or where live planting is not practical. As with all practices, seeding should be overseen by a trained professional or volunteer with a focus on seed bed preparation and insuring that no invasive species in the area will undermine the seeding efforts. While restoring or augmenting plant species is recommended in each of the management units discussed in the following chapter, it may not be realistic to plant or seed entire areas due to costs, labor, access, or time.

Restoration is an ongoing process, so planting or seeding some areas as "seed islands" is appropriate. A seed island is an area that has been planted or seeded with the intent of the plant material spreading to surrounding areas. The area can be quite

Figure 3.9: Areas recommended for ecological restoration. Sources: COA, NAIP.



small (as small as 8 ft by 8 ft). The area should have invasive species removed, soil supplemented (with mulch or compost per recommendations in soil restoration section above), and erosion controlled as needed. After preparation, the area should be seeded and/or planted. The Grow Zone program uses this approach in some areas. The seed island concept can be used in any of the management units and all planting and seeding efforts should be thought of as seed islands for the surrounding areas.

The practices outlined above for live plantings also apply to seeding (with the exception of "Size matters"). An additional consideration is proper seeding rates, which will vary based on whether the seeding is adding diversity to an area with existing vegetation, complementing live plantings, or establishing vegetation in an area prepped specifically for seeding. It is important to remember that good timing for seeding may be different than for live plantings. Cool season grasses and spring wildflowers will do better if sown in the fall, while warm season grasses and fall wildflowers may be planted in late winter.

As discussed previously in the trampling section, it is recommended that newly planted or seeded areas be fenced off where additional trampling is a risk.

*Table 3.1: Recommended plants by growth form. *Included in TPWD's Wildscapes plant list. Ecological zone codes: SW=shoreline woodland, SH=shoreline non-woodland, FT=floodplain terrace, away from edge, GS=Gaddy savanna, SV=savanna, RO=rocky outcrops/slopes, FP=floodplain terrace, away from edge, showy/formal planting.*

Recommended Plants

Herbaceous Species

Common Name	Scientific Name	Ecological Zones						
		SW	SH	FT	GS	SV	RO	FP
American basketflower	*Centaurea americana*				x	x		
Antelope horns	*Asclepias asperula*					x		
Beardtounge	*Penstemon laxiflorus*					x		
Black-eyed susan	*Rudbeckia hirta**				x	x		
Blue curls	*Phacelia congesta*	x		x				
Blue-eyed grass	*Sisyrinchium scabrum*				x	x		
Cardinalflower	*Lobelia cardinalis*		x					
Carolina larkspur	*Delphinium carolinianum* subsp. *virescens*					x		
Cedar sage	*Salvia roemeriana**	x		x				
Clammyweed	*Polanisia dodecandra* subsp. *trachysperma*				x			
Clasping coneflower	*Dracopis ampelexicaulis*					x		
Cowpen daisy	*Verbesina encelioides*	x		x		x		
Cutleaf evening primrose	*Oenothera laciniata*				x			
Engelmann's daisy	*Engelmannia peristenia**				x	x		
Four o'clock	*Mirabilis albida*	x		x				
Frostweed, iceplant	*Verbesina virginica*	x		x				
Gayfeather	*Liatris pycnostachya*					x		
Golden groundsel	*Packera obvata*	x		x				
Golden groundsel	*Senecio obovatus*	x		x				
Golden wave coreopsis	*Coreopsis basalis*				x			
Hairy zexmenia	*Wedelia hispida*					x		
Horsemint	*Monarda citriodora*				x	x		
Indian blanket	*Gaillardia pulchello*				x	x		
Indian paintbrush	*Castilleja indivisa*				x	x		
Lanceleaf coreopsis	*Coreopsis lanceolata*				x	x		
Late boneset	*Eupatorium serotinum*	x		x				
Limestone gaura	*Gaura calcicola*				x	x		
Lindheimer's senna	*Senna lindheimeri*					x		
Maxilillian sunflower	*Helianthus maximiliani*				x	x		
Mealy sage	*Salvia farinacea*		x			x		
Missouri primrose	*Oenothera missouriensis*					x		

Common Name	Scientific Name	Ecological Zones						
		SW	SH	FT	GS	SV	RO	FP
Narrowleaf sunflower	*Helianthus angustifolius*					x		
Netted milkvine	*Matelea reticulata*	x		x				
Old-man's-beard	*Clematis drummondii*			x				x
Partridge pea	*Chamaecrista fasciculata*				x			
Pigeonberry	*Ravina humilis*	x	x	x				
Pink evening primrose	*Oenothera speciosa*				x	x		
Plains coreopsis	*Coreopsis tinctoria* var. *tinctoria*				x	x		
Prairie agalinis	*Agalinis heterophylia*					x		
Prairie fleabane	*Erigeron modestus*				x	x		
Prairie gaillardia	*Gaillardia aestivalis*				x			
Prairie nymph	*Herbertia lahue*					x		
Prairie parsley	*Polytaenia nuttallii*					x		
Prairie verbena	*Glandularia bipinnatifida* var. *bipinnatifida*				x	x		
Purple coneflower	*Echinacea purpurea*				x	x		
Purple leatherflower	*Clematis pitcheri*	x		x				x
River fern	*Theypteris ovata*	x		x				
Scarlet clematis	*Clematis texensis*	x		x				
Scrambled eggs	*Corydalis curvisiliqua*					x		
Shrubby boneset	*Ageratina havanensis**	x		x			x	
Slender greenthread	*Thelesperma filifolium**				x	x		
Slenderleaf four-nerve daisy	*Tetraneuris linearifolia*					x		
Slenderlobe passionflower	*Passiflora tenuiloba*	x		x				
Snapdragon vine	*Maurandya antirrhiniflora*	x		x				
Standing cypress	*Ipomopsis rubra**				x	x		
Texas bluebonnet	*Lupinus texensis*				x	x		
Texas vervain	*Verbena halei*				x	x		
Texas yellow star	*Lindheimera texana*				x	x		
Turk's cap	*Malvaviscus drummondii**	x		x				
Winecup	*Callirhoe involucrata*				x	x		
Yellow passionflower	*Passiflora lutea*	x		x				

Tree and Shrub Species

Common Name	Scientific Name	Ecological Zones SW	SH	FT	GS	SV	RO	FP
American beautyberry	*Callicarpa americana**	x		x				x
American elm	*Ulmus americana**	x		x				
Anachacha orchid tree	*Bauhinia lunariodes*							x
Bald cypress	*Taxodium distichum**	x						
Black walnut	*Juglans nigra**	x		x				
Black willow	*Salix nigra*	x						
Bois d'arc	*Maclura pomifera*	x		x				
Box elder	*Acer negundo*	x		x				
Burr oak	*Quercus macrocarpa**			x			x	
Buttonbush	*Cephalanthus occidentalis**		x					
Cedar elm	*Ulmus crassifolia**			x		x	x	
Chinquapin oak	*Quercus muhlenbergii**			x				x
Common elderberry	*Sambucus nigra* subsp. *canadensis**	x	x					
Cottonwood	*Populus deltoides**	x						
Desert willow	*Chilopsis linearis*							x
Eastern redbud	*Cercis canadensis**			x				x
Eve's necklace	*Styphnolobium affine*			x			x	x
False indigo	*Amorpha fruticosa*	x	x					
Green ash	*Fraxinus pennsylvanica*	x		x				
Gum bumelia	*Sideroxylon lanuginosum*			x				

Common Name	Scientific Name	Ecological Zones SW	SH	FT	GS	SV	RO	FP
Lacey oak	*Quercus glaucoides*							x
Live oak	*Quercus fusiformis*			x		x	x	x
Mesquite	*Prosopis glandulosa*					x		
Mexican buckeye	*Ungnadia speciosa*			x		x		x
Mexican plum	*Prunus mexicana**			x				x
Monterrey oak	*Quercus polymorpha*							x
Pecan	*Carya illinoensis**	x		x			x	
Possumhaw holly	*Ilex decidua**			x				
Red mulberry	*Morus rubrum**			x				
Retama	*Parkinsonia aculeata*					x		x
Roughleaf dogwood	*Cornus drummondii*	x	x	x				
Scarlet buckeye	*Aesculus pavia**			x			x	x
Spanish oak	*Quercus buckleyi**			x			x	x
Sugar hackberry	*Celtis laevigata*	x		x				
Sycamore	*Platanus occidentalis**	x						
Texas ash	*Fraxinus albicans*							
Texas persimmon	*Diospyros texana**			x		x		
Wafer ash	*Ptelea trifoliata*			x				
Western soapberry	*Sapindus drummondii*			x				
Yaupon holly	*Ilex vomitoria**			x			x	

Grasses and Grass-like Species

Common Name	Scientific Name	Ecological Zones SW	SH	FT	GS	SV	RO	FP
Big bluestem	*Andropogon gerardii*		x			x		
Buffalograss	*Bouteloua dactyloides*				x	x		
Bushy bluestem	*Andropogon glomeratus*		x					
Canada wildrye	*Elymus canadensis**	x		x				
Carolina joint-tail	*Coelorachis cylindrica*				x	x		
Curly mesquite	*Hilaria belangeri*				x	x		
Eastern gamagrass	*Tripsacum dactyloides*		x					
Feather windmillgrass	*Chloris virgata*				x	x		
Green sprangletop	*Leptochloa dubia*				x	x		
Hall's panicum	*Panicum hallii*					x		
Indiangrass	*Sorghastrum nutans**				x	x		
Inland sea oats	*Chasmanthium latifolium*	x		x				
Little bluestem	*Schizachyrium scoparium**				x	x		
Lovegrass	*Eragrostis intermedia*				x	x		

Common Name	Scientific Name	Ecological Zones SW	SH	FT	GS	SV	RO	FP
Meadow dropseed	*Sporobolus compositus*					x		
Purple threeawn	*Aristida purpurea*				x	x		
Purpletop	*Tridens flavus*				x	x		
Sand dropseed	*Sporobolus cryptandrus*				x			
Sideoats grama	*Bouteloua curtipendula*				x	x		
Silver bluestem	*Bothriochloa laguroides*				x	x		
Spikesedge	*Eleocharis sp.*		x					
Switchgrass	*Panicum virgatum*		x					
Texas cupgrass	*Eriochloa sericea*					x		
Texas wintergrass, speargrass	*Nassella leucotricha*				x	x		
Virginia wildrye	*Elymus virginicus*	x		x				
Wild barley	*Hordeum pusillum*					x		
Windmillgrass	*Chloris verticillata*				x	x		
Witchgrass	*Panicum capillare*				x			

Recommended Plants (*continued*)

Aquatic Species

Common Name	Scientific Name	Common Name	Scientific Name
American pondweed	*Potamogeton nodosus*	Slender spikerush	*Eleocharis acicularis*
Arrowhead	*Sagittaria latifolia*	Smooth beggartick	*Bidens laevis*
Bulltounge	*Sagittaria platyphylla*	Softstem bulrush	*Schoenoplectus tabernaemontani*
Creeping burrhead	*Echinodorus cordifolius*	Spatterdock	*Nuphar advena*
Emory sedge	*Carex emoryi*	Squarestem spikerush	*Eleocharis quadrangulata*
False dragonhead	*Physostegia virginiana*	Swamp milkweed	*Asclepias incarnata*
Flatstem spikerush	*Eleocharis palustris*	Water hyssop	*Bacopa monnieri*
Giant bulrush	*Schoenoplectus californicus*	Water stargrass	*Heteranthera dubia*
Illinois pondweed	*Potamogeton illinoensis*	Water willow	*Justicia americana*
Pale spikerush	*Eleocharis macrostachya*	White water lily	*Nymphaea odorata*
Pickerelweed	*Pontederia cordata*	Wild celery	*Vallisneria americana*

Figure 3.10: Planting shoreline species like bald cypress and eastern gamagrass close to the water will greatly increase the likelihood of restoration success.

Fencing should be accompanied by explanatory interpretation.

Expanding and Enhancing the Urban Forest

As mentioned in the Ecology chapter, the study area is part of the floodplain terrace that would naturally be wooded. Many parts of the study area are recommended for woodland expansion in order to return more of the site to a natural state and to increase ecological function, shade, and visual interest (Figure 3.9). These areas were carefully chosen to minimize impacts on recreation or infrastructure. The establishment of woodlands in underutilized areas is one of the most effective ways to enhance the user experience and increase the ecological functionality of the natural areas.

This expansion will begin to naturally happen through regeneration (as seen in Figure 3.11) in areas designated as Grow Zone—which we suggest should include all areas recommended for woodland enhancement, woodland expansion, or savanna restoration in Figure 3.9. The simple act of changing visitor use patterns and mowing regimes will create new woodlands, though some maintenance will be needed to ensure that the regenerating species are desirable.

Tree planting is necessary to expedite the establishment of an ecologically functional, diverse, and aesthetically pleasing canopy. A diverse canopy will be more resilient when facing blight, drought, and climate change in the future. The recommendations in the Management Units chapter include 80 acres of woodland expansion throughout the study area. Planting densities in these areas will be variable according to the availability of resources and desired

effect in each area.

There are two primary methods used to plant trees in City of Austin parkland. The first method, primarily used by PARD, uses container plants (5 gallon or similar) with accompanying temporary irrigation, support, and ongoing maintenance. The second method, primarily used by the Watershed Protection Department in Grow Zones, is the high density planting of seedlings along waterways with little to no supporting infrastructure. These two methods vary in survival rate, installation labor, ongoing maintenance needs, overall costs, initial impact, and control of final aesthetics. The restoration and expansion of woodlands around Lady Bird Lake will rely on both of these methods.

Recommended tree planting densities should consider the benefits of these tree planting methods as well as standards for riparian and bottomland forest restoration (Allen et al. 2001). For our purposes we can look at the 80 acres of woodland expansion with a desired density of at least 85 container trees per acre to be planted over the next 4 years and an additional 200 seedlings per acre. To maximize the benefits of both practices, container trees should be initially planted in groves with accompanying infrastructure and should be concentrated in, but not limited to, areas that shade the trail. Spacing can range from 10 to 30 ft. These areas can then be expanded with additional seedlings planted within and around the groves. This combination of planting, along with proper site preparation as described above, will substantially increase seedling survivorship, especially if there is temporary irrigation or a water source available during drought periods. In addition to this method, seedlings can be planted along the water's edge and near existing woodlands.

In woodland enhancement areas, the density and type of planting will be contingent on what is currently there. The overall goal will be to increase age class, size, and species diversity to create a more resilient canopy. Planting in these areas is currently not as high a priority as establishing new woodlands in other areas. The highest priorities in existing woodlands are controlling invasives and erosion. When the degradation is significant enough, however, planting may be necessary to repair an erosion issue or to fill an ecological niche formerly filled by an invasive species.

In woodland expansion areas, understory and groundcover establishment will be a critical part of creating healthy woodland plant communities. As canopy trees are being established, the understory can also be enhanced by planting species such as: yaupon holly, possumhaw holly, gum bumelia, red mulberry, roughleaf dogwood, common buttonbush, wafer ash, Eve's necklace, American beautyberry, Texas persimmon, and false indigo. In addition, early successional species and fast growing plants that can begin to reduce the dominance of Bermuda grass can be used as transitional species as trees are establishing. These areas can also be seeded with native wildflowers to make them more visually appealing as they transition to woodlands.

Figure 3.11: Abundant cottonwood seedlings in a recently converted Grow Zone in the Southeast Shore.

As trees become established in a three to five year timeframe, more attention should be given to more shade-tolerant understory and groundcover species.

In woodland enhancement areas, increasing the diversity of understory and groundcover is an effective means of filling ecological niches after invasive species control and/or erosion mitigation. As other management priorities are addressed, increasing diversity within existing woodlands will become a higher priority. It is also a way to supplement wildlife food plants and create aesthetic appeal throughout the study area.

Tree Care

As a part of this assessment, consulting arborist Don Gardner compiled a list of trees in need of care or removal. A list of trees needing attention, along with location information, was provided to PARD. Gardner also pointed out 7 live oak groves in need of crown cleaning and structural pruning in the following locations:

- In Festival Beach south of Nash Hernandez Street between I-35 and nearest parking lot.
- In Festival Beach north of the parking lot mentioned above to the old Aquatic Center.
- In Festival Beach north of the eastern end of Nash Hernandez, just west of Fiesta Gardens.
- In the "Love of Christi" grove in Festival Beach.
- On the south shore, near the Austin American Statesmen building and going east.
- Near the Hostel in the Southeast Shore.
- Near Lakeshore Drive, from the new restroom at the east end of the boardwalk, going east.

In his assessment he noticed a positive change in the maintenance of trees and encouraged the Urban Forestry Department to maintain their efforts along the Butler Trail. We also recommend institutionalizing an annual tree risk assessment for the Trail.

Savanna Restoration

Many of the large mowed areas in the study area present opportunities for more sun-loving plants characteristic of the Blackland Prairie found in the eastern portions of Austin and the unique Gaddy soils found in several parts of the study area. Grasses such as little bluestem, big bluestem, Indiangrass, switchgrass, and eastern gamagrass can be planted to shade out Bermuda grass in select areas and, where appropriate, plants appropriate for Gaddy Soils such as witchgrass, sand dropseed, evening primrose, and partridge pea should be included in the seed mix. A list of recommended savanna species is in Table 3.1.

Restoring native savanna is challenging in general and will be particularly challenging in the study area due to an entrenched carpet of Bermuda grass and other urban influences. While increasing diversity in the study area is a goal, savanna restoration is not seen as an immediate high priority due to the resource intensity of dealing with invasive species, the high level of ongoing management needed, and the long list of other priorities in the study area. As other priorities are addressed in the study area and better options for savanna restoration become available with examples from comparable sites, the restoration of savanna plant communities on the Gaddy soils will become a higher priority for implementation.

In the shorter-term, it is recommended that areas recommended for savanna restoration move towards the wildflower meadow practices already in place for parts of the study area that reduce overall mowing. A mix of Texas wildflowers can transform the current lawns into beautiful spring wildflower displays—pleasing to trail users and beneficial for native bees, butterflies, and other pollinators—like the ones currently found in several areas along the north shore near Cesar Chavez Street. The long-term restoration of savanna plant communities and the near-term increase in wildlfower and savanna species will increase the diversity of plants and animals found within the study area and protect a plant community currently unprotected in Travis County.

Aquatic Restoration

The City of Austin's Watershed Protection Department is working to increase the diversity and volume of aquatic plantings in Lady Bird Lake. Since 2004 the City of Austin has partnered with the University of North Texas on aquatic vegetation restoration efforts in Lady Bird Lake and Lake Austin (Dodd, Dick, and Schad 2013). To facilitate expanding upon those efforts, we have identified areas that may be appropriate for aquatic plantings based on existing vegetation, protection from flood flows, and the existing water levels. The goal of the aquatic plantings is to increase the diversity of the site overall, increase wildlife habitat, and improve water quality. Plantings should follow City of Austin best management practices and practices laid out in TPWD's Propagation and Establishment of Native Aquatic Plants in Reservoirs document (Clamman 2015, Webb et al. 2012). Best management practices will need to include sediment stabilization, species selection, caging to protect against herbivory (as shown in Figure 3.12), and protection from high winds and wave action.

Wildlife Habitat Enhancement

The urban forest and natural areas of Lady Bird Lake serve as a refuge and a corridor for wildlife in the highly urbanized Austin area. Over 190 bird species have been documented in the study area and the immediate surroundings, with over 80 additional species of reptiles, amphibians, and mammals known to inhabit surrounding areas. By addressing degradation issues, changing land management practices, and restoring natural areas per the recommendations here, the wildlife habitat within the study area will more than double in size and food and shelter options will increase substantially. Continued enhancement of the natural areas and creation of more resilient native plant communities, with an emphasis on plants that provide wildlife food or habitat as shown in Table 3.1, will encourage a greater amount and diversity of wildlife to inhabit the study area.

Aquatic plantings will provide valuable food and cover for invertebrates, fish, and other wildlife. Additional riparian trees will increase shade to help regulate temperature on hot summer days and provide important refugia for fish such as perch. Woodland expansions will increase patch sizes substantially, from a narrow strip throughout most of the site to contiguous woodland as large as 20 acres. Large woodland patches will provide more cover and food, improving habitat for numerous animals not currently common around Lady Bird Lake but seen in other natural areas nearby. Savannas and expanded wildflower meadows can provide habitat for wintering sparrows and numerous migratory species passing through every year. They can also provide habitat and food needed by lizards, small mammals, and numerous beneficial insects including native species of bees and butterflies.

Expanding the amount of land under natural area management and improving the quality of the existing plant communities will lead to better wildlife habitat. Wildlife habitat can be augmented with nesting boxes for both birds and native pollinators as desired. In addition, formal garden areas along the Trail can continue to be planted in "wildlife themes" that also work as seed sources, such as:

- Native milkweed-dominated beds for monarch butterflies.
- Urban bird food plants.
- Plants beneficial for native bees.
- Plants beneficial for native butterflies.

Figure 3.12: Exclosures are recommended for some aquatic plantings to protect against herbivory.

Management Units

The project area has been divided into management units to facilitate implementation and discussion of current conditions, needed management, priorities, and work tasks. The management units can be seen in Figure 4.2. They are primarily distinguished by slope, the ratio of heavily managed lawn to lightly managed woodland, and the quality of natural areas present.

This chapter contains a description of the current ecological state of each management unit, a narrative description of management needs, and a list of prioritized management tasks. While there are discrete tasks recommended, this document should remain dynamic and adapt to successes and challenges within the study area, new information from related projects, changes in weather patterns, the availability of resources, and/or changes in user preferences.

To generally categorize management needed in each area, the tasks have been put into the following categories:

{R} Restoration: This category includes activities such as converting an area from lawn to woodland and planting to increase diversity.

{I} Invasive species management: These actions actively or passively reduce a particular invasive species, and include: physical removal, the use of herbicides, out competing, and shading out.

{E} Erosion control and soil restoration: This category includes all activities designed to mitigate erosion impacts or repair damaged soil. Activities address the need for green infrastructure, hard infrastructure, and/or soil restoration and include: bioswale instillation, regrading, culvert instillation, soil decompaction, and mulching.

{U} User experience: This category encompasses a wide range of activities designed to enhance the experience of using the Trail, including: increased aesthetic appeal, improved access to the water, trail improvements, and increased safety.

About the Tree Data

The ecological descriptions for each unit include tree inventory information for both woodland areas and mowed areas. All data about number and density of trees refers only to individuals with a diameter at breast height (4.5 ft) of 8" or more.

There are also two designations from the City of Austin Code of Ordinances used in the descriptions:

Protected Trees: trees 19" or greater in diameter at breast height.

Heritage Trees: certain desirable native trees 24" or greater in diameter at breast height. Species that qualify as heritage trees are: Texas ash, bald cypress, American elm, cedar elm, bigtooth maple, all oak species, pecan, Arizona walnut, and eastern black walnut.

Tables 4.1 and 4.2 provide summaries of the tree data and overall vegetation information by management unit for quick comparison across the entire study area.

Figure 4.1: Area in Festival Beach where woodland expansion and re-establishment of groundcover will improve the aesthetics, reduce erosion, and increase ecological function.

Table 4.1: Summary of tree data by management unit based on information collected during the 2014 tree inventory conducted by Siglo Group.

Management Unit	Total acres	Tree count	Trees/ acre	Basal area (ft2/acre)	Average DBH	Protected tree count	Heritage Tree count	Trees/100' of shoreline	% shade on trail	% canopy cover	Acres woodland	Trees/acre woodland	Acres non-woodland	Trees/acre non-woodland
Deep Eddy	1.7†	90	53	66	13	7	3	4.8	36%	57%	1.0	86	0.8	11
Austin High	12.2	917	75	87	13	154	61	7.5	71%	71%	8.7	104	3.5	3
Cesar Chavez	19.4	745	38	72	17	232	110	6.7	40%	46%	3.0	141	16.4	20
City Hall Strip	7.7	247	32	49	15	54	22	5.2	63%	46%	1.3	131	6.4	13
Hotel Slope	4.8	135	28	66	19	36	17	2.9	72%	69%	0.9	40	4.0	25
Waller Creek	5.1	n/a	n/a	n/a	13*	n/a	n/a	n/a	45%	67%	3.1	n/a	2.1	n/a
Rainey	12.9	406	31	54	16	114	51	4.3	47%	57%	3.0	81	9.9	16
Festival Beach	35.3	722	20	44	18	293	148	1.8	44%	41%	1.6	96	33.8	17
Holly Shores	20.9	535	26	41	15	108	50	4.5	22%	29%	5.2	85	15.7	6
Southeast Shore	30.7	373	14**	28**	18	194	76	3.5	21%	35%	5.3	70**	25.4	11
The Cliffs	5.6†	349	63	70	13	49	n/a	7.6	94%	89%	5.6	63	0.0	n/a
Southcentral Shore	3.3	276	83	190	19	118	62	6.8	69%	66%	2.0	120	1.4	29
Auditorium Shores	3.7	99	26	46	16	27	9	3.1	25%	40%	0.0	n/a	3.7	26
PARD Woodland	8.2	403	49	99	17	108	59	6.1	82%	77%	6.0	59	2.2	23
Zilker East	6.1	316	52	156	19	116	73	5.3	55%	76%	5.9	53	0.3	12
Zilker West	13.2	660	50	59	13	86	31	7.8	22%	54%	7.6	83	5.6	6
All	190.9†	6273	34	56	16	1696	772	5.4	48%	49%	59.8	80	131.1	14

**The average DBH reported for Waller Creek was based on the 70 trees for which information was available from PARD as that unit was not included in Siglo Group's tree inventory. **Data reported excludes 3.8 acres of woodland that were outside of Siglo Group's inventory and for which consistent data were not available from PARD. †Excludes dog park, community garden, and fenced off areas.*

Table 4.2: Summary of species counts by management unit based on botanical survey by Bill Carr in Fall 2014.

Management Unit	Species count	Native species	Exotic Species	Invasive Species	Aquatic Species	Annual Forbs	Annual Forb Vines	Perennial Forbs	Perennial Forb Vines	Annual Grasses*	Perennial Grasses*	Perennial Ferns or Fern Allies	Shrubs	Trees	Woody Vines
Deep Eddy	53	30	12	4	0	8	0	7	2	3	4	0	10	12	7
Austin High	124	89	28	3	4	21	1	31	8	4	12	0	13	20	10
Cesar Chavez	148	91	24	13	2	11	0	28	5	4	20	0	32	35	11
City Hall Strip	89	53	19	2	2	9	0	16	4	2	8	0	21	21	6
Hotel Slope	56	36	12	3	3	4	0	10	3	0	8	0	7	13	8
Rainey	60	46	8	1	1	7	0	10	5	1	7	0	7	15	7
Festival Beach	122	86	21	5	5	18	0	25	5	3	17	0	15	27	7
Holly Shores	115	79	24	6	1	18	0	30	5	3	14	1	12	25	6
Southeast Shore	168	114	30	4	6	25	0	36	7	7	23	1	26	30	7
The Cliffs	118	75	23	4	1	14	0	23	5	6	10	1	24	27	7
Southcentral Shore	73	49	16	3	1	5	0	9	3	2	8	0	14	23	8
Auditorium Shores	93	69	16	4	3	12	1	20	4	5	9	1	11	21	6
PARD Woodland	67	48	12	1	2	6	0	12	5	1	6	0	8	21	6
Zilker East	92	69	13	3	2	9	0	22	4	1	8	0	14	22	10
Zilker West	87	65	14	2	1	18	0	16	4	3	8	1	10	19	7

**Or grass-like species.*

SUMMARY OF HIGH PRIORITY LAND MANAGEMENT TASKS FOR ALL UNITS

[E & R] Use downed material as mulch to increase organic matter in the soil where it has been eroded or depleted.

[R & I] Passively reduce patch size and health of Johnsongrass and giant reed through increased density of the native canopy.

[R] Annual mulching under trees that are currently without an herbaceous layer.

[E] Stabilize trail and eliminate crushed granite deposition off-trail.

[U] Ensure there is formal access along the water's edge in every unit where feasible to enhance the user experience and reduce degradation from informal access to the sensitive shoreline area.

[U, E, & R] Where the trail is impacting the water's edge or is next to a steep slope, move the trail farther inland by reducing trail width (where practical) and/or moving the trail inland as space allows to increase riparian area and reduce degradation of the shoreline.

[R] Consider the majority of the study area as part of the Grow Zone and work towards a fully functional riparian area.

[R] Demarcate existing Grow Zones (defined on page 27) as well as those being added and ensure coordination of land management activities between PARD and Watershed Protection.

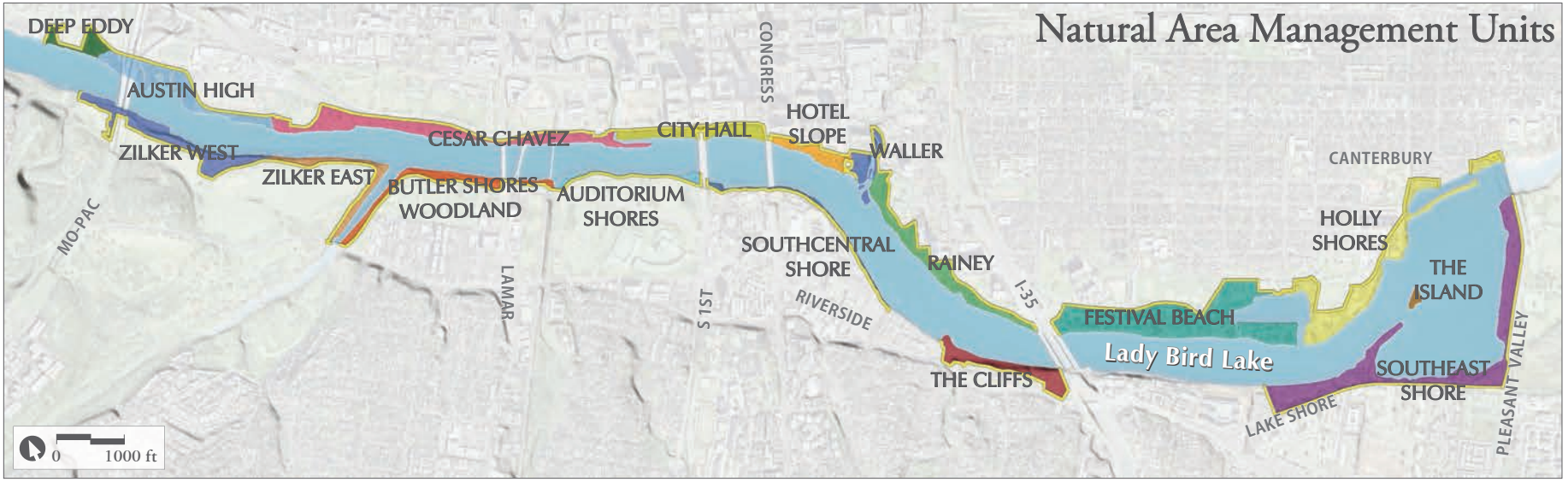
[R] Reduce the amount of underutilized mowed areas wherever feasible and restore areas to Floodplain Terrace Woodland or Shoreline Woodland, depending on location.

[R] Increase diversity of plants beneficial to wildlife through seeding and live planting with special attention to areas around the Trail, park infrastructure, the Lake, and creeks.

[I] Monitor for invasives biannually and address new issues as they arise. This will require ensuring that resources are available on an ongoing basis for these activities.

[R & I] Where tree establishment is occurring, control for invasives and thin more common trees to allow for the establishment of a more diverse canopy.

Figure 4.2: Natural Area Management Units. Sources: COA, NAIP. Note: While The Island is considered part of the study area, because of its remoteness and other high priorities, no management recommendations area made for The Island at this time.



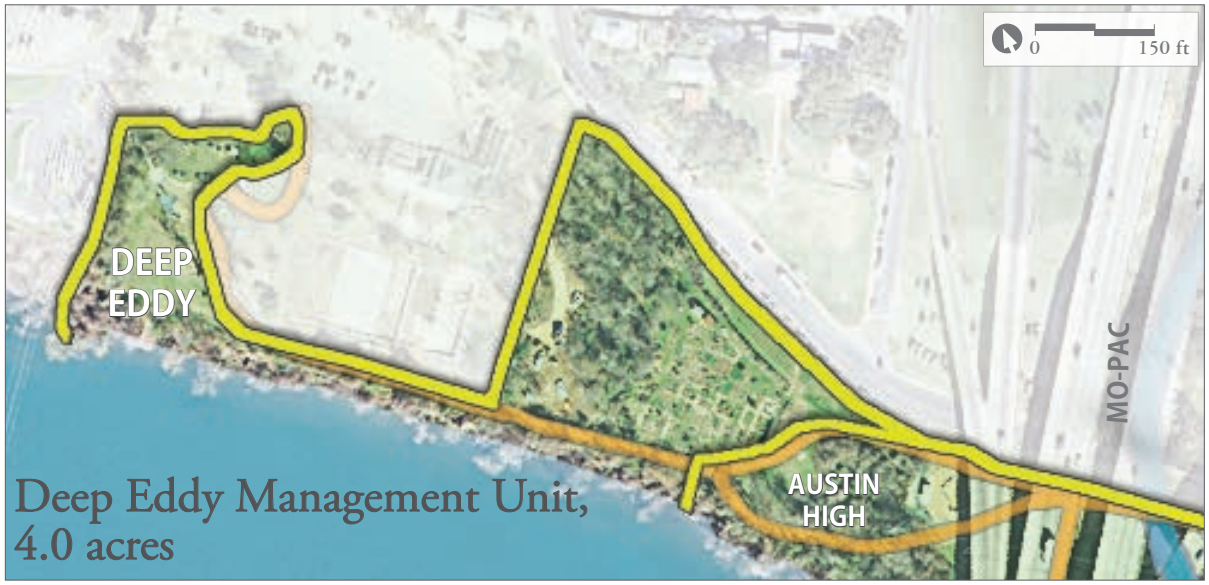
DEEP EDDY UNIT

The Deep Eddy Unit consists of the western portion of Eilers Park (the eastern portion of which contains Deep Eddy pool) and woodland areas on the western edge of the park and south of Butler Creek Trail (Figure 4.3). The unit also includes a woodland area east of Eilers Park that is fenced off and a community garden, neither of which were included in the description and recommendations below. Recommendations are made for 1.3 acres of the 4-acre unit (Figure 4.5).

Ecology

Eilers Park is a mowed area, but contains a 60" diameter cottonwood and several smaller trees. The woodland section is just under 1 acre of the 1.7 acres inventoried (which excludes the fenced-off area and community garden) and is on a short, steep slope to the Lake. Current overstory trees of the woodland include sugar hackberry, pecan, American elm, and Chinaberry. Chinese tallow, black willow, and bald cypress are common along the shore. It is not a very dense shoreline woodland, with fewer than 5 trees per 100 ft of shoreline. The woodland is dominated by small trees, with only 6 protected trees in the woodland. The understory consists primarily of cherry laurel, along with white mulberry and Texas redbud along the Trail. There are also substantial patches of American elm regeneration. The slope from the Trail to the Lake is relatively steep. The most distinguishing feature of this management unit is the proliferation of vines that cover much of the natural area. English ivy is an abundant groundcover and many trees and shrubs are shrouded in peppervine, poison ivy, mustang grape, Virginia creeper, and sweet autumn clematis (Figure 4.4). Large metal scraps and the remains of a short limestone wall within the woodland suggest that this area was once heavily managed or manicured.

Figure 4.3: Deep Eddy Management Unit boundaries. Sources: COA, NAIP



Invasive Species

Invasive species pose a significant threat in this management unit. A large catclaw vine infestation at the entrance of Eilers Park is one of only 5 documented locations for the species within the study area. Sweet autumn clematis is another invasive vine found in the unit. It, along with several native vine species, is smothering many of the trees along the Trail. Chinese tallow is found along much of the shoreline, with an especially large infestation in the southwest corner of the unit. Chinaberry is also common in the overstory farther inland. Loquat is

*Table 4.3: Tree summary for all trees ≥8" diameter in the Deep Eddy Unit. *Excludes the 2.3 acres of community garden and fenced-off woodland.*

Tree Summary

Unit area	1.7 acres*
Total trees	90
Trees/acre	53
Basal area	66 ft^2/acre
Average diameter	13"
Protected tree count	7
Heritage Tree count	3
Trees/100' of shoreline	4.8
Canopy cover	57%
Shaded trail	36%
Woodland area	0.95 acres
Trees/acre in woodland	86
Non-woodland area	0.75 acres
Trees/acre non-woodland	11

quite common in this unit. There are also several large, very dense patches of giant reed along the shoreline and north and west of Eilers Park.

Disturbance

Though there are relatively steep slopes within this unit, they are currently stable and do not show signs of excessive erosion.

Management Recommendations

The primary management goals in this area are to increase both the size and ecological health of the woodlands. Underutilized portions of Eilers Park can be converted to woodland, and the health of the woodlands can be improved through a combination of addressing invasive species issues, managing the abundant vines, and, eventually, increasing biodiversity by seeding and planting.

Land Management Tasks

[R] Increase area and canopy cover of the woodlands in lower section of Eilers Park. **High priority**

[I] Remove catclaw vine at the entrance to Eilers Park. **High priority**

[U & R] Cut grape vines off some of the trees south of trail, use this as an opportunity to cut "windows" through the vegetation so that the Lake can be seen from Deep Eddy Pool area. **High priority**

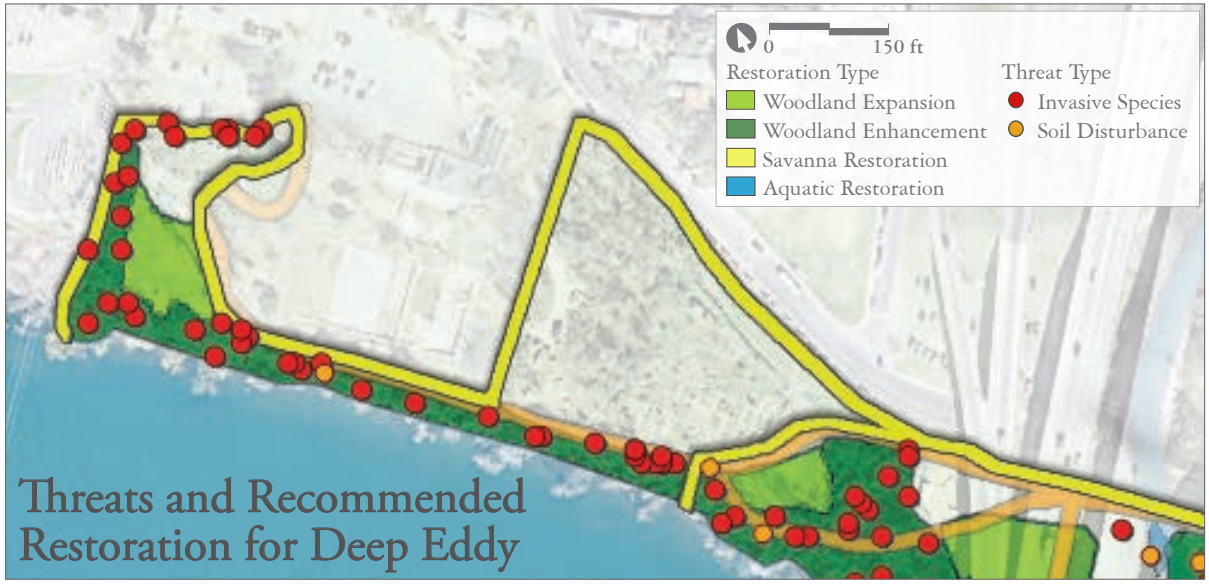
[I & R] Remove giant reed along shoreline. This action will necessitate bank stabilization, planting, and seeding in the following years. **Medium priority**

[I] Remove Chinese Tallow and Chinaberry in woodland. **Low priority**

[R] Increase diversity of existing woodland—will become higher priority after the above issues are addressed. **Low priority**

[I] Remove English ivy. Not worth the soil disturbance at this time. **Not recommended**

Figure 4.4 (Left): Abundant vines cover much of the Deep Eddy Unit. Figure 4.5 (Below): Invasive species, erosion issues, and recommended restoration work in the Deep Eddy Unit. Sources: COA, NAIP.



AUSTIN HIGH UNIT

The Austin High Unit lies between Veteran's Trail to the north, the community gardens to the west, the Lake to the south, and the boat ramp to the east (Figure 4.6). The far western extent of the unit is part of Eilers Park, but the remainder is part of Lamar Beach at Lady Bird Lake Metro Park. MoPac and Johnson Creek cross the unit, Austin High is just to the north, and there is a rowing facility within the unit. The unit includes 12.2 acres with recommendations here for 10.2 acres and aquatic restoration recommended in an additional 2.8 acres (Figure 4.9).

Ecology

This management unit primarily consists of woodland, 8.7 acres, except for the area under the MoPac bridges. To the west of MoPac, the woodland is primarily young sugar hackberry with some older pecans and a dense understory of roughleaf dogwood, cherry laurel, and poison ivy. The woodland is on a steep slope down to the shoreline, where bald cypress is dominant. The central section of the unit slopes steeply from the Trail down to a relatively wide and flat woodland that fingers out into the Lake. These low peninsulas have some of the wettest soils in the study area and some of the most intact, diverse woodlands with a mixture of box elder, sugar hackberry, American elm, black willow, and invasive Chinese tallow. The wettest portion, near the mouth of Johnson Creek, is primarily young box elder and black willow, with a thick groundcover of poison ivy, inland sea oats, false-nettle, and giant ragweed along with invasives including elephant ear, Mexican petunia, and sweet autumn clematis. Several seasonal pools on the peninsula are among the only such features found in the study area. Farther upland, the woodland is heavily dominated by sugar hackberry, with abundant cherry laurel in the shrub layer.

Table 4.4: Tree summary for all trees ≥8" diameter in the Austin High Unit.

Tree Summary

Unit area	12.2 acres
Total trees	917
Trees/acre	75
Basal area	87 ft²/acre
Average diameter	13"
Protected tree count	154
Heritage Tree count	61
Trees/100' of shoreline	7.5
Canopy cover	71%
Shaded trail	71%
Woodland area	8.7 acres
Trees/acre in woodland	104
Non-woodland area	3.5 acres
Trees/acre non-woodland	3

Figure 4.6: Austin High Management Unit boundaries. Sources: COA, NAIP.

Figure 4.7: The dense woodlands in much of the Austin High unit shade the Trail, making it one of the most pleasant and popular stretches along the Trail.

The numerous inlets and peninsulas in this management unit result in nearly 4,000 ft of shoreline. With 7.5 trees per 100 ft of shoreline, it is one of the most densely treed sections of shoreline in the study area. Bald cypress is abundant in the unit, including numerous Heritage Trees. The Trail is extremely close to the shoreline in the eastern portion of this unit, providing little room for riparian vegetation and in some cases spilling decomposed granite directly into the Lake (Figure 4.8). Though there is little terrestrial riparian vegetation, there are several aquatic plant species present. Native species include American water-willow, Emory sedge, and pickerel weed (which is native to Texas, but not to Travis County).

Invasive Species

Invasive species in this unit include: elephant ear, Mexican petunia, and Chinese tallow. Sweet autumn clematis is also abundant on the peninsulas. Several aquatic invasives are found along the eastern section of the unit, including yellow iris, and alligator-weed. Chinaberry is present primarily on the edges of the woodland, and heavenly bamboo is present throughout much of the upland forest.

Disturbance

Several heavily used informal trails connect Veterans Drive to the Trail (Figure 4.10). These trails are quite wide in some areas and have compacted soils. Additional informal trails are found on the peninsulas. One heavily used trail goes to a wooden landing at the water's edge, suggesting that it was at one time a formal trail. Several other more lightly used trails lead farther onto the peninsulas, some leading to trash and debris from former encampments. High water events have also deposited large amounts of trash on the peninsulas and led to bank erosion along Johnson Creek.

Management Recommendations

Management in this area should focus on enhancing the relatively intact woodland in this unit while addressing acute issues. In the woodlands and associated aquatic areas, efforts should focus on invasive species removal, general cleanup, and increasing plant diversity through planting and seeding. In the eastern portions of the unit, the Trail should be shifted several feet inland and the trail surface should be stabilized. This change will necessitate restoration plantings. Two informal trails between Veterans Drive and the Trail and one in the wooded peninsulas should be formalized and the rest should be decommissioned. As resources become available, the area under MoPac can be restored. Work under the highway has great potential to expand the natural areas but will need to address stormwater issues, soil decompaction, and a lack of direct sun for most of the area.

Figure 4.8: Decomposed granite covering riparian vegetation and falling directly into the Lake.

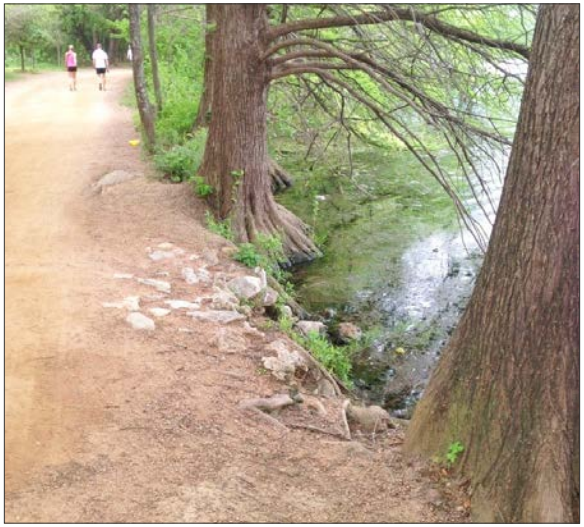


Figure 4.9: Invasive species, erosion issues, and recommended restoration areas in the Austin High Unit. Sources: COA, NAIP.

Figure 4.10: One of several of the heavily used informal trails between Veteran's Drive and the Trail.

Land Management Tasks

[U, E, & R] Move edge of Trail inland several feet where feasible to create more habitat for riparian plants. This can be accomplished through a combination of reducing the width of the Trail and moving it inland. High priority

[E] Stabilize Trail and eliminate crushed granite deposition off-trail. High priority

[R] Plant riparian areas between moved trail and water's edge. Temporary signage and/or fencing may be needed to discourage trampling until plants become established. High priority

[U, E, & R] Formalize the two major informal trails leading from Veterans Drive to the Trail and restore others with a combination of brushing, soil decompaction, and planting tree seedlings. High priority

[I] Remove catclaw vine patches before they become a major issue in the area. High priority

[R] Increase woodland diversity with special attention to the more intact areas in western portions of the management unit. Medium priority

[R] Plant aquatic species to promote greater aquatic plant diversity. Medium priority

[U, E, &R] Formalize a portion of the trails on the peninsula and decommission other trails with a combination of brushing, soil decompaction, and planting of tree seedlings. Medium priority

[R] Add sediment capture structures near existing wetland to encourage its spread. Medium priority

[R] Remove homeless encampment debris on peninsulas. Medium priority

[I] Remove Chinaberry and Chinese Tallow throughout area with special attention to those impacting native trees. Medium priority

CESAR CHAVEZ UNIT

The Cesar Chavez Unit is bordered by Cesar Chavez Street to the north, the boat launch to the west, the Lake to the south, and Shoal Creek to the east (Figure 4.12). It is crossed by Lamar and the Pfluger Pedestrian Bridge, and it contains the now-retired Green Water Treatment Plant intake buildings that are currently being considered for restoration. The majority of the unit is within Lamar Beach at Lady Bird Lake Metro Park, but the area east of Lamar is in Shoal Beach at Lady Bird Lake Metro Park. The unit is 19.4 acres, with recommendations for 16.5 acres (Figure 4.13).

Ecology

The unit is relatively flat, with large expanses of lawn edged by steep, narrow woodlands sloping down to the Lake. Just under 3 acres of this unit are considered woodland, primarily in a thin 10 to 30-ft strip between the Lake and the Trail. Bald cypress makes up over 40% of the surveyed trees. Of the 187 bald cypress surveyed in the woodland,

Tree Summary

Unit area	19.4 acres
Total trees	745
Trees/acre	38
Basal area	72 ft²/acre
Average diameter	17”
Protected tree count	232
Heritage Tree count	110
Trees/100’ of shoreline	6.7
Canopy cover	46%
Shaded trail	40%
Woodland area	3.0 acres
Trees/acre in woodland	141
Non-woodland area	16.4 acres
Trees/acre non-woodland	20

Table 4.5 (Above, left): Tree summary for all trees ≥8” diameter in the Cesar Chavez Unit. Figure 4.11 (Above, right): The majority of the Cesar Chavez Unit is mowed lawn accented with shade trees. Figure 4.12 (Below): Cesar Chavez Management Unit boundaries. Sources: COA, NAIP.

Land Management Tasks

[R] Expand woodland throughout the area. High priority

[E & U] Stabilize crushed granite trail to minimize granite deposition off-trail. High priority

[U & R] Move sections of the Trail away from the shore to create more interesting trail, reduce granite deposition onto the sensitive shoreline area, and allow for a wider riparian zone. High priority

[I & R] Remove Chinaberry near Shoal Creek restoration project to reduce potential infestation in newly restored areas. May require tree planting and erosion control blankets. High priority

[R] Amend and decompact soil, plant, and seed areas formerly part of the Trail. High priority

[R] Convert areas recommended for savanna restoration to wildflower meadow management to begin transition towards savanna. High priority

[I & R] Remove Chinese Lacebark elm. Will require extensive lakeshore tree plantings and erosion control blankets. Medium priority

[U & E] Coordinate with Watershed Protection Department to determine need for and proper location of water access. Medium priority

[R] Increase diversity of existing woodland—will become higher priority after the above issues are addressed. Medium priority

[R] Restore savanna on Gaddy soils just east of baseball field. Low priority

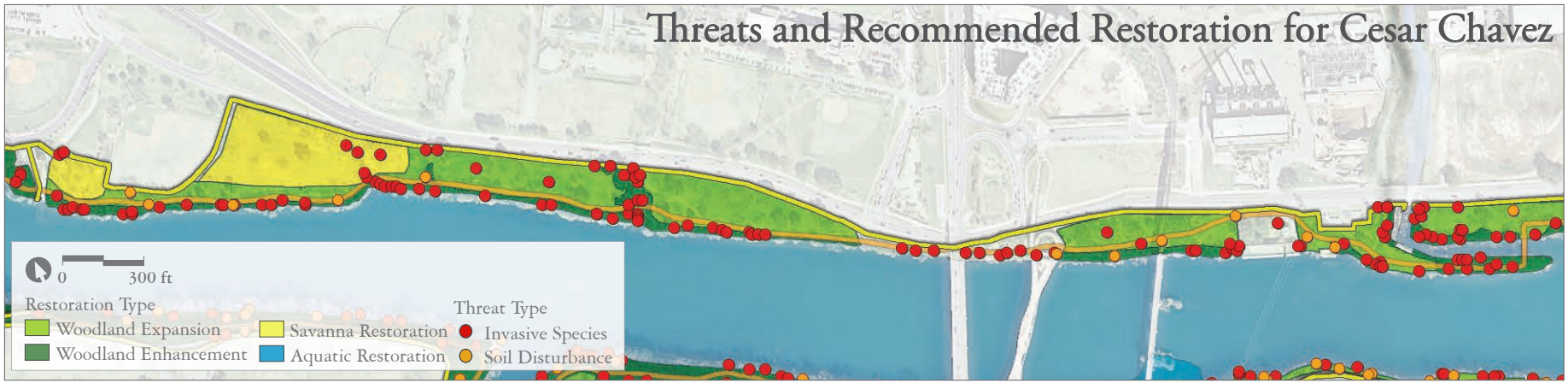
[R] Restore savanna area under Mesquite grove southwest of the Austin High baseball field. Low priority

[U & E] Decommission informal trails near Seaholm with a combination of brushing, soil decompaction, and planting tree seedlings. Low priority

66 are Heritage Trees. Although it is narrow, the woodland is quite dense, with 141 trees per acre, and contains larger trees than many comparable sections of the study area. Despite their dominance in the canopy, there is very little regeneration of bald cypresses. The understory in the western portion of the unit is dominated by invasive Chinese lacebark elm. Farther east, cherry laurel and roughleaf dogwood are abundant in the understory.

The remainder of the area is managed lawn with scattered shade trees and ornamental plantings (as seen in Figure 4.11), much of which is on Gaddy sandy soils. Pecan and live oak are the most abundant shade trees in the lawn, though Chinese tallow, sugar hackberry, and red oak, are also common. In addition to the more common shade tree species, the area west of the baseball field contains one of the few mesquite groves found in the study area. Tree plantings by The Trail Foundation, the most recent taking place in 2012, contain a mixture of native (bur oak) and native but out of natural range (Mexican white oak) trees.

Figure 4.13: Invasive species, erosion issues, and recommended restoration areas in the Cesar Chavez Unit. Sources: COA, NAIP.



The peninsula at the mouth of Shoal Creek is the site of a restoration project, including native tree plantings as well as restoration of the herbaceous layer. Because the peninsula has already been the focus of extensive planning and restoration work, this report does not make detailed recommendations for that area.

Invasive Species

Invasive trees form a significant component of the woodlands in this unit. Chinese lacebark elm is the most abundant throughout, forming a near monoculture of both saplings and mature individuals in the western portion. There is a large, dense infestation of sweet autumn clematis at the western extent of the unit and smaller patches scattered east of Lamar Boulevard. Elephant ear is common along the shoreline, but less pervasive than in much of the study area. Chinese tallow is common along the shoreline, both as dense stands and as scattered individuals. Invasive species are also posing a threat to the restoration project at Shoal Creek. Johnsongrass and elephant ear are already common, and nearby infestations of Chinaberry and Chinese tallow are likely serving as undesirable seed sources to the restored area.

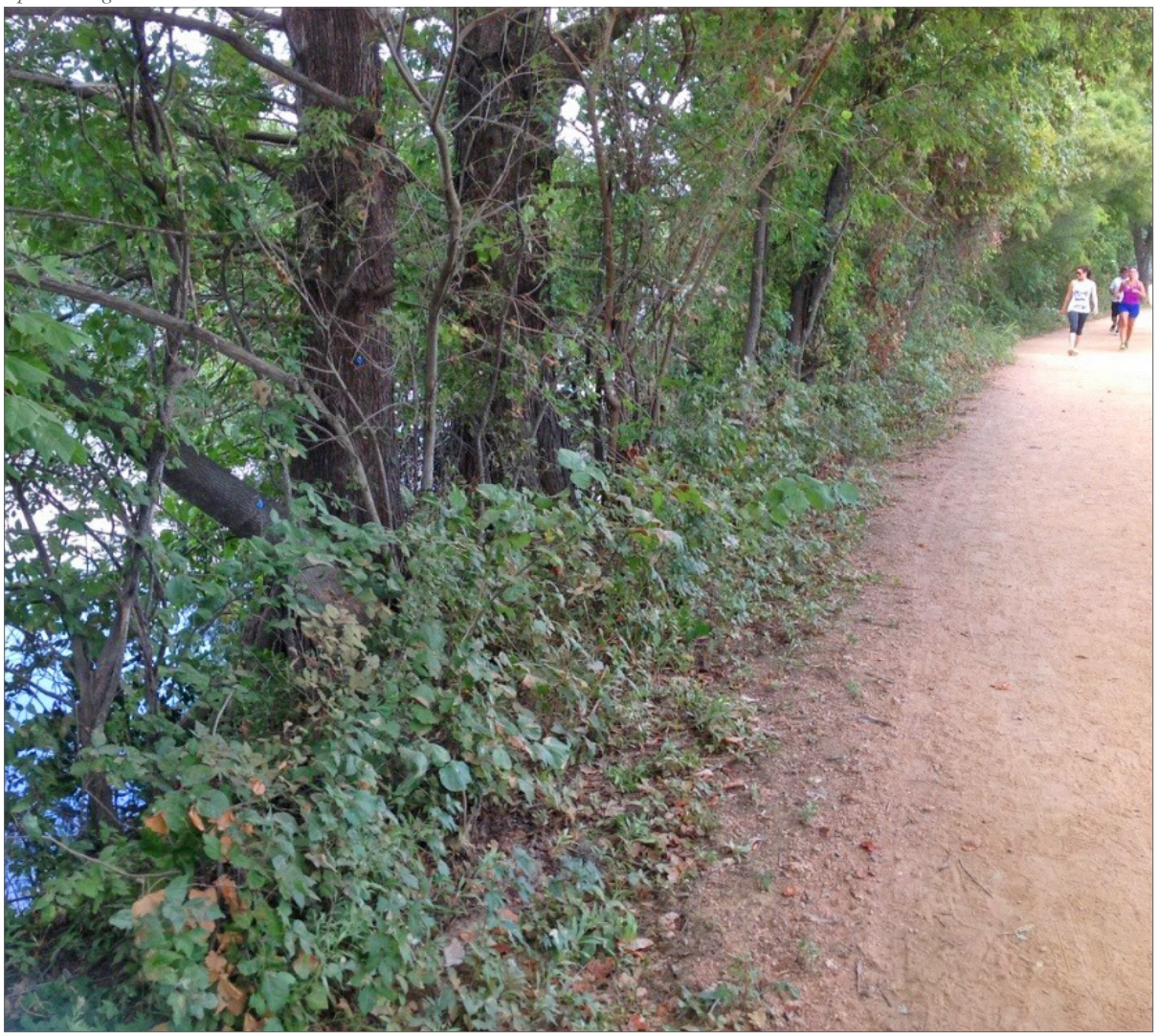
Disturbance

There are several informal trails near the Seaholm intake area and occasional informal trails elsewhere. There is some waterside trampling and a culvert resulting in gully erosion just south of the baseball diamond in the western portion of the unit.

Management Recommendations

The area will benefit greatly from expansion of the woodlands into underutilized lawn areas as well as trail alignment alterations that move the Trail away from commonly wet areas and allow for a larger riparian edge (Figure 4.14). As resources become available, restoring savanna plant communities in the Gaddy soils can make this a unique site among protected lands in Travis County.

Figure 4.14: The Trail is extremely close to the Lake in parts of the Cesar Chavez unit. Trail realignment would allow for a wider riparian edge.



CITY HALL UNIT

The City Hall Unit is bordered by Cesar Chavez Street to the north, Shoal Creek to the west, the Lake to the south, and Congress Avenue to the east (Figure 4.15). The unit makes up the majority of the Shoal Beach at Lady Bird Lake Metro Park. It is crossed by South 1st Street, has overhead powerlines running through its length, and is heavily influenced by downtown. The unit consists of 7.7 acres, with 6 acres recommended for specific natural area management tasks along with 0.3 additional acres of aquatic restoration (Figure 4.17).

Ecology

The City Hall Unit's woodland is a thin strip between the Trail and the Lake ranging from approximately 8 to 35 ft wide. Only 1.3 acres of this unit are currently woodland. The woodland area is heavily impacted by invasive species. East of 1st Street the understory is dense and almost entirely golden rain tree. West of 1st Street the understory is less dense but also more diverse, with sugar hackberry, American elm, cedar elm, huisache, box elder, green ash, and Spanish oak. Bald cypress is present but is less abundant here than comparable areas. Only 11 bald cypress were recorded out of 168 inventoried trees (6%), whereas bald cypress made up 42% of inventoried woodland trees in the Cesar Chavez Unit and 19% in the Austin High Unit. The woodland is composed primarily of small trees, with 64% of trees surveyed falling between 8 and 14" diameter. This unit has fewer trees along the shoreline than other similar units.

North of the Trail is steeply sloping lawn with both older and newly planted trees and shrubs. The older plantings include exotic species such as crepe myrtle, Bradford pear, and golden rain tree. The recent plantings by The Trail Foundation include live oak, cedar elm, desert willow, flameleaf sumac, evergreen sumac, Texas kidneywood, Mexican-olive, and anacacho orchid tree. Portions of the lawn are managed as wildflower meadows, with spring mowing delayed until after wildflowers have gone to seed (Figure 4.16).

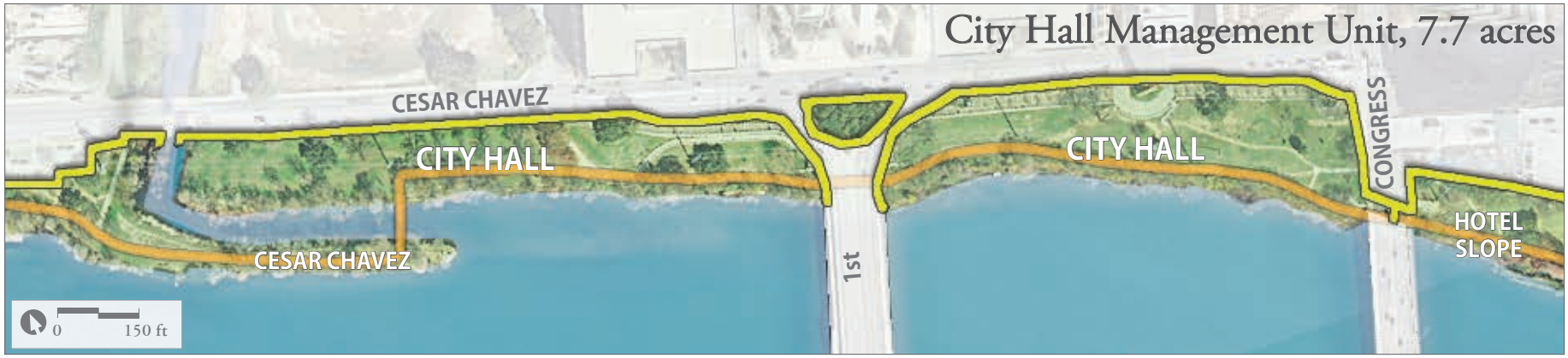
Invasive Species

In the woodland area, invasive species infestation is extensive, with 26 inventoried invasive trees per acre. This is by far the highest density of inventoried (≥8" diameter) invasive trees in the study area. Golden rain tree is rampant between 1st Street and Congress Avenue (Figure 4.18). Chinese lacebark elm, Chinese tallow, sweet autumn clematis, and giant reed are present, along with substantial stands of elephant ear at the Lake's edge. Chinaberry is another common woodland invader and is also present in the mowed areas.

Disturbance

There is gully erosion just west of Congress Avenue Bridge (Figure 4.19). The lawn area just east of Shoal Creek has been used as a staging area during restoration work at Shoal Creek and has compacted soils.

Figure 4.15: City Hall Management Unit boundaries. Sources: COA, NAIP.



Management Recommendations

Planting of native trees, invasive species treatment and erosion control are urgently needed in this unit. The area provides an opportunity to add many trees to a highly urban census tract that was deemed a high priority area for tree planting by Austin's Urban Forestry Program (Halter 2014). Due to the extent of infestations, removal of giant reed and invasive trees will need to be accompanied by substantial erosion control efforts and plantings. In addition, the underutilized, steep lawns can be converted to woodland. Plant selections should complement the recently planted native shrubs and, where necessary, should be appropriate for planting under powerlines. Trail alignment and stability also need to be addressed in this area. Finally, the western-most portion of this area, adjacent to Shoal Creek, is in need of soil remediation and decompaction from use as a staging area. This western portion offers great potential for restoration and further aesthetic improvements to the natural areas.

Tree Summary

Unit area	7.7 acres
Total trees	247
Trees/acre	32
Basal area	49 ft^2/acre
Average diameter	15"
Protected tree count	54
Heritage Tree count	22
Trees/100' of shoreline	5.2
Canopy cover	46%
Shaded trail	63%
Woodland area	1.3 acres
Trees/acre in woodland	131
Non-woodland area	6.4 acres
Trees/acre non-woodland	13

Table 4.6 (Above, left): Tree summary for all trees ≥8" diameter in the City Hall Unit. Figure 4.16 (Above, right): Some sections have a delayed mowing schedule to allow for spring wildflowers. Figure 4.17 (Below): Invasive species, erosion issues, and recommended restoration areas in the City Hall Unit. Sources: COA, NAIP.

Land Management Tasks

[I & R] Manage and remove golden rain tree, Chinese tallow, and Chinaberry. Initial treatment should focus on removal from around native trees. Secondary treatment should include the entire area. Treatment must be coupled with erosion control and restoration plantings due to the extent of the issue. **High priority**

[E & U] Stabilize Trail to eliminate crushed granite deposition off-trail. **High priority**

[R] Expand woodland throughout area, with species selection meeting height limits set by Austin Energy due to overhead powerlines. Aesthetics and seasonal color should also be considered due to the high visibility of the area. **High priority**

[E & R] Decompact soils used as a staging area in the western extent of the unit and plant and seed for woodland expansion. **High priority**

[E] Stabilize gully west of Congress Avenue Bridge. **High priority**

[R] Convert areas recommended for savanna restoration to wildflower meadow management to begin transition towards savanna. **High priority**

[E & U] Move the Trail inland where topography allows to expand the riparian area. **Medium priority**

[I & R] Remove giant reed. This action will necessitate bank stabilization, planting, and seeding in the following years. **Medium priority**

[U & E] Coordinate with Watershed Protection Department to determine need for and proper location of water access. **Medium priority**

[R] Increase diversity of existing woodland—will become higher priority after the above issues are addressed. **Low priority**

[R] Add sediment capture structures near existing wetland to encourage its spread. **Low priority**

[R] Plant aquatic species to promote greater aquatic plant diversity. **Low priority**

Figure 4.18 (Above): Golden rain tree dominates much of the woodland in the City Hall Unit.
Figure 4.19 (Below): Gully erosion west of Congress Avenue Bridge.

HOTEL SLOPE UNIT

The Hotel Slope Unit is bordered by the Radisson and Four Seasons to the north, Congress to the west, the Lake to the south, and the Austin Rowing Club Boat House to the east (Figure 4.20). It includes numerous trails to the hotels, as well as the boat dock for the Austin Rowing Club, and is entirely within the Waller Beach at Lady Bird Lake Metro Park. The unit consists of 4.8 acres with land management recommendations over 3.1 acres described here (Figure 4.22).

Ecology

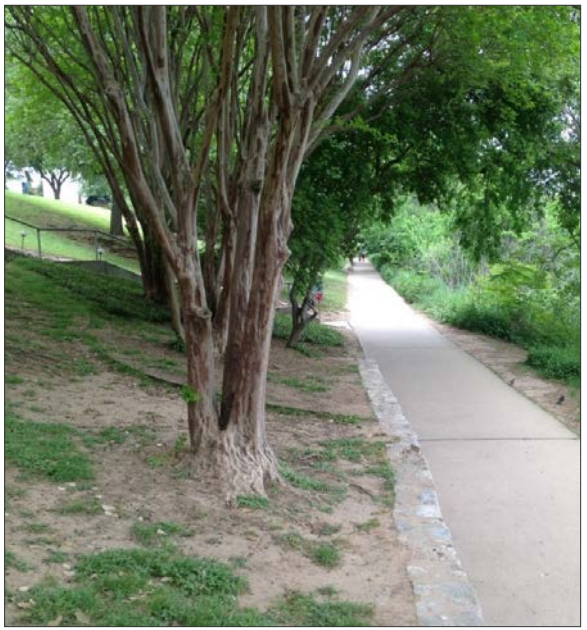
The wooded riparian strip between the Trail and the Lake makes up only 0.9 acres of this unit. The majority of the woodland is between 20 and 30 ft wide, but the eastern extent widens to nearly 70 ft. The size distribution within the woodland is distinct from many other sections of the study area. There are comparatively few trees per acre, but they have an average diameter of 19". There are relatively few medium-size trees, but numerous shrubs, small trees, and vines give the impression of a dense woodland. Grape vine is particularly dense and weighing down trees in some cases.

The unit has comparatively few shoreline trees, with 2.9 trees per 100 ft. The quality of woodland improves from west to east as invasive species density decreases and the amount of bald cypress and green ash increases, both in the understory and the canopy. The banks of the western portion of woodland are steep and narrow. At the eastern end, the shore-

Tree Summary

Unit area	4.8 acres
Total trees	135
Trees/acre	28
Basal area	66 ft^2/acre
Average diameter	19"
Protected tree count	36
Heritage Tree count	17
Trees/100' of shoreline	2.9
Canopy cover	69%
Shaded trail	72%
Woodland area	0.9 acres
Trees/acre in woodland	40
Non-woodland area	4.0 acres
Trees/acre non-woodland	25

Figure 4.20 (Below, left): Hotel Slope Management Unit boundaries. Sources: COA, NAIP. Table 4.7 (Above, right): Tree summary for all trees ≥8" diameter in the Hotel Slope Unit. Figure 4.21 (Below, right): The Hotel Slope Unit is characterized by sloping lawns, with a narrow woodland between the Trail and Lake.



line is very low, and many small green ash grow in shallow water. Tule has formed large colonies near the boat docks. Other naturally occurring species include: American water-willow, false nettle, Emory sedge, tall aster, climbing hempweed, American germander, major plantain, and tall water-primrose. Planted species include: bushy bluestem, Lindheimer's muhly, and eastern gamagrass. The majority of the area that is not currently woodland contains moderately sloping St. Augustine and Bermuda grass lawns maintained by the neighboring hotels, with shade from live oak, cedar elm, crepe myrtle, and other planted trees. Although they are currently maintained by the hotels, these lawns are public parkland.

Land Management Tasks

[R] Expand riparian woodland upslope. **High priority**

[I] Remove golden rain tree. **High priority**

[I] Cut grape vines. **High priority**

[I] Remove common chaste tree. **Medium priority**

[E] Decommission informal trails with a combination of brushing, soil decompaction, and restoration plantings. **Medium priority**

[R] Add sediment capture structures near existing wetland to encourage its spread. **Medium priority**

[R] Increase diversity of existing woodland—will become higher priority after the above issues are addressed. **Low priority**

[R] Plant aquatic species to promote greater aquatic diversity. **Low priority**

Invasive Species

Common chaste tree is pervasive in the unit, with several individuals in the maintained hotel lawns as well as a large infestation at the western end of the herbaceous wetland. Within the wetland, elephant ear and giant reed are plentiful. Alligator weed was also observed. Sweet autumn clematis was found both near the wetland and in the central portion of the unit. The western end of this unit is dominated by golden rain tree in the understory and canopy.

Disturbance

The main form of disturbance in this unit is informal trails between the Trail and the shore. There is also sheet erosion that has exposed tree roots in several parts of the parkland mowed by the hotels.

Management Recommendations

The unit's ecological function and user experience can be improved by converting portions of the Bermuda grass and St. Augustine lawn area to woodland. Increasing the amount of woodland would also support the work of the City's Urban Forestry Program, which has deemed the census tract containing the Hotel Slope Unit a high priority for tree planting (Halter 2014). In addition, repair and improvement of dilapidated water access points would improve the user experience and reduce trampling issues. The wetland area near the boat docks can be protected and enhanced through the addition of sediment capture structures and aquatic plantings.

Figure 4.22: Invasive species, erosion issues, and recommended restoration areas in the Hotel Slope Unit. Sources: COA, NAIP.

WALLER CREEK UNIT

The Waller Creek Unit is bound by residential and commercial buildings to the north, the Austin Rowing Club to the west, the Lake to the south, and the Trail to the east (Figure 4.25). The area consists of 5.1 acres and contains sections of Waller Beach at Lady Bird Lake Metro Park and the Waller Creek Greenbelt. While some general recommendations are made here, the area is being substantially planned for by the Waller Creek Conservancy, and therefore the major recommendations look at protecting vital resources and supporting the forthcoming plan (4.26).

Ecology

This management unit is in the process of being radically transformed. Almost the entire site is either construction zone or woodland. It is unique among the management units because it contains almost no lakeshore other than right at the mouth of Waller Creek. The banks of Waller Creek are extremely steep, with abundant erosion problems. The island at the mouth of the creek has high conservation value as a wildlife and bird refuge. Woodland areas contain high levels of invasive species. A thorough tree inventory of this management unit was not included in this project because several tree inventories have recently been conducted on portions of the site. Data for 70 woodland trees are available for the southern portion of the unit, where sugar hackberry and black willow are the most abundant species, fol-

Table 4.8 (Right, above): Canopy cover summary for the Waller Creek Unit. Figure 4.23 (Right, middle): The wooded banks of Waller Creek, looking upstream from the footbridge. Figure 4.24 (Right, below): The ecologically siniftcant wooded island at the mouth of Waller Creek, viewed from the footbridge over the creek. Figure 4.25 (Far right): Waller Creek Management Unit Boundaries. Sources: COA, NAIP.

Tree Summary

Unit area	5.1 acres
Canopy cover	67%
Woodland area	3.1 acres
Non-woodland area	2.1 acres

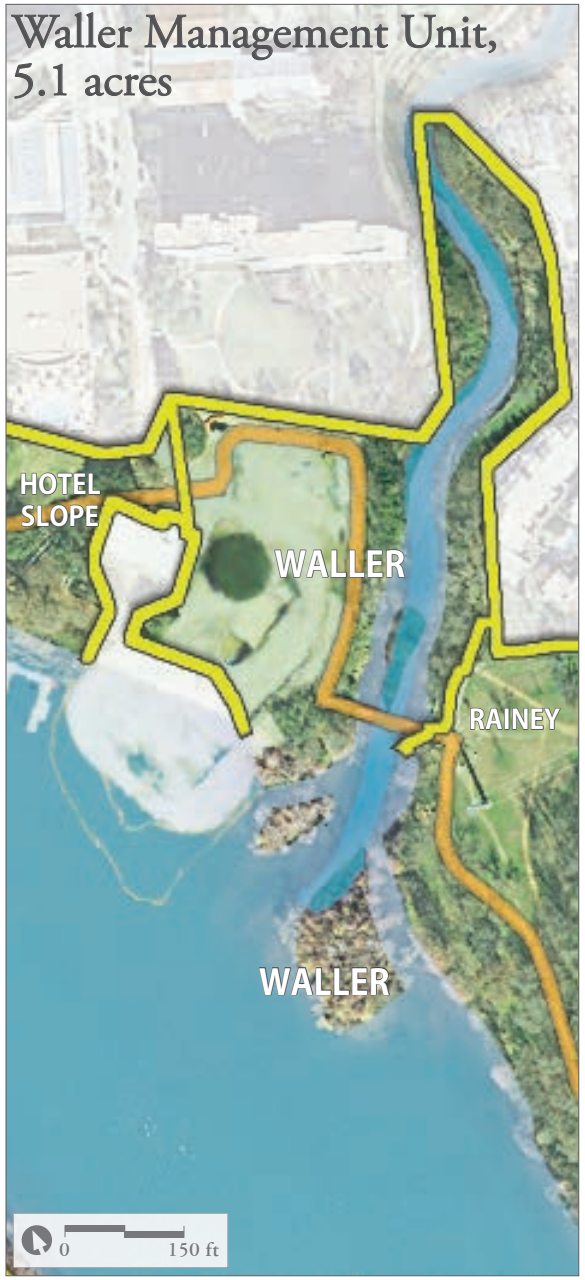


Figure 4.26: Invasive species, erosion issues, and recommended restoration areas in the Waller Creek Unit. Sources: COA, NAIP.

lowed by cottonwood, cedar elm, bald cypress, mulberry, and Chinaberry. The majority of these trees are small, with an average diameter of 13".

Invasive Species

Several invasive species are abundant in this unit. Perhaps the most concerning is the large infestation of giant reed along the western banks of Waller Creek. The mouth of Waller Creek is also laden with elephant ear and Mexican petunia. On the banks, Chinaberry is common and golden rain tree is present in the northern portion of the unit. Ligustrum, common chaste tree, and heavenly bamboo are present, particularly on the western banks.

Disturbance

The steep banks of Waller Creek, coupled with flashy flows, have led to high amounts of sheet erosion on the eastern upper banks despite armoring on the lower banks. The western banks also suffer from erosion, exacerbated by an extensive network of informal trails.

Management Recommendations

Management in the Waller Creek Unit should support the implementation of plans by the Waller Creek Conservancy and the City of Austin. Goals for management should include protecting the island at the mouth of Waller Creek, enhancing existing wetland communities, stabilizing banks, and addressing rampant invasive species such as giant reed.

Land Management Tasks

[R & I] Ensure island at mouth of creek is protected as plant and wildlife refuge and enhance by increasing plant diversity and managing invasives. **High priority**

[U, E, I, & R] Complement restoration and bank stabilization efforts being planned by Waller Creek Conservancy, the City of Austin Watershed Protection Department, and their partners. **High priority**

[I] Remove Mexican petunia and elephant ear where feasible. **High priority**

[R] Restore herbaceous and shrub layer throughout. **High priority**

[I & R] Remove giant reed on western banks of Waller Creek. This action will necessitate bank stabilization, planting, and seeding in the following years. **High priority**

[I] Remove woody invasive species including Ligustrum, Chinaberry, heavenly bamboo, and common chaste tree on western side of Waller Creek. **Medium priority**

[U & E] Decommission informal trails with a combination of brushing, soil decompaction, and planting tree seedlings west of Waller Creek. **Medium priority**

[R] Add sediment capture structures near existing cattail patch to encourage its spread. **Low priority**

[R] Plant aquatic species to promote greater aquatic plant diversity. **Low priority**

RAINEY UNIT

The Rainey Unit is bound by the banks of Waller Creek to the west, the Lake to the south, I-35 to the east, and various roads and buildings to the north, including East Avenue, Cummings Street, and the Mexican American Cultural Center (Figure 4.27). The unit is entirely within Waller Beach at Lady Bird Lake Metro Park. The site is 12.9 acres, with recommendations here for 11.7 acres and an additional 0.1 acres of aquatic restoration (Figure 4.30). There is no current master plan known for this area although the Waller Creek Plan will likely have impacts on the western portion of the unit. As these plans become known, the recommendations here can be adapted to support that plan as appropriate.

Ecology

This unit contains 3 acres of woodland. Woodland slopes south of the Trail in the central part of the unit are very steep, and many have erosion problems. The steepness does, however, ensure that there is a wider buffer between the Trail and the Lake than occurs along most of the northern shoreline. The woodland in the western portion generally ranges between 50 and 100 ft. The canopy of sugar hackberry, pecan, American elm, and the invasive Chinaberry is generally continuous, with green ash, mulberry, box elder, and American elm near Waller Creek. Slope and soil erosion issues limit groundcover growth. There are 4.3 trees per 100 ft of shoreline, primarily bald cypress and eastern sycamore. Invasive trees form a smaller percentage of the canopy than in many other units. In the western and eastern portions of the unit, there are large expanses of underutilized lawn areas, 1.8 acres and 6.9 acres respectively (Figure 4.28). In the eastern portion, the Trail is within 25 ft of the shoreline and sometimes as close as 10 ft. The trees are sparse between the Trail and Lake in this portion, with no continuous woodland and only 2.3 trees per 100 ft of shoreline.

Invasive Species

While invasive trees only make up a small portion of the surveyed trees, there is an abundance of smaller Chinaberry in the woodland and Chinese tallow is found in the drainage area near East Avenue and as scattered individuals. Multiple giant reed patches on the woodland slopes are likely preventing tree regeneration, and yellow bamboo is present. A large patch of sweet autumn clematis is affecting much of the lakeshore near the mouth of Waller Creek.

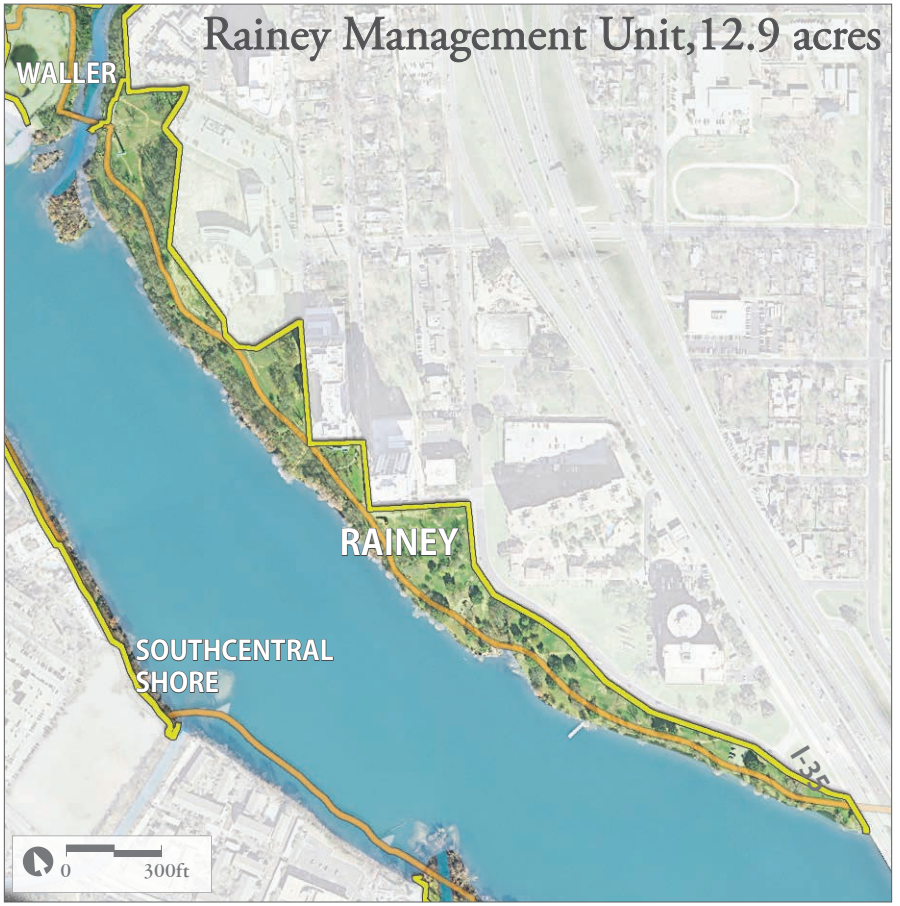


Figure 4.27: Rainey Management Unit boundaries. Sources: COA, NAIP.

Disturbance

Several instances of incomplete or failing infrastructure are causing problems within this unit, including dumped culvert material southwest of the Mexican American Cultural Center (MACC) and two crumbling docks. Southeast of the MACC, a long concrete staircase descends to the Shoreline Woodland with no additional infrastructure near the water's edge and has led to a large trampled area (Figure 4.29). In addition to the infrastructure-related issues, there is a

Figure 4.28 (Above): Much of the Rainey Unit is underutilized lawn. Figure 4.29 (Below): Staircase ends without infrastructure to access water, causing extensive trampling.

Tree Summary

Unit area	12.9 acres
Total trees	406
Trees/acre	31
Basal area	54 ft^2/acre
Average diameter	16”
Protected tree count	114
Heritage Tree count	51
Trees/100’ of shoreline	4.3
Canopy cover	57%
Shaded trail	47%
Woodland area	3.0 acres
Trees/acre in woodland	81
Non-woodland area	9.9 acres
Trees/acre non-woodland	16

Table 4.9: Tree summary for all trees ≥8” diameter in the Rainey Unit.

large gully erosion issue in the woodlands. In both the western and eastern flatter portions of the unit, gullies are being created from stormwater runoff. Waterside trampling is an issue throughout the eastern portions of this unit.

Management Recommendations

Converting areas of underutilized lawn to woodland and enhancing the diversity of the existing woodlands are priorities for this unit. This aligns with the work of the Urban Forestry Program, which has deemed the census tract containing the Rainey Unit a high priority for tree planting (Halter 2014). There are multiple erosion issues that need to be addressed before restoration plantings occur. Grading and green infrastructure should be used in western and eastern portions to slow down stormwater entering the areas and address gully erosion. Rill erosion caused by culverts under the Trail can be miti-

Figure 4.30: Invasive species, erosion issues, and recommended restoration work in the Rainey Unit. Sources: COA, NAIP.

gated with armoring and dispersal. The extensive trampling at the bottom of the concrete stairs requires a hardscape or other infrastructure solution, and the network of informal trails needs to be decommissioned and restored. Erosion control efforts will be needed in areas where giant reed removal is recommended. If appropriate, small streamlets in the lawn areas in the western and eastern portions of the unit can be enhanced. On the steep woodland slopes, increasing the herbaceous and understory layers will help control erosion as well as increase woodland diversity.

Land Management Tasks

[R] Convert underutilized lawn to woodland through planting and seeding west and southeast of the Mexican American Cultural Center and south of East Avenue. This will require added irrigation. **High priority**

[E] Install green infrastructure in the western and eastern portions of the study area to retain and slow down stormwater as it moves through the unit. **High priority**

[R] Replace and enhance shade tree cover at terminus of Rainey Street. **High priority**

[U & E] Add formal water access from base of concrete stairs and restore areas affected by trampling and compaction. **High priority**

[I] Remove Chinaberry. **High priority**

[E & R] Enhance the growing streamlets in the western and eastern portions of the management unit through rock placement and plantings appropriate for small ephemeral streams. **High priority**

[U, E, & R] Decommission informal trails with a combination of brushing, soil decompaction, and planting tree seedlings. **High priority**

[I] Remove giant reed. This action will necessitate bank stabilization, planting, and seeding in the following years. **High priority**

[E & R] Stabilize the two principal gullies with green infrastructure that includes a combination of armoring, diversion, swales and retention upslope, and planting. **High priority**

[R] Increase diversity of existing woodland. **Medium priority**

[E] Use armoring, diversion and/or dispersal to address erosion caused by numerous small culverts that shunt water under trail. **Medium priority**

[U & R] Remove old wooden docks. **Low priority**

[R] Add sediment capture structures near existing cattail patch to encourage its spread. **Low priority**

[R] Plant aquatic species to promote greater aquatic plant diversity. **Low priority**

FESTIVAL BEACH UNIT

The Festival Beach Unit is bordered by Nash Hernandez Senior Road and Jesse E. Segovia Street to the north, I-35 to the west, the Lake to the south, and the lagoon to the east (Figure 4.31). The unit is part of the Edward Rendon Sr. Metro Park at Festival Beach. It includes three picnic areas, a boat ramp, an old fire station, and the western portions of Fiesta Gardens. The unit is 35.3 acres, with land management recommendation for 21.4 acres and an additional 0.9 acres of aquatic restoration. There is an approved master plan for this area and the adjacent Holly Shores Unit that will eventually include substantial changes to amenities including opening new waterways to the lagoon and adding new trails. The recommendations made here are compatible with these overall goals and revisions can be made as the master plan moves towards implementation (Figure 4.32).

Ecology

This is a relatively flat, wide management unit where the Trail stays very close to the shoreline, with an expansive mowed area to the north. The majority of the Trail is within 15 ft of the Lake and some areas are less than 5 ft from the Lake, like the area shown in Figure 4.33. While there are numerous trees in Festival Beach, including many Heritage Trees, there is almost no continuous canopy and the riparian area is heavily impacted. The proximity of the Trail to the water is degrading existing vegetation, causing trail erosion, and inhibiting regeneration of the woodland canopy and understory plants. There are only 1.8 trees per 100 ft of shoreline, the fewest of any management unit. There are, however, a number of good specimens of bald cypress, pecan, and other canopy trees scattered along the shoreline. The mowing regime has been recently altered within this area, resulting in dense stands of giant ragweed. As of yet, natural regeneration of native trees has been limited. The Trail Foundation has planted approximately 20 bald cypress trees along the shoreline in recent years, which will help to fill out the riparian canopy as they mature.

There is woodland surrounding the lagoon that is laden with invasive species. In this 1.6 acres of woodland, sugar hackberry is the most abundant tree, followed by bald cypress along the shoreline. Sabal is abundant in this area, likely escaped from the landscaping at Fiesta Gardens. Other trees in the woodland include American elm, live oak, green ash, sycamore, pecan, Chinaberry, and Chinese tal-

Figure 4.31: Festival Beach Management Unit Boundaries. Sources: CAO, NAIP.

low. It is notable that there is substantial regeneration of bald cypress in the woodland along the southern shore of the lagoon. While these are currently small trees, they are protected from mowing and will likely create a substantial change in the canopy in the years to come.

The vast majority of the management unit is mowed lawn, with shade trees and ornamental shrubs throughout (Figure 4.34). Live oak is the most abundant species, though crepe myrtle, pecan, Spanish oak, chinquapin oak, cedar elm, and Chinese tallow are also common. There are 125 Heritage Trees in the Festival Beach lawn, the majority of which are live oaks. Most of the remaining Heritage Trees are pecan or Spanish oak. The overall density of trees and shrubs large enough to be inventoried is 17 per acre, but the distribution of those trees is highly variable. There are several dense groves of live oaks with almost 30 trees per acre as well as large expanses of open lawn. Under several oak groves there is no groundcover due to leaf litter accumulation, trampling, sheet erosion, and/or lack of sun. This lack of groundcover is causing erosion issues. The mowed area is heavily used in some areas, but many areas are underutilized.

Invasive Species

The shoreline of Festival Beach has lower amounts of invasive species than comparable areas, though Chinaberry, sweet autumn clematis, and elephant ear are common. Ubiquitous Bermudagrass in the area has likely limited the amount of other invasives. There are numerous large Chinese tallow within the mowed area, and recently planted Chinese lacebark elm is a potential issue. Johnsongrass is becoming abundant in areas that have recently changed mow-

Tree Summary

Unit area	35.3 acres
Total trees	722
Trees/acre	20
Basal area	44 ft^2/acre
Average diameter	18”
Protected tree count	293
Heritage Tree count	148
Trees/100’ of shoreline	1.8
Canopy cover	41%
Shaded trail	44%
Woodland area	1.6 acres
Trees/acre in woodland	96
Non-woodland area	33.8 acres
Trees/acre non-woodland	17

Table 4.10: Tree summary for all trees ≥8” diameter in the Festival Beach Unit.

Figure 4.32: Invasive species, erosion issues, and recommended restoration work in the Fetival Beach Unit. Sources: COA, NAIP.

ing regimes, especially on the southern edge of the lagoon. King Ranch bluestem is abundant in one such area in the eastern part of the unit.

The woodland around the lagoon has much higher densities of invasive species. Chinese tallow is abundant throughout the woodland and Chinaberry is present, though less pervasive. On the northern shore of the lagoon, these common invaders are joined by tree of heaven at the western edge of the woodland and extremely dense infestations of both confederate jasmine and primrose jasmine near Fiesta Gardens.

Disturbance

The unit contains numerous erosion and soil issues due to stormwater flows and user impacts. The thin area between the Trail and the Lake is severely impacted by informal trails and trampling. There is also substantial trampling around benches that lack appropriate infrastructure. Several areas under dense tree groves are lacking vegetation due to stormwater flows, trampling, and limited light availability. These issues have resulted in many areas with sheet erosion and some progressing to rill and/or gully erosion. Informal trails are abundant on the steep southern shore of the lagoon, creating significant erosion. There is an informal trail as wide as the main Trail extending nearly 600 ft to the east of the boat ramp parking area.

Management Recommendations

Major recommendations for this unit include woodland expansion into some of the large areas of underutilized lawn and relocation of portions of the Trail away from the water's edge to allow for a more stable trail and a healthy riparian edge. Expanding the woodland here is in line with the work of the Urban Forestry Program, which has deemed the census tract containing Festival Beach a high priority for tree planting (Halter 2014). The live oak groves pointed out in Don Gardner's report should be pruned. They are located south of Nash Hernandez Street between I-35 and nearest parking lot, north of the same parking lot to the old Aquatic Center, the Love of Christi Grove, and north of the eastern end of Nash Hernandez, just west of Fiesta Gardens.

Waterside trampling is currently an issue along much of the shoreline, but could be mitigated by simultaneously formalizing several access points to the water,

Figure 4.33: The majority of the Festival Beach unit has only a thin strip of vegetation between the Trail and the shoreline and has scattered trees rather than a continuous canopy.

increasing the density of vegetation in riparian areas, relocating the Trail farther away from the shoreline in selected areas, and restoring damaged areas. Because of the openness of much of this unit, there is the opportunity for small scale grading changes that will reduce the overall impacts of stormwater on the natural areas. There are several long erosion channels in the mowed areas where streamlet enhancement may be appropriate. Overall, invasive species are not currently as problematic in this management unit as in others, but several species should

Figure 4.34: Festival Beach consists primarily of large underutilized lawns.

be addressed quickly before they become worse. Johnsongrass is beginning to take over some of the Grow Zone areas and should be managed so that it does not become rampant as more area is converted to a more natural state. Tree of heaven is uncommon in the study area, but several individuals were found in the natural area around the lagoon at Fiesta Gardens. Swift removal of these trees will help prevent a more substantial infestation.

Land Management Tasks

[R] Convert underutilized lawns to woodland; leave more utilized lawns in current use. **High priority**

[I] Remove Johnsongrass. **High priority**

[R] Mulch and prune pecan trees near covered pavilion and prune live oak groves designated by Don Gardner. **High priority**

[U, E & R] Realign the Trail to a create more dynamic experience and allow for greater riparian habitat near the shoreline. **High priority**

[R] Amend and decompact soil, plant, and seed in areas that were formerly part of the Trail. **High priority**

[U, E, &R] Decommission informal trails and informal water access points with a combination of brushing, soil decompaction, planting, and seeding. **High priority**

[I] Remove tree of heaven before it becomes a larger issue. **High priority**

[R] Increase diversity of existing woodland. **Medium priority**

[I] Remove Chinese tallow and Chinaberry. **Medium priority**

[U & E] Coordinate with Watershed Protection Department to determine need for and proper location of water access. **Medium priority**

[E & R] Install bioswales to increase water retention and eliminate numerous erosion issues throughout area while creating small-scale grading changes that increase the diversity of habitat. **Medium priority**

[I] Remove and replace Chinese lacebark elm planted in the mowed areas. **Medium priority**

[R] Add sediment capture structures near cattail patch to encourage its spread. **Medium priority**

[R] Plant aquatic species to promote greater aquatic diversity. **Medium priority**

[E &R] Enhance streamlets in existing erosion channels. **Medium Priority**

[U & E] Add hardscape around existing bench just east of I-35 to prevent continued erosion and provide a better view of the Lake. **Low priority**

HOLLY SHORES UNIT

The Holly Shores Unit is bordered on the west by the lagoon, the south by the Lake, the east by Pleasant Valley Drive, and the north by Canterbury Street, private homes, the electric transmission station that is remaining at the former Holly Power Plant, and the Rendon Baseball fields (Figure 4.35). The western portion of the unit is part of Edward Rendon Sr. Metro Park at Festival Beach, and the eastern portion is Holly Shores at Lady Bird Lake Metro Park. The central portion is not currently managed as part of a park. The unit is 20.9 acres, with land management recommendations made for 15.2 acres and an additional 2.7 acres of aquatic restoration (Figure 4.36). The recent Holly Shores Master Plan calls for various amenities and changes to the site including reconfigurations of the baseball fields and reclamation of the former Holly Power Plant area for passive and active recreation. The recommendations made here are compatible with these overall goals and revisions can be made as the master plan moves towards implementation.

Figure 4.35: Holly Shores Management Unit boundaries. Sources: COA, NAIP.

Ecology

The central portion of this unit is dominated by the former Holly Power Plant and recreational fields, while the western section contains a combination of mowed lawn and woodland, and the eastern end is primarily natural area. Only 5.2 acres are currently considered woodland, spread out along the shorelines of the lagoon, the Lake, and the inlet near Longhorn Dam. The woodland in this management unit is comparable in density to much of the study area. American elm is the most abundant species in the eastern section of the unit. Bald cypress is also common throughout, as are sugar hackberry, black willow, box elder, sycamore, live oak, and Chinaberry. The stretch of shoreline directly south of the baseball fields, shown in Figure 4.38, has only 2.5 trees per 100 ft of shoreline. The herbaceous layer in this section is comparatively well-developed, with native sawgrass, water hemlock, false-nettle, tall goldenrod, and Emory sedge.

In the eastern part of this management unit, the Trail crosses a long, narrow peninsula. On the peninsula, 10 to 15 ft on each side of the Trail is mowed, and decomposed granite from the Trail has migrated into the surrounding vegetation in many places (Figure 4.39). The woodland of the peninsula differs slightly from the woodland of the mainland, containing more sycamore trees and invasive common chaste tree. Some of the natural area along the peninsula is in comparatively good condition, with eastern gamagrass, sawgrass, and natural regeneration of bald cypress.

As the power plant lands are opened for restoration and new ball fields, the Trail can be realigned and the two ball fields closest to the Lake can be relocated to Riverview Street.

Invasive Species

Chinaberry is common throughout the woodlands in this unit. Chinese tallow is present on the eastern peninsula but most abundant on the shore of the Fiesta Gardens lagoon. Sweet autumn clematis is also abundant on the peninsula and present in several patches on the shoreline south of the baseball fields. Common chaste tree is more abundant here than in other management units. One of the few occurrences of tree of heaven along the Trail is found at the western end of

Tree Summary

Unit area	20.9 acres	Trees/100' of shoreline	4.5
Total trees	535	Canopy cover	29%
Trees/acre	26	Shaded trail	22%
Basal area	41 ft²/acre	Woodland area	5.2 acres
Average diameter	15"	Trees/acre in woodland	85
Protected tree count	108	Non-woodland area	15.7 acres
Heritage Tree count	50	Trees/acre non-woodland	6

Table 4.11: Tree summary for all trees ≥8" diameter in the Holly Shores Unit.

the peninsula. Dense patches of giant reed have been treated in this unit but show signs of regrowth. Elephant ear is abundant in the inlet near Longhorn Dam and present in patches along the majority of the shoreline. The unmanaged areas in the Holly Street Power Plant grounds contain large amounts of Johnsongrass.

Disturbance

The southwest corner of this unit is a heavily trampled informal water access. There are also many informal trails and substantial trampling along the peninsula and on the slopes south of the Canterbury parking area. The peninsula has some bank erosion where giant reed has been treated and is littered with large chunks of concrete that were previously placed for erosion control. The central section of the unit is largely fenced off and therefore has comparatively few informal trails and trampling issues. There is a large gully caused by power plant infrastructure on the eastern edge of the power plant facility.

Management Recommendations

As the site of the former Holly Street Power Plant is converted to parkland, those areas not designated for active recreation will be restored to woodland through planting and seeding. The new trail alignment should meet the criteria recommended here to reduce impact to the natural areas and allow for a substantial riparian edge. In addition, several formal water access points will help protect the newly-restored vegetation by guiding users to appropriate access points.

Figure 4.36 (Above): The woodland along the western edge of the Holly Shores unit contains severl large bald cypress. Figure 4.37 (Below): Invasive species, erosion issues, and recommended restoration work in the Holly Shores Unit. Sources: COA, NAIP.

Figure 4.38 (Above): The strip of vegetation between lawn and Lake is extremely narrow south of the baseball fields. Figure 4.39 (Below): Trail material extends well beyond the width of the Trail on portions of the peninsula.

Land Management Tasks

[R] Expand woodlands through planting and seeding of canopy, understory, and herbaceous layers with special attention to those areas retired from the Holly Power Plant and lawn that are now planned for passive recreation and natural areas. **High priority**

[U, E, & R] Reduce the existing trail width to 14 ft, stabilize surface, install connecting trail through former Holly Power Plant area and on to Festival Beach Unit using standards described in management section. **High priority**

[E & R] Remove concrete embankments as feasible. **High priority**

[I & R] Continue giant reed removal along with bank stabilization, planting, and seeding. **High Priority**

[R & I] Plant canopy trees around giant reed invasion to shade out reed and enhance woodland canopy. **High priority**

[I] Remove tree of heaven. **High priority**

[E] Utilize open areas to install green infrastructure such as swales and rain gardens where feasible to increase absorption and reduce erosion issues. **High priority**

[R] Increase diversity of existing woodland. **Medium priority**

[R] Plant aquatic species to promote greater aquatic plant diversity, especially in the lagoons. **Medium priority**

[E] Decommission informal trails with a combination of brushing, soil decompaction, and plantings with special attention to the steep areas near the Canterbury parking area. **Medium priority**

[U & E] Coordinate with Watershed Protection Department to determine need for and proper location of water access. **Medium priority**

[R] Add sediment capture structures near cattail patch to encourage its spread. **Medium priority**

[I] Remove common chaste tree, Johnsongrass, Chinaberry, and Chinese tallow. **Low priority**

SOUTHEAST SHORE UNIT

The Southeast Shore is bound by the Lake to the north and west, by Pleasant Valley Drive to the east, and by South Lakeshore Boulevard to the south (Figure 4.40). The unit includes Longhorn Shores, Lakeshore, Peace Point, and International Shores at Lady Bird Lake Metro Park. The Trail Foundation's Southeast Shore Master Plan (adopted in 2014) covers the entire unit, which forms the eastern shoreline of the Lake and wraps around to form the eastern most portions of the southern shore. It includes a peninsula jutting out substantially into the Lake. There are high overhead powerlines running through the site parallel with Pleasant Valley, and local overhead powerlines running parallel with S. Lakeshore Blvd. The Hostelling International Austin building is located within this unit and the Boardwalk starts at the western end of this unit. The unit consists of 30.7 acres and recommendations have been made for 25.4 acres (Figure 4.41).

Tree Summary

Unit area	30.7 acres
Total trees	373
Trees/acre	14
Basal area	28 ft²/acre
Average diameter	18"
Protected tree count	194
Heritage Tree count	76
Trees/100' of shoreline	3.5
Canopy cover	35%
Shaded trail	21%
Woodland area	5.3 acres
Trees/acre in woodland	70*
Non-woodland area	25.4 acres
Trees/acre non-woodland	11

*Table 4.12: Tree summary for all trees ≥8" diameter in the Southeast Shore Unit. *Calculated only for the 1.5 acres inventoried by Siglo Group.*

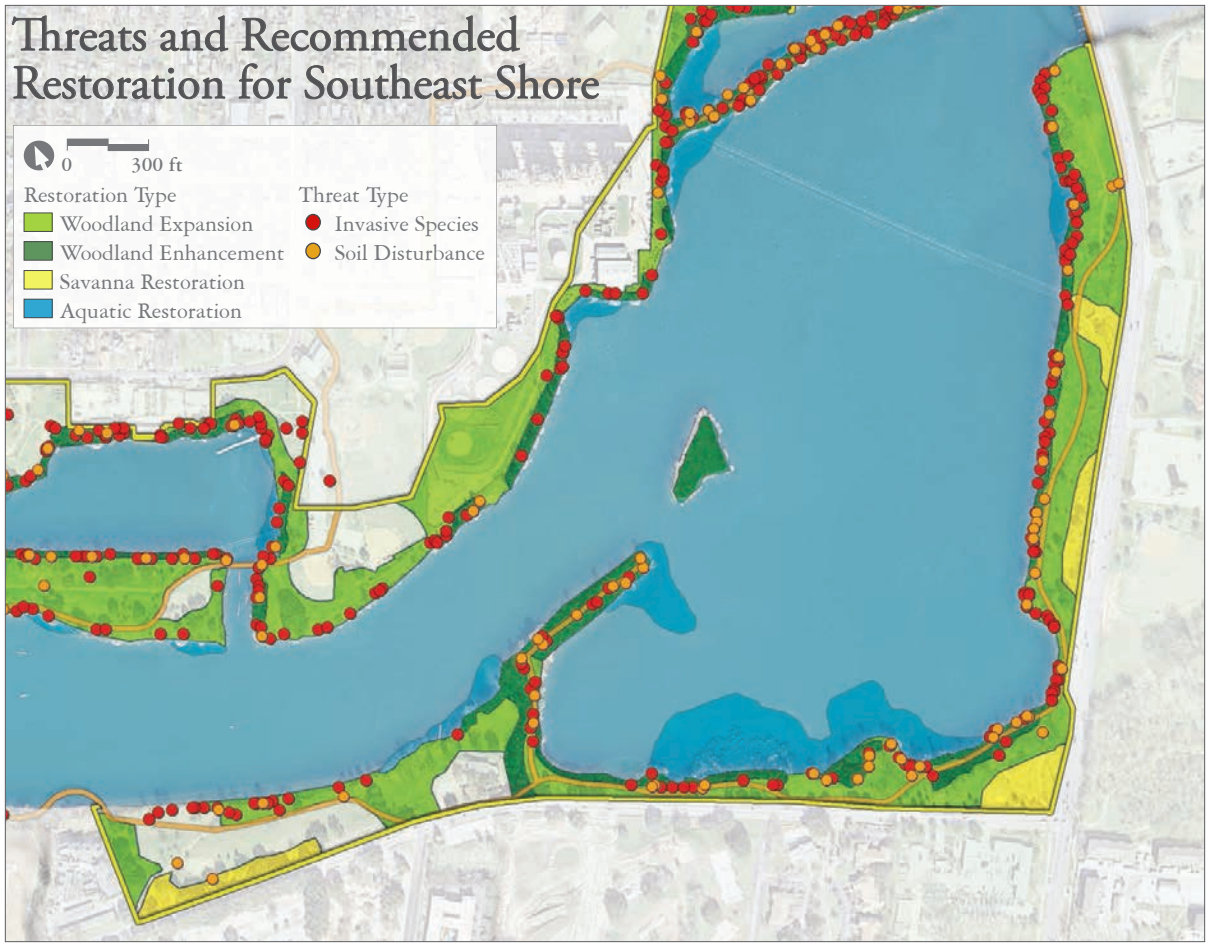
Ecology

The majority of the area is managed lawn with a variety of planted trees and shrubs with 5.3 acres of woodland. Older plantings throughout the area are primarily crepe myrtle, live oak, and pecan. More recent plantings are a variety of native trees and shrubs, including sycamore, cedar elm, chinquapin oak, Mexican buckeye, Texas kidneywood, and Texas mountain laurel. Aquatic plantings have also been added recently at several locations along the shoreline. The vegetation survey revealed that burrobrush, a shrub that has not been documented in Travis County since 1937, is thriving on the uncommon Gaddy soils found in this unit.

Figure 4.40: Southeast Shore Management Unit Boundaries. Sources: CAO, NAIP.

The woodland is primarily a thin strip along the shoreline, often between 5 and 25 ft wide, with the exception of a small area just south of the Trail near the corner of Lakeshore Boulevard and Pleasant Valley. The Shoreline Woodland is dominated by bald cypress, along with American elm, cottonwood, and sycamore. Sugar hackberry is also common farther inland. The western section of the management unit was not included in the tree inventory due to limitations in project scope and because there was relatively recent tree inventory data available from the City of Austin Parks and Recreation Department (PARD). The 1.7 acres of woodland in the eastern section (running parallel to Pleasant Valley) has only 70 trees per acre, but has a dense understory of box elder, false indigo-bush, buttonbush, roughleaf dogwood, common chaste tree, and false willow along with dense poison ivy, mustang grape, and sweet autumn clematis. PARD data were not available for some of the woodland, but did cover an additional 2.7 acres, including the peninsula.

Figure 4.41: Invasive species, erosion issues, and recommended restoration work in the Southeast Shore Unit. Sources: COA, NAIP.



The western section of shoreline is not considered woodland as it has only 2.2 trees per 100 ft of shoreline and lacks a well-developed understory. This section gently slopes into the water, and therefore has a comparatively rich aquatic plant community. The City of Austin is currently constructing an ADA accessible fishing pier in this area.

Invasive Species

Giant reed is the most conspicuous invasive species in this management unit, with large, dense stands along much of the unshaded shoreline. Many of the stands have been treated, but are growing back. Sweet autumn clematis is abundant, especially in the eastern woodland. Elephant ear is common along the shoreline. Chinese tallow, chinaberry, and common chaste tree are present throughout the woodlands. Johnsongrass is abundant in grassy areas with recent changes in mowing regime.

Disturbance

Lack of sufficient formal water access has resulted in numerous informal trails and trampling near the water's edge. The end of the peninsula and the two areas with picnic tables are badly trampled. There is also a large gully on the southern shore and significant erosion underneath a nearby concrete embankment. Bank erosion is common in the southeast portion of the shoreline and along Longhorn Shores, mainly associated with giant reed treatment.

Management Recommendations

Much of the area is recommended for woodland

expansion to increase overall canopy, shading, ecological function, and to passively control giant reed along the shore. Before planting occurs, grading changes should be made at erosion points to slow down and retain water and reduce erosive effects of stormwater. Gaddy soils also occur in this unit, making savanna restoration a long-term goal for limited areas. Additional recommendations include the continued treatment of giant reed, wetland expansion at multiple sites along the substantial shoreline found in this unit, and pruning of live oak groves near the hostel and between the restroom and the eastern end of the Boardwalk, as identified in Don Gardner's report.

Land Management Tasks

[E & R] Stabilize eroding banks with erosion control fabric and plant additional trees and herbaceous material. High priority

[I] Treat Johnsongrass. High priority

[R] Expand woodland throughout much of the area, with special attention to the areas behind the hostel, the peninsula, the eastern shore, and the area parallel with Lakeshore Drive east of the hostel. Shorter species will be needed in some areas to accommodate the overhead powerlines. High priority

[I & R] Continue removal of giant reed along shoreline. This action will necessitate bank stabilization, planting, and seeding in the following years. High priority

[R & I] Plant canopy trees around giant reed invasion to shade out reed and enhance woodland canopy. High priority

[E & R] Utilize grading in the upper portions of the unit to retain and slow down stormwater. Plant as appropriate. High priority

[E] Stabilize gully erosion using green infrastructure where feasible. Armoring may be necessary in some places. High priority

[R] Convert areas recommended for savanna restoration to wildflower meadow management to begin transition towards savanna. High priority

[R] Prune live oak groves designated by Don Gardner. High priority

[I] Remove sweet autumn clematis, with focus on the eastern woodland. Medium priority

[U & E] Coordinate with Watershed Protection Department to determine need for and proper location of water access. Medium priority

[R] Install sediment capture structures at edges of existing wetlands and install emergent aquatic plants, using exclosures as needed, as part of wetland expansion pilot project. Medium priority

[R] Create a pilot area of Gaddy soil savanna under powerlines in eastern part of unit. Low priority

[I] Remove Chinese tallow, Ligustrum, and common chaste tree. Low priority

Figure 4.42 (Above): The unit contains many large patches of invasive giant reed. Figure 4.43 (Below): A combination of savanna restoration and woodland expansion is recommended for the mowed area between the Lake and Pleasant Valley.

THE CLIFFS UNIT

The Cliffs Unit is bound by I-35 on the east, the Lake on the north, Blunn Creek on the west, and Riverside Drive, residential lots, and Edgecliff Terrace on the south (Figure 4.44). The unit is within the Norwood Tract at Town Lake Metro Park. The Boardwalk cuts through the unit near Blunn Creek and runs parallel to it over the water to I-35. The area is 8.7 acres, with land management recommendations for 5.6 acres and 0.9 acres of aquatic restoration (Figure 4.47). Recommendations were not made for the dog park or Norwood House lot as their specific uses are incompatible with natural area management and therefore beyond the scope of this project.

Ecology

This is the only unit that contains exposed limestone bluffs (Figure 4.45), defined by the City as Critical Environmental Features. The bluffs have populations of Mexican Buckeye, wafer ash, Eve's necklace, and shrubby boneset, which are either absent or rare along the rest of Trail. The wetland at the mouth of Blunn Creek is undergoing a substantial restoration project by The Trail Foundation (Figure 4.46).

*Table 4.13: Tree summary for all trees ≥8" diameter in The Cliffs Unit. *Excludes dog park and Norwood House lot.*

Tree Summary

Unit area	5.6 acres*
Total trees	349
Trees/acre	63
Basal area	70 ft²/acre
Average diameter	13"
Protected tree count	49
Trees/100' of shoreline	7.6
Canopy cover	89%
Shaded trail	94%
Woodland area	5.6 acres

The wetland contains the globally rare Correll's false-dragonhead. The trees in this area were not inventoried as a part of this project, so the ability to quantify tree density and type is limited. The riparian woodland along the Boardwalk contains bald cypress, black willow, green ash, and American elm and has 7.6 trees per 100 ft of shoreline.

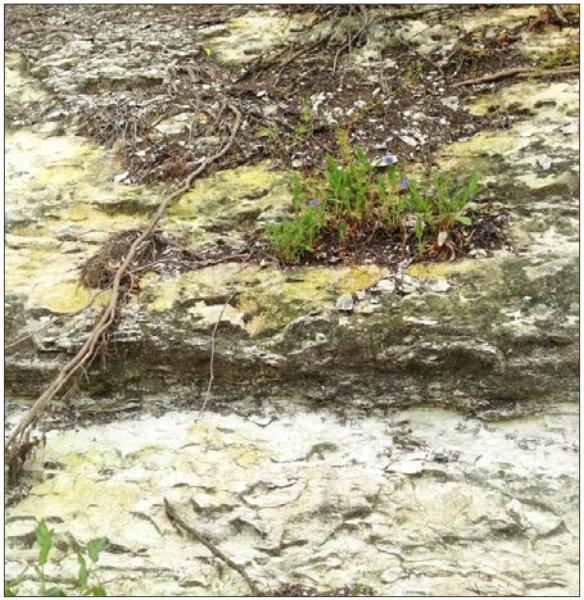
Invasive Species

Invasive species are rampant in this unit. An impressive catclaw vine infestation is blanketing a large area (over ¼ acre) about 400 ft east of the mouth of Blunn Creek and there are several smaller patches of it along the Boardwalk spur leading to Riverside Drive (Figure 4.48). Both sweet autumn clematis and Japanese honeysuckle are also mixed in with the catclaw, adding to the thick mat of vines covering much of the native vegetation. Ligustrum is dense and abundant on the cliffs and Chinaberry is present throughout. There are also small patches of giant reed along the shoreline. The dog park has a very large stand of golden bamboo that is spreading downslope into the woodland. A non-native morning glory is behaving invasively throughout the area and is the dominant vine in some eastern sections of the unit. Elephant ear is abundant in the western end.

Management Recommendations

The primary management goals for this unit are to lessen the impact of invasive species, support existing restoration efforts, increase woodland diversity, and expand and enhance the wetland through sediment capture, plantings, and maintenance.

Figure 4.44 (Above): The Cliffs Management Unit Boundaries. Sources: CAO, NAIP.



Land Management Tasks

[I] Treat catclaw vine throughout. **High priority**

[R] Maintain and expand wetland restoration project at mouth of Blunn Creek. **High priority**

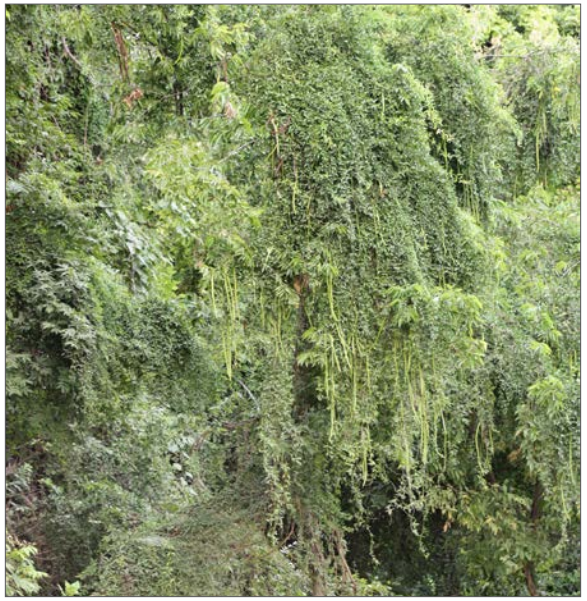
[R & I] Maintain plantings near Boardwalk and keep free of invasive species. **High priority**

[R] Install sediment capture structures and plant aquatic species to increase aquatic plant diversity. **Medium priority**

[R] Increase diversity of existing woodland. **Medium priority**

[I] Control invasive plants on steep slopes using caution not to create erosion problems. **Medium priority**

Figure 4.45 (Above, left): The exposed rock cliffs in this unit are unique within the study area. Figure 4.46 (Above, right): Many plantings have recently been added to the wetland surrounding the mouth of Blunn Creek. Figure 4.47(Below, left): Invasive species, erosion issues, and recommended restoration work in the The Cliffs Unit. Sources: COA, NAIP. Figure 4.48 (Below, right): The largest infestation of catclaw vine in the study area is found in The Cliffs.



SOUTHCENTRAL SHORE UNIT

The Southcentral Shore Unit is bound by the Lake on the north, the western end of the Boardwalk on the east, the Austin American Statesman and apartments on the south, and the 1st Street Bridge on the west (Figure 4.49). It includes the viewing area for the bat colony at the Congress Avenue Bridge, and portions of the unit are part of Auditorium Shores at Lady Bird Lake Metro Park. The study area is 3.3 acres, with recommendations here for 3 acres. Recommendations are also made for an additional 2.8 acres that are adjacent to the study area and 0.7 acres of aquatic restoration (Figure 4.53).

Ecology

The Southcentral Shore Unit is currently an extremely narrow unit that encompasses a thin shoreline woodland running its length. This narrowness is due to the fact that this section of the Trail runs through an easement on private property rather than through public parkland (Figure 4.50). Though it is narrow, the woodland makes up 2 acres. Bald cypress is the dominant overstory tree, making up over half of the trees surveyed. The vast majority of the trees in the unit are considered shoreline trees, for a total of 6.8 trees per 100 ft of shoreline. Though the number of trees in the area is comparable to other units, the basal area is relatively high due to the high number of large bald cypress. The understory in the woodland is variable. There are pockets of comparatively intact native understory and groundcover, consisting of yaupon holly, trumpet vine, and native grasses and sedges. In most areas, however, native understory is lacking except for the ubiquitous presence of poison ivy. The eastern end of the management unit has good natural tree regeneration with live oak, Spanish oak, and bald cypress trees all becoming established.

West of Congress Avenue, the Trail runs alongside a lawn maintained by the Hyatt, and the narrow strip between the Trail and the armored bank is primarily occupied by palms and common chaste tree. This

Table 4.14: Tree summary for all trees ≥8" diameter in the Festival Beach Unit.

Tree Summary

Unit area	3.3 acres
Total trees	276
Trees/acre	83
Basal area	190 ft²/acre
Average diameter	19"
Protected tree count	118
Heritage Tree count	62
Trees/100' of shoreline	6.8
Canopy cover	66%
Shaded trail	69%
Woodland area	2.0 acres
Trees/acre in woodland	120
Non-woodland area	1.4 acres
Trees/acre non-woodland	29

Figure 4.49: Southcentral Shore Management Unit Boundaries. Sources: CAO, NAIP.

area is one of the largest bottlenecks along the Trail, with the width reducing to 6ft and containing numerous congestion-inducing turns.

Invasive Species

Ligustrum, golden rain tree, Chinese lacebark elm, and Chinaberry are concerns in this area. Ligustrum and golden rain tree both form near monocultures in portions of the understory. Both golden rain tree and Chinese lacebark elm are abundant in several management units on the northern shore, but are uncommon on the southern shore other than in this unit. Chinaberry is present throughout, but is most abundant in the eastern portion of the unit. Common chaste tree is also abundant along the shoreline in the eastern portion of the unit. Sweet autumn clematis is also found in patches throughout much of the unit, especially in the section between Congress Avenue and South 1st Street.

Figure 4.50: In this unit, the Trail runs through a narrow easement on private property.

Disturbance

There are several major areas of granite deposition into the riparian area between Congress Avenue and the Boardwalk, like the one shown in Figure 4.51. Informal trails and concrete slabs are scattered throughout the area, with major issues near Congress Avenue, where severe trampling is leading to sheet erosion.

Management Recommendations

Though the area is narrow, changes to the hardscape and the vegetation would make substantial improvements to the aesthetics and functionality of the Trail. This is especially true near the Hyatt, where congestion can be alleviated with relatively minor changes in some cases and more substantial changes in others. From Congress to the Boardwalk, underutilized mowed areas like that in Figure

Figure 4.51: Trail erosion is damaging the thin strip of vegetation between the Trail and Lake.

4.52 can be converted to woodland by the City or by landowners. The live oak grove pointed out in Don Gardner's report near and to the east of the Austin American Statesman building should be pruned. Invasive species removal with a focus on Ligustrum, golden rain tree, and Chinaberry as well as planting and seeding are recommended. Trail stabilization is essential for the area from the Boardwalk to Congress.

Land Management Tasks

[E & U] Stabilize crushed granite trail to eliminate granite deposition off-trail. **High priority**

[I] Remove Ligustrum, golden rain tree, and Chinaberry. **High priority**

[U & R] Work with landowners and city planners to expand riparian woodland and reduce hardscape bottlenecks for Trail users. **High priority**

[R] Prune live oak grove designated by Don Gardner. **High priority**

[R] Expand woodland throughout. **Medium priority**

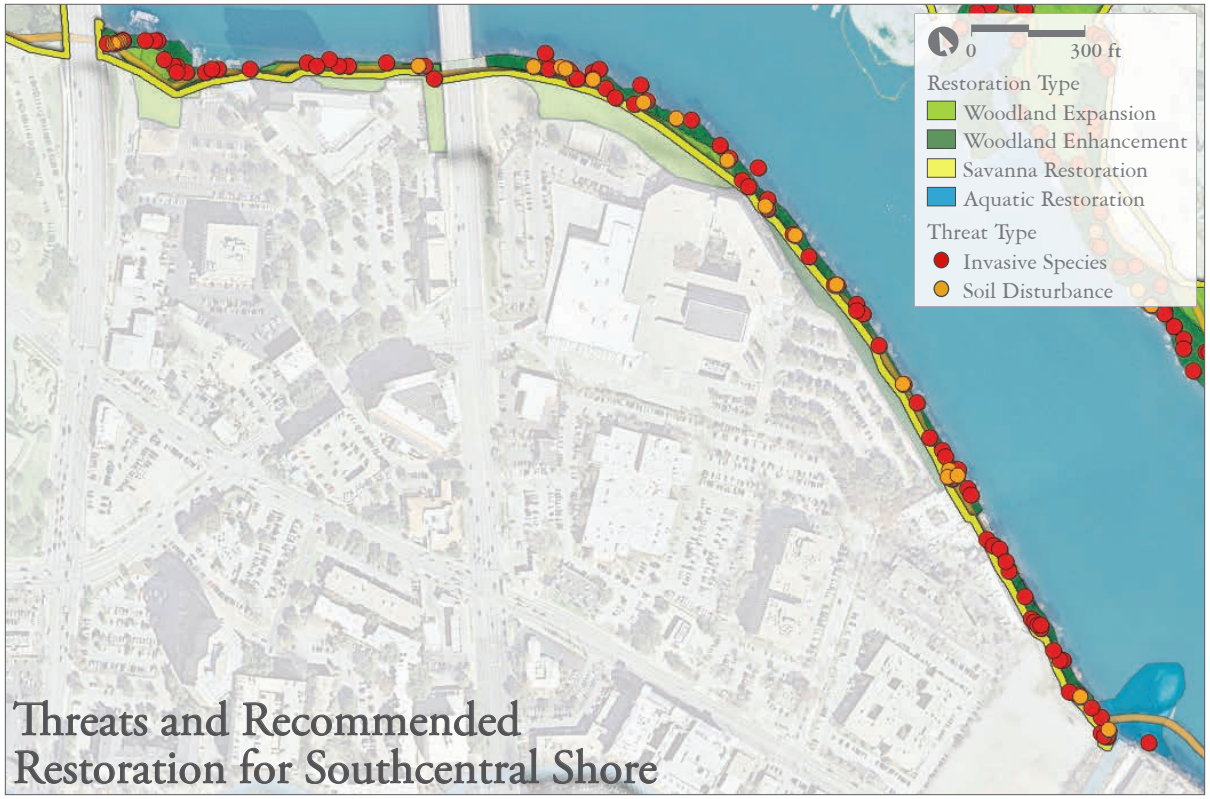
[R] Increase understory and herbaceous layers throughout. **Medium priority**

[E & U] Decommission informal trails and informal water access points with a combination of brushing, soil decompaction, and planting of tree seedlings. **Medium priority**

[U & E] Coordinate with Watershed Protection Department to determine need for and proper location of water access. **Medium priority**

Figure 4.52: The woodland can be expanded into mowed areas.

Figure 4.53: Invasive species, erosion issues, and recommended restoration work in Southcentral Shore. Sources: COA, NAIP.



AUDITORIUM SHORES UNIT

The Auditorium Shores Unit stretches from South 1st Street to the Mouth of West Bouldin Creek, with the Lake on the north side (Figure 4.54). The unit consists of 3.7 acres with recommendations for 1.2 acres (Figure 4.57). The unit contains only the narrow riparian strip between the Trail and the Lake, as numerous improvements are being made to the area through the implementation of the Auditorium Shores Master Plan.

Ecology

None of the area being evaluated is currently woodland. The far western end of the unit contains bald cypress, American elm, and hackberry, but is so small that it is not classified as a woodland. The area also contains elderberry and smooth horsetail, both of which are relatively uncommon in the study area. There are only 3.1 trees per 100 ft of shoreline in the unit, a relatively low density of trees.

Invasive Species

Chinaberry is present throughout much of the unit, but at relatively low density. There are several patches of Johnsongrass and sweet autumn clematis along the shoreline, and elephant ear is present at the eastern end of the unit.

Disturbance

Trampling and informal trails are substantially impacting much of the unit, causing major erosion and compaction issues throughout. The frequently used dog water access point shown in figure 4.55 is one of the most heavily trampled areas. Additionally, runoff from the mowed upland areas is causing extreme erosion of trail material despite recent resurfacing of the Trail (Figure 4.56). Several portions of the Trail are poorly drained and hold water after rain events, causing users to create informal trails around the water.

Tree Summary

Unit area	3.7 acres	Heritage Tree count	9
Total trees	99	Trees/100' of shoreline	3.1
Trees/acre	26	Canopy cover	40%
Basal area	46 ft²/acre	Shaded trail	25%
Average diameter	16"	Non-woodland area	3.7 acres
Protected tree count	27		

Table 4.15: Tree summary for all trees ≥8" diameter in the Auditorium Shores Unit.

Figure 4.54: Auditorium Shores Management Unit Boundaries. Sources: CAO, NAIP.

Management Recommendations

This management unit and the adjacent lawn are currently undergoing a significant renovation through the implementation of the Auditorium Shores master plan. Management activities for this area should complement the master plan implementation. Special attention should be paid to the shoreline, formalized water access, and plantings that will mitigate and prevent trampling issues. Ongoing monitoring, woodland enhancement, and woodland expansion in this unit should be equivalent to those mentioned throughout these guidelines.

Land Management Tasks

[R, I, E, & U] Work with City of Austin to ensure the implementation and ongoing maintenance of the Auditorium Shores master plan is successful and natural area management is aligned with these guidelines to the extent feasible. **High priority**

[R] Plant shoreline that is not being utilized for recreation at a density that will discourage informal access and prevent erosion. May need tree cages or some other structure to protect them. **High priority**

Figure 4.55 (Above): This popular water access point for dogs is badly trampled. Figure 4.56 (Middle): Poor trail drainage leads to visitors taking alternative routes, generally in the mulch around tree roots in the upper-left corner of this photo. Figure 4.57 (Below): Invasive species, erosion issues, and recommended restoration work in the Auditorium Shores Unit. Sources: COA, NAIP.

BUTLER SHORES WOODLAND UNIT

The Butler Shores Woodland Unit is bound by West Bouldin Creek to the east, Riverside Drive, Butler Shores Park, and Barton Springs Road to the south, Barton Creek to the west, and the Lake to the north (Figure 4.59). The portion east of Lamar is part of Auditorium Shores at Lady Bird Lake Metro Park, while the remainder is within Butler Shores at Lady Bird Lake Metro Park. The site is 8.2 acres, with recommendations for 7.8 acres within the unit, 2.7 acres outside of the unit boundaries, and an additional 0.9 acres of aquatic restoration (Figure 4.60). South Lamar Boulevard bisects the unit, and the PARD headquarters are immediately adjacent to the unit.

Figure 4.58: Numerous large pecan trees create a cathedral-like canopy and provide shade along the Butler Shores Woodland section of the Trail.

Ecology

The unit contains relatively little mowed lawn. A dense-canopied mix of native and non-native trees and shrubs covers 6 acres of the unit. Slopes are steep and discourage off-trail recreation. Pecan is the dominant overstory tree, making up 39% of woodland trees surveyed. Many of the pecans are impressive individuals including 43 Heritage Trees, 9 of which are over 40" in diameter (Figure 4.58). Box elder, American elm, sugar hackberry, and green ash are common. Bald cypress is present along the lakeshore, but less abundant here than in many areas. Though the number of trees in the woodland is lower than many other portions of the study area, the basal area is comparable. The understory and

Tree Summary

Unit area	8.2 acres
Total trees	403
Trees/acre	49
Basal area	99 ft^2/acre
Average diameter	17"
Protected tree count	108
Heritage Tree count	59
Trees/100' of shoreline	6.1
Canopy cover	77%
Shaded trail	82%
Woodland area	6.0 acres
Trees/acre in woodland	59
Non-woodland area	2.2 acres
Trees/acre non-woodland	23

Table 4.16: Tree summary for all trees ≥8" diameter in the Butler Shores Woodland Unit.

Figure 4.59: Butler Shores Woodland Management Unit Boundaries. Sources: CAO, NAIP.

groundcover layers are variable. There are pockets in good condition, with abundant roughleaf dogwood, inland sea oats, and Turk's cap, but invasive shrubs and young trees dominate the understory in many areas. Poison ivy is a major component of the understory and groundcover in much of the woodland, and is encroaching on the Trail in several areas.

Invasive Species

The eastern banks of Barton Creek have an extreme invasive species problem with giant reed patches and bamboo (some of which was recently treated) entering from private property near the footbridge. English ivy is abundant in many locations along Barton Creek as well as western portions of the unit. Chinaberry is pervasive in the upland along the Trail near Barton Creek and Chinese tallow forms several dense patches on the lakeshore in western portions of the unit. The largest infestation of paper mulberry seen in the study area is near the PARD parking lot. The shoreline in the central section of the unit is not greatly impacted by invasives, with the exception of elephant ear. Bradford Pear is scattered throughout and forms a dense thicket near the Lamar Bridge.

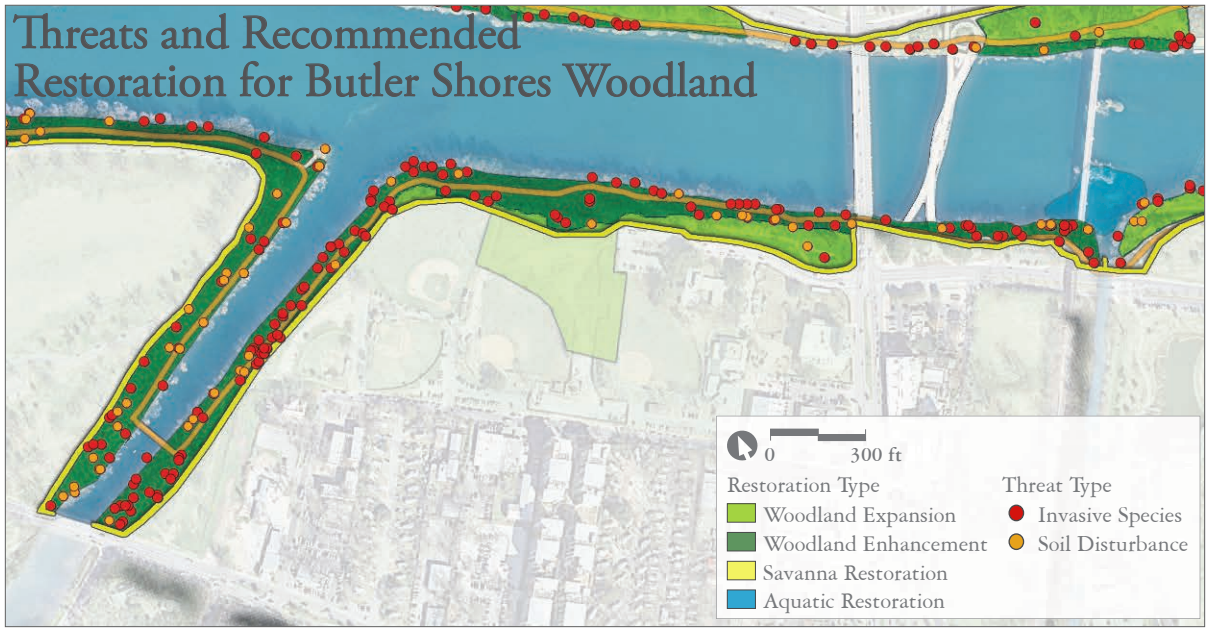
Disturbance

Erosion issues within the unit stem from user traffic and stormwater. There is a broken culvert that is causing a serious erosion issue on the southeast bank of Barton Creek. In addition, there are multiple informal trails from various parking locations to the Trail. Water access issues include staircases descending to the water's edge without supporting infrastructure as well as water access points without sufficient hardscape to prevent decomposed granite deposition into the water, such as the one shown in Figure 4.61. Trail stabilization and trail material deposition is a problem throughout this unit because of its steepness and/or the Trail's proximity to the shore.

Management Recommendations

Management activities in this unit will be varied, addressing invasive species, erosion, and user experience issues. Erosion issues should be handled throughout the unit, with special attention to nonfunctional infrastructure. Conversion of underutilized portions of Butler Shores Park to woodland with supporting green infrastructure can alleviate numerous erosion problems within the unit while expanding the overall natural areas (Figure 4.62). Problematic invasive species not commonly found in other units need to be addressed, including Bradford Pear, bamboo, and paper mulberry.

Figure 4.60: Invasive species, erosion issues, and recommended restoration work in Butler ShoresWoodland Unit. Sources: COA, NAIP.



Land Management Tasks

[E] Repair broken culvert in bank of Barton Creek. **High priority**

[E] Stabilize large gully near Barton Creek footbridge with armored banks/gabions if necessary. **High priority**

[E & U] Stabilize crushed granite trail to eliminate granite deposition off-trail. **High priority**

[I & R] Remove giant reed along shoreline. This action will necessitate bank stabilization, planting, and seeding in the following years. **High priority**

[U & R] Trim poison ivy back from the Trail. **High priority**

[U & R] Incorporate green infrastructure into Butler Shores Park under-utilized areas to reduce stormwater coming into the unit and expand the woodland canopy into these areas. **High priority**

[U & R] Coordinate with Watershed Protection Department to determine need for and proper location of water access. Remove dilapidated access points and associated infrastructure. **High priority**

[R] Increase diversity of existing woodland. **Medium priority**

[R] Actively restore wetland and emergent aquatic plantings on sediment bar at the mouth of West Bouldin Creek. **Medium priority**

[I] Remove paper mulberry. **Medium priority**

[I &R] Follow up on recent bamboo clearing east of Barton Creek with additional treatment (as necessary), planting, and seeding. **Medium priority**

[E & U] Decommission informal trails with a combination of brushing, soil decompaction, and planting of tree seedlings. **Medium priority**

[I] Remove chinaberry, Chinese tallow and other invasive woody plant species. **Medium priority**

[U] Formalize a trail between athletic fields and Trail. **Low priority**

[I] Remove Bradford Pear near Lamar Bridge. **Low priority**

Figure 4.61 (Above): A well used formal water access point has stairs leading users to the shore, the surface below is heavily trampled and eroding into the Lake. Figure 4.62 (Below): The underutilized lawn near PARD offices is recommended for woodland expansion.

ZILKER EAST UNIT

The Zilker East Unit is bound by Barton Creek to the east, Barton Springs Blvd and Lou Neff Road to the south, Zilker West to the west and the Lake to the north (Figure 4.63). The entire unit is part of Zilker Metro Park. The pedestrian bridge over Barton Creek connects this unit to the Butler Shores Woodland Unit. Lou Neff Point sits at the confluence of the Lake and Barton Creek, and the Zilker Zephyr Train runs through upper portions of the unit. It is 6.1 acres, with recommendations for 5.9 acres (Figure 4.66). The upper portions of the site are adjacent to Zilker Park and are influenced by park uses.

Ecology

Extremely steep topography and large bald cypress characterize this management unit. Almost no lawn is present except along the edge of the Zilker Zephyr Train tracks. Woodlands make up 5.3 acres of the unit. Pecan is the most abundant overstory tree, especially in the upland area along the western bank of Barton Creek. This unit has the largest trees in the study area, including 3 bald cypress over 90" in diameter, one of which is shown in Figure 4.64. There are 59 Heritage Trees, including 40 pecans, 32 bald cypress, and 1 live oak. Hackberry (primarily upland of the Trail as shown in Figure 4.65), American elm, and eastern sycamore are common. Similar to the Butler Shores Woodland Unit, the number of surveyed trees in the woodland is comparatively low (53 per acre), but the large size of many of the trees makes the basal area higher than many other units in the study area. The number of shoreline trees is lower than comparable areas. Throughout much of the unit there is an intact ground layer dominated by inland sea oats and Turk's cap. Poison ivy and greenbrier are also dense throughout the majority of the woodland. The Trail Foundation has removed invasive species in the upland stretch between Barton Creek and Zilker Park in the past, which has resulted in a richer groundcover than much of the study area.

Invasive Species

This management unit has relatively low amounts of invasive species. There are scattered Chinese tallow, Chinaberry, and Ligustrum, but no dense stands. There are also several tree of heaven individuals, which are not common in the study area.

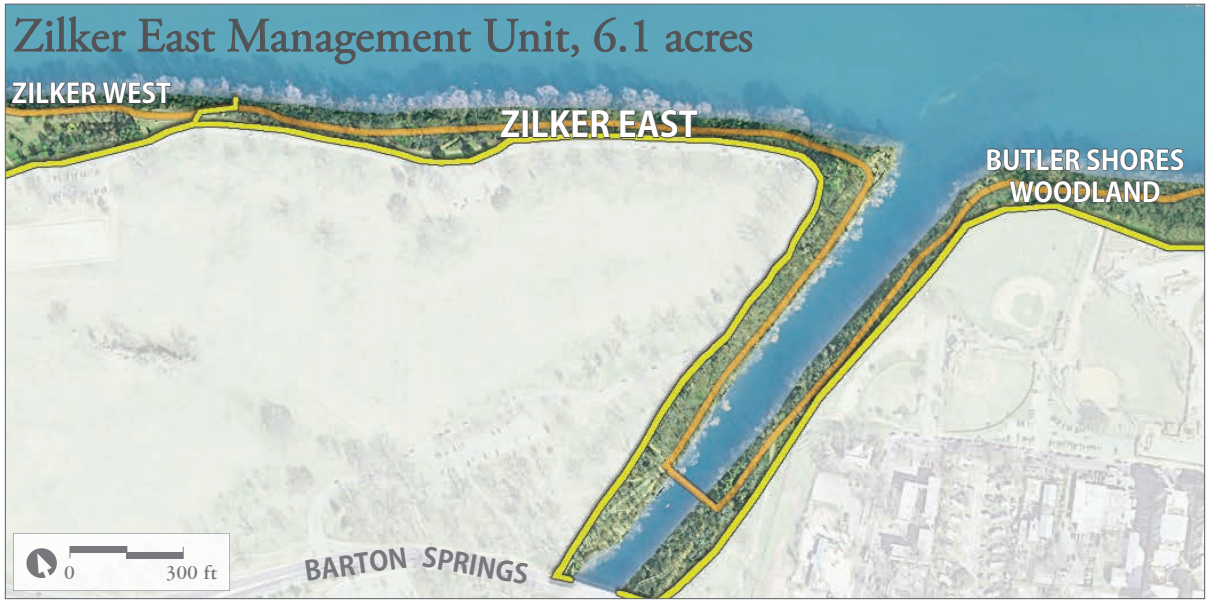
Disturbance

Along the slopes and banks of Barton Creek, there is trampling and erosion due to informal trails and off-trail recreation at the water's edge. Granite deposition on the Lake side of the Trail is resulting in major parts of the slope being covered in trail material. There is a dilapidated staircase from the Trail to the shore that should be removed.

Management Recommendations

Management objectives for this unit include stabilizing the formal trail, mitigating damage from off-trail recreation, and formalizing and/or improving water access points along with restoration planting and seeding, with a focus on future generations of canopy trees. Special attention should be given to protecting heritage trees throughout the unit.

Figure 4.63: Zilker East Management Unit boundaries. Sources: COA, NAIP.



Tree Summary

Unit area	6.1 acres
Total trees	316
Trees/acre	52
Basal area	156 ft²/acre
Average diameter	19”
Protected tree count	116
Heritage Tree count	73
Trees/100’ of shoreline	5.3
Canopy cover	76%
Shaded trail	55%
Woodland area	5.9 acres
Trees/acre in woodland	53
Non-woodland area	0.3 acres
Trees/acre non-woodland	12

Table 4.17: Tree summary for all trees ≥8” diameter in the Zilker East Unit.

Land Management Tasks

[E & U] Stabilize crushed granite trail to eliminate granite deposition off-trail. High priority

[E & U] Decommission informal trails with a combination of brushing, soil decompaction, and planting, especially in area between the Creek and Zilker Park. High priority

[R] Increase diversity of existing woodland. High priority

[I] Remove tree of heaven. High priority

[U] Improve water access near Barton Creek footbridge and duck feeding area. Medium priority

[I] Remove Chinaberry, Chinese tallow, and Ligustrum close to the Trail where feasible. Low priority

[U] Remove dilapidated staircase down to the Lake. Low priority

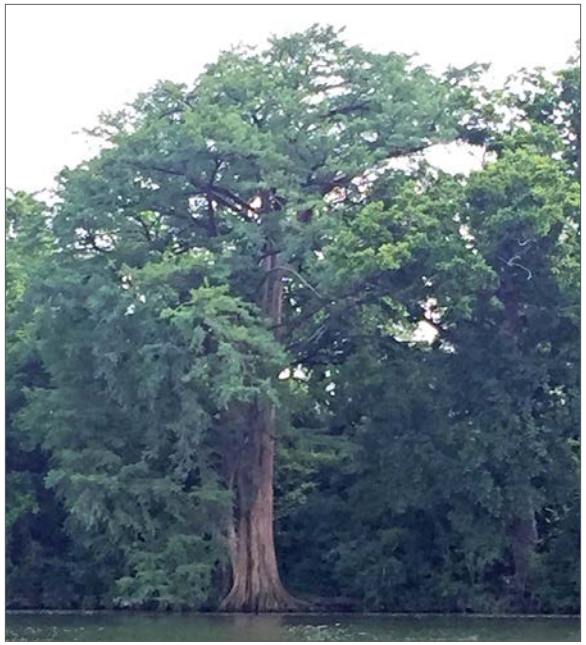


Figure 4.64 (Above, left): This bald cypress in Zilker East is one of the largest trees in the study area and in Austin. Figure 4.65 (Above, right): Young hackberry trees dominate the woodland upland of the Trail along Barton Creek. Figure 4.66 (Below): Invasive species, erosion issues, and recommended restoration work in the Zilker East Unit. Sources: COA, NAIP.

ZILKER WEST UNIT

The Zilker West Unit is bound by the Zilker East Unit to the east, Lou Neff Road, Zilker Auxillary Parking, and a utility yard adjacent to Stratford Drive to the south, Eanes Creek to the west, and the Lake to the north (4.67). The majority of the unit is part of Zilker Metro Park, but the portion west of MoPac is part of the Zilker Nature Preserve. The unit is 13.2 acres with recommendations for 11.0 acres within the study area. Recommendations are also made for 3.0 adjacent acres and for 0.2 acres of aquatic restoration (Figure 4.70). The unit is bisected by MoPac.

Ecology

This unit is characterized by rich riparian woods in relatively good condition between the Trail and the Lake and broad mowed areas in the central upland portion. Woodland makes up 7.6 acres of this unit. The eastern end of the study area is narrow and has steep slopes similar to those of the Zilker East Unit. Moving west, the area between the Trail and Lake broadens to include a flat, low area that includes several small islands. Hackberry, box elder, American elm, sycamore, and black willow are the most common canopy trees. This woodland has diverse micro-topography and some of the most intact understory and herbaceous layers in the study area with large amounts of Canada wildrye and other native species (Figure 4.68). West of MoPac, the areas north of the utility yard are relatively intact. There is a young huisache woodland in the more disturbed area adjacent to the yard.

There are more trees per acre in the woodlands of this unit than in Zilker East, but the trees are smaller, leading to a much lower overall basal area. The shoreline has 7.8 trees per 100 ft, more than any other management unit.

Two plants uncommon in Travis County, blackbristle greenbrier and anglefruit milkvine, were identified by Bill Carr in this management unit. Neither are rare plants globally, but Travis County is the western edge of their ranges.

Invasive Species

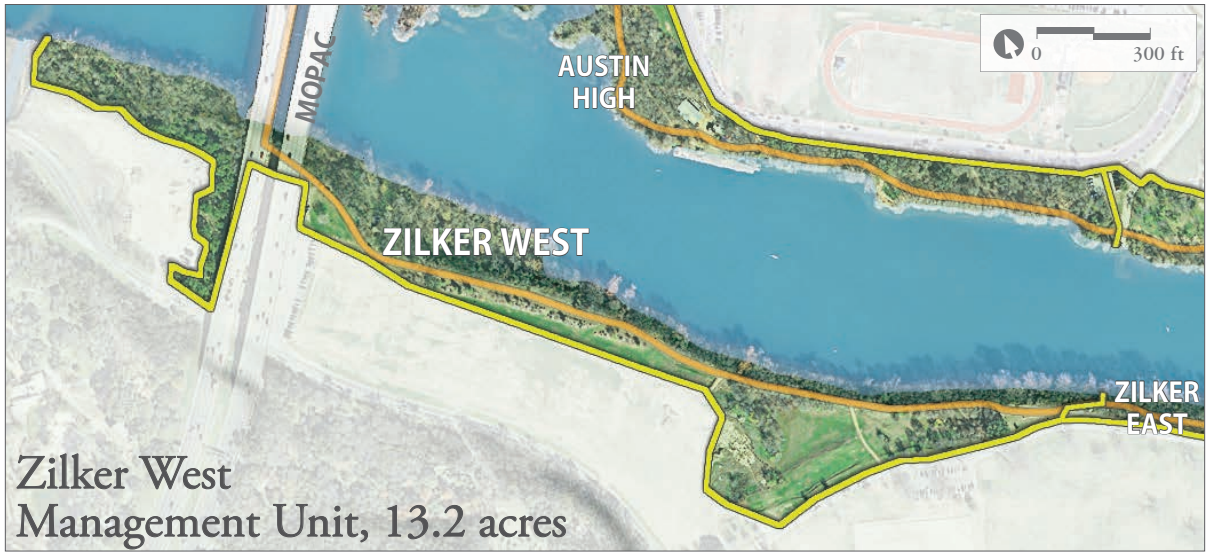
There are two catclaw patches, one just east and one just west of MoPac (Figure 4.69). Both are currently limited in area, but very dense. Two patches of sweet autumn clematis were found right along the Trail 850 ft east of MoPac. This species is abundant in many units but is not currently common in Zilker East or West. Silverberry, *Elaeagnus macrophylla,* was

Table 4.18 Tree summary for all trees ≥8" diameter in the Zilker West Unit.

Tree Summary

Unit area	13.2 acres
Total trees	660
Trees/acre	50
Basal area	59 ft^2/acre
Average diameter	13"
Protected tree count	86
Heritage Tree count	31
Trees/100' of shoreline	7.8
Canopy cover	54%
Shaded trail	22%
Woodland area	7.6 acres
Trees/acre in woodland	83
Non-woodland area	5.6 acres
Trees/acre non-woodland	6

Figure 4.67: Zilker West Management Unit boundaries. Sources: COA, NAIP.



found here and has not been observed naturalizing in the past. It should be controlled as a preventative measure. Elephant ear and Chinese tallow are abundant near the islands, but notably absent in the eastern half of the unit. Chinaberry is ubiquitous at the Trail's edge, but less common within the woodland itself. Over all, invasive occurrence was lower in the eastern portions of this unit as compared to other units. West of MoPac, however, Ligustrum and heavenly bamboo are becoming problematic.

Disturbance

This unit has more gully erosion than any other. There are two large gullies west of MoPac. One has been armored with large rocks and appears stable, but the other is not. There are numerous gullies starting underneath MoPac Bridge to approximately 300 ft east of the bridge. Dense vegetation and some minor upper slope armoring hide the problem from the Trail, but large amounts of soil are being lost. Numerous informal trails crisscross the lower portions of the management unit, but the steep topography of the majority of the woodlands appears to limit off-trail recreation.

Management Recommendations

Significant erosion control efforts are needed in this area, both on the Trail itself and downslope from it. To the extent possible, moving the Trail away from the steep slope and stabilizing the crushed granite is recommended. Green infrastructure with a focus on retention is needed between the trail and parking areas with a focus on the compacted overflow parking. Invasive species removal, especially of the aggressive catclaw vine, should occur as soon as possible. Savanna restoration and woodland expansion are recommended in the upland areas along with enhancement of the existing woodlands.

Figure 4.68: Sloping woodlands of the Zilker West unit have some of the most intact understory and herbaceous layers found in the study area.

Figure 4.69: Invasive catclaw vine in Zilker West.

Figure 4.70: Invasive species, erosion issues, and recommended restoration work in the Zilker West Unit. Sources: COA, NAIP.

Figure 4.71: The wide Trail throughout much of Zilker West should be narrowed to allow more space between the Trail and the slope.

Land Management Tasks

[E & U] Stabilize crushed granite to eliminate deposition off-trail. **High priority**

[E, U, & R] Move trail towards bermed landscaping to the south and reduce width to allow for greater buffer between trail edge and steep slopes. This will require planting and seeding along the downslope side as well as temporary barriers to prevent trampling. **High priority**

[E] Install green infrastructure at the northern edge of the overflow parking to reduce the amount and velocity of stormwater entering the natural areas. **High priority**

[E] Repair gully erosion east of MoPac. Where repair is not feasible, armor areas to minimize damage to surroundings. **High priority**

[I] Remove catclaw vine on both sides of parking area under MoPac. **High priority**

[R] Convert areas recommended for savanna restoration to wildflower meadow management to begin transition towards savanna. **High priority**

[R] Increase diversity of existing woodland. **Medium priority**

[E] Install green infrastructure, armoring, and/or diversion/dispersal structures at downslope end of culverts shunting water under trail to control erosion downslope. **Medium priority**

[R] Restore woodland and savanna in underutilized lawn areas. **Medium priority**

[I & R] Remove giant reed, Ligustrum, heavenly bamboo, and Chinaberry west of MoPac with additional treatment as necessary, planting, and seeding. **Medium priority**

[I] Remove Chinaberry at edge of existing woodlands. **Low priority**

Toward Implementation

To sustain the benefits we receive from the natural areas around Lady Bird Lake, active management is necessary in the coming years. The Toward Implementation sections build upon the guidelines and concepts in this document with a focus on the practical elements needed to complete tasks, including: professional and volunteer services, scheduling and coordination, documentation and monitoring, and metrics to evaluate success.

PROFESSIONAL AND VOLUNTEER SERVICES

The implementation of this project and the setup of its tasks will require trained oversight in all cases. The work is configured such that a team of professionals can complete all tasks or professionals can take on some tasks in coordination with volunteer efforts. The difference between these two approaches are overall costs, professional accountability, length of time before completion, and the outcome quality of some tasks. Professional services are regularly used throughout Austin to complete all tasks associated with land management and restoration, as exemplified by the current projects at Shoal Creek in Pease Park and the Waller Creek restoration project associated with the University of Texas at Austin Dell Medical School. These projects are resource intensive, have a high level of accountability, and a relatively short time frame to contractual satisfaction. With limited funds and the ongoing need for land management, many parks and preserves have turned to trained volunteers. At Blunn Creek Preserve and Mayfield Park, "friends of the park" groups have been used to remove substantial amounts of invasive species and replant with trained and professional oversight. There are limits to what volunteers can do based on safety and complexity of task, so professionals must be used to complement the work of volunteers. This process has the advantages of lower cost, the creation of interested parties that can keep the project going for numerous years, and the ability to treat persistent problems and new problems as they arise. It is likely that the tasks laid out within this report will fall between these examples, with both professional and volunteer services working together to create a more robust natural area around Lady Bird Lake.

Figure 5.1: Underutilized lawn area in the Southeast Shore Management Unit appropriate for woodland expansion.

The Trail Foundation and the City have an established relationship with the Texas Conservation Corps (TxCC). Their experience with similar restoration projects makes them an ideal group for implementation of many of the tasks listed here. TxCC crews are trained in many management activities including: invasive plant removal, trail building, soil remediation, planting, and seeding. TxCC can also work with professionals on other tasks including: installing and repairing culverts, some components of tree care, constructing bioswales, decompacting soils, stabilizing banks, constructing sediment capture structures, removing concrete, and installing gabions. Some of the tasks recommended here will require the specialized experience of arborists, landscape architects, engineers, heavy equipment operators, and/or concrete contractors.

The Trail Foundation has used volunteers and coordinated the work of other non-profit organizations within the natural areas. Several organizations already offer programming that would be beneficial for The Trail Foundation's volunteers, including:

- Invasive plant identification and treatment training with the Invaders of Texas Program at the Lady Bird Johnson Wildflower Center, http://www.texasinvasives.org/invaders/
- Capital Area Master Naturalists training, http://camn.org/
- Native Plant Society in Central Texas for educational programming and native plant material sources, http://npsot.org/wp/austin/
- Travis Audubon for bird identification and habitat restoration, http://travisaudubon.org/

These organizations are known places for interested volunteers to gain knowledge that will be helpful in accomplishing many of the ongoing tasks called out

in this document, though the work itself will be coordinated and overseen by The Trail Foundation.

The recommendations and tasks laid out in this document will be completed by a combination of professional and volunteer services, with the assumption that the Texas Conservation Corps or an equivalent organization will play a key role. Professional efforts are needed for their knowledgebase and specialty skills. Volunteers are needed for their long-term knowledge and dedication. The combination of efforts will result in the most efficient and effective use of resources.

Table 5.1: Four Year Area Work Schedule. See Appendix 1 for the detailed task list.

Four Year AreaWork Schedule

Fall 2015 to Summer 2016

Entire Site Tasks
Deep Eddy Primary Treatment
Austin High Primary Treatment
City Hall Primary Treatment
Waller Creek—Discrete Task
Rainey Primary Treatment
Holly Shores Primary Treatment
Southeast Shores Primary Treatment
Cliffs Treatment—Discrete Task
Southcentral Shore Primary Treatment

Fall 2016 to Summer 2017

Entire Site Tasks
Cesar Chavez Primary Treatment
Hotel Slope Primary Treatment
Waller Creek—Discrete Tasks
Festival Beach Primary Treatment
Cliffs- Discrete Tasks
Auditorium Shores—Discrete Tasks
PARD Woodland Primary Treatment
Zilker East Primary Treatment
Zilker West Primary Treatment

Fall 2017 to Summer 2018

Entire Site Tasks
Deep Eddy Secondary Treatment
Austin High Secondary Treatment
City Hall Secondary Treatment
Rainey Secondary Treatment
Holly Shores Secondary Treatment
Southeast Shore Secondary Treatment
Southcentral Shore Secondary Treatment

Fall 2018 to Summer 2019

Entire Site Tasks
Cesar Chavez Secondary Treatment
Hotel Slope Secondary Treatment
Waller Creek—Discrete Tasks
Festival Beach Secondary Treatment
Cliffs Secondary Treatment
PARD Woodland Secondary Treatment
Zilker East Secondary Treatment
Zilker West Secondary Treatment

SCHEDULE AND COORDINATION

Restoration and land management are not discrete events, but ongoing processes. A four year land management schedule can be seen in Appendix 1, with a simplified version in Table 5.1. It is a dynamic schedule that can be altered based on shifting priorities, management successes, degradation concerns, and available funding. The schedule serves as a baseline of important tasks that should be considered for completion in the coming years. In 2019, it is recommended that the entire document be revised to look forward an additional four years.

To ensure all efforts are being coordinated between the many City departments and organizations working in the study area, it is recommended that The Trail Foundation hold quarterly work plan meetings with key personnel from TTF, TxCC, COA-PARD, COA-Forestry, COA-WPD, and other appropriate entities. In these meetings work plans associated with the tasks in these guidelines, new priorities, as well as documented efforts described below can be discussed. Through this coordination, complementary actions and resource allocations can be aligned for more efficient and successful implementation. Before work begins in an area, these guidelines and/or equivalent plans should be reviewed by The Trail Foundation, the City, TxCC, and any other parties involved in the work. It is also critical that plans be in place for follow-up treatments, restorations, and resource allocations before work is started in an area. This allows for scheduling coordination between entities and ensures treatments work effectively.

DOCUMENTATION, MONITORING & CITIZEN SCIENCE

It is critical that all efforts towards the completion of recommendations here are documented to gauge success, facilitate an adaptive management approach, track change, and allow the numerous entities working in the study area to be aware of each other's work. Either a City department or The Trail Foundation could take on this information management role—likely in the form of a database. Ongoing documentation can facilitate coordination by ensuring all entities working in the area are aware of what has been done, what was effective, what remains to be done, and how best to allocate resources.

Monitoring of the study area is recommended through geographic, photographic, and narrative descriptions that include annual photo points, early detection evaluation, land management documentation and evaluation, and biodiversity

observations. Records from this monitoring should be standardized and readily available. Over time these collective documents will serve to drive future management practices and to educate both professionals and volunteers working in the study area.

To ensure fidelity of monitoring information, documentation should take place at the time of monitoring. Example monitoring documents are in Appendix 2. It is recommended, however, that all monitoring documentation be done through smartphone or tablet devices using a field data application such as Fulcrum. Advantages of using such a program include immediate incorporation of the information into a database, reduced data errors, location tracking, association of photos and voice recordings with specific locations, and customizable datasheets that can meet the needs of the Trail Foundation and the City of Austin.

Photo points

Photo points are a fairly quick and easy way to perform qualitative monitoring. 68 photo points were established within the study area as seen in Figure 5.2. The photographs and descriptions are included in Appendix 3. GPS points were taken at each location so that they can easily be found, and the photos can be replicated. It is recommended that photos be taken once a year at each of these points. Comparing the photos over time will provide a sense of how areas are changing and guide future management decisions.

Early Detection Monitoring

Early detection monitoring is not designed to assess the effectiveness of management actions but rather to detect new threats at an early stage of development so that they can be addressed quickly. This is considered a best management practice and is called out in both the City's Urban Forest Plan and Invasive Species Management Plan. It is not tied to a specific photo point or vegetation plot, but requires a staff member, professional, or volunteer to periodically walk the entire study area and observe new invasive threats, expanding invasive plant issues, areas being overused and denuded, new informal trails, and new erosion issues. Once new threats are identified, staff or volunteers can quickly take action and prevent a small problem from becoming a larger one that takes more time and resources to control in the future. To be effective, early detection monitoring requires a staff member, professional, or volunteer who is:

- Adept at identifying invasive plants, even obscure ones;
- Very familiar with the natural areas around Lady Bird Lake and can ac-

Figure 5.2: Locations of photo points established around Lady Bird Lake. Sources: COA, NAIP.

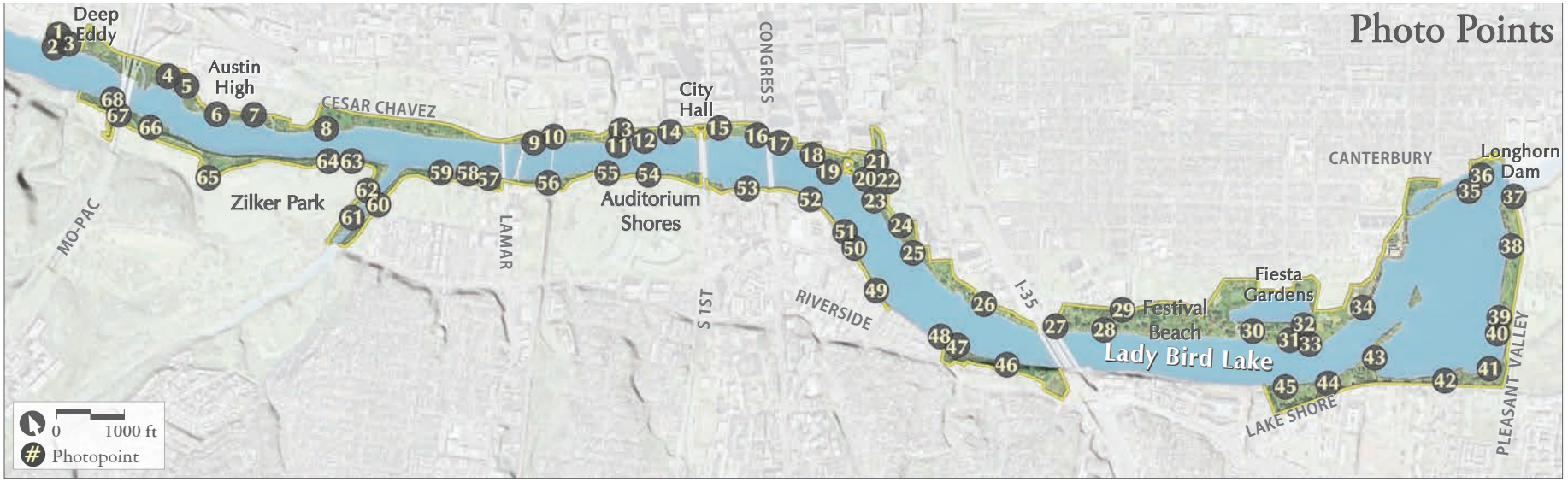


Table 5.2: Priority areas for invasive species control. The point number does not indicate priority.

Priority Areas for Invasive Treatment

Point	Latitude	Longitude	Primary Invasives	Notes
1	30.277179	-97.773393	Catclaw vine	At entrance of Eiler's Park
2	30.27534	-97.771479	Catclaw vine	Just west of MoPac overpasses
3	30.265007	-97.751632	Chinaberry	Dense patch of Chinaberry near recent restoration project at Shoal Creek
4	30.263036	-97.745569	Golden rain tree	Abundant throughout the woodland between 1st St. and Congress Ave.
5	30.262415	-97.744651	Golden rain tree	East of Congress Ave.
6	30.258638	-97.740771	Chinaberry	Present throughout woodlands in Rainey Unit
7	30.255491	-97.740066	Giant reed	Along shoreline south of Rainey St.
8	30.2478	-97.726814	Johnsongrass	In Grow Zones along much of the shoreline of the Lake and the lagoon
9	30.249587	-97.727897	Tree of heaven	One of few patches in the study area, in the woodland near the pavilion at Festival Beach
10	30.250523	-97.717201	Giant reed	In many patches along the peninsula in the Holly Shores Unit
11	30.250411	-97.718584	Tree of heaven	Single tree at west end of the peninsula in the Holly Shores Unit
12	30.246281	-97.715751	Johnsongrass, giant reed, sweet autumn clematis	Found throughout much of the Grow Zone area and the shores of the Southeast Shores Unit
13	30.251323	-97.739623	Catclaw vine, sweet autumn clematis, Japanese honeysuckle	Abundant vines south of the Trail in the Cliffs Unit
14	30.260352	-97.744628	Ligustrum, golden rain tree, Chinaberry	Throughout much of the shoreline woodland of the Southcentral Shore Unit, particularly the western portion
15	30.266437	-97.761906	Giant reed	Along eastern banks of Barton Creek
16	30.26841	-97.764269	Tree of heaven	Scattered individuals within the Zilker East Unit
17	30.273271	-97.772427	Catclaw vine	Patches both east and west of the Mopac Underpasses

curately determine if change is occurring; and
- Willing to walk the grounds a minimum of 2 times a year looking for new threats.

It is recommended that field data be recorded electronically with the following variables: date, recorder, type of threat (species name, new invasive species, expanding invasive species, new or expanding erosion, new or expanding trampling, new or expanding informal trail, new or expanding stormwater flow), location (including latitude and longitude, along with general identifiers), size of issue (for invasive species should include patch size, percent cover, and if appropriate number of plants), and a narrative description of the problem and potential cause. If electronic recording is not feasible, a potential early detection monitoring form template can be found in Appendix 2.

Land Management Task Monitoring

The Trail Foundation, City of Austin, Austin Parks Foundation, and numerous other organizations have been actively managing and improving the natural areas around Lady Bird Lake through tree planting, soil amendments, trash clean up, and invasive species control. However, piecing together a narrative of their efforts currently relies heavily on the institutional memory of key individuals. To facilitate an ongoing record, it is recommended that electronic records be kept of all management activities that include the following variables: date, recorder, general activity, area treated, location of area, size of area, how it was treated, and resources used (including labor), along with photo documentation. A simple, standard stewardship action form can be found in Appendix 2. Once management has taken place in an area, the area should be placed on a list of areas to evaluate annually along with the existing photo points.

Tracking Biodiversity

Citizen Science is becoming a vital way to track biodiversity information, with numerous individuals in the Austin area actively recording biodiversity data through eBird, iNaturalist, Odonates of Texas, Fishes of Texas, and other online services. Individuals input data, which goes through a validation process that allows final users to understand the quality of the data. For the natural areas around Lady Bird Lake, the Trail Foundation has begun working with Travis Audubon to curate the biodiversity information. To this end "places" were cre-

ated in iNaturalist that include "East Lady Bird Lake" from Longhorn Dam to Congress, "Central Lady Bird Lake" from Congress to Mopac, and "West Lady Bird Lake" from MoPac to Tom Miller Dam. There are also existing hot spots around the Lake listed on eBird that park visitors can contribute to.

Travis Audubon is engaging its volunteers to serve as monthly spotters to encourage recording observations and to promote interest and participation by the general public. Wildlife observations can, if desired, also be dynamically linked to the Trail Foundation and Travis Audubon websites from iNaturalist and eBird.

METRICS

The process of restoration in the natural areas around Lady Bird Lake will have successes and failures in the coming years, with an overall trend towards enhancing the natural areas. By following the recommendations here and maintaining an adaptive management approach, The Trail Foundation and its partners will see measurable changes. To evaluate these changes, we recommend the metrics below as measures of success. For our purposes, a metric is an element that can be measured with relative ease that indicates progress is being made towards the goals stated on page 2.

These metrics suggest a path towards success and provide a quick articulation of some of the overall reasons for the land management practices laid out in these guidelines. They also provide a motivation for people to become more familiar with and committed to the study area. For instance, the metrics associated with increased species numbers will motivate restoration and habitat enhancement efforts while at the same time motivating observations and record keeping. The metrics catalyze involvement and resource allocation while allowing for measurable, tangible outcomes.

Recommended Metrics

- Reduce the highest priority invasive species populations by 80% area occupied over 3 years (listed in Table 5.2).
- Plant 4,000 container trees over the next 4 years with a 75% survival rate at the end of 6 years.
- Plant 8,000 tree seedlings over the next 4 years.
- Increase overall canopy cover to 70% of the study area in 20 years (currently 49%).
- Increase native species confirmed observations for major taxa by 20% in 10 years including: mammals, reptiles, amphibians, fish, insects, and birds.
- Restore at least two acres of savanna on Gaddy soils in 10 years.
- Repair and restore 75% of off-trail erosion problems recorded in this document over 5 years.
- Increase shade over trail to 80% over 15 years (currently at 48%).
- Address 100% of critical tree care tasks outlined by Don Gardner within 6 months.
- Address 80% of all tree care tasks outlined in Don Gardner's assessment in 1 year.

Conclusions

The urban forest and natural areas of Lady Bird Lake and the Butler Trail are an irreplaceable part of Austin. They form an ecological and cultural nexus unmatched in the City and rarely matched in other places. 1.5 million people come to the site each year for relaxation in nature, beautiful views, and great recreation, making it the most used trail in Central Texas and one of the most used trails in the country. Beyond aesthetics and play, the site gives back to the community by cleaning the air, reducing urban temperatures, providing shade, cleaning water, building soil, reducing erosion, and providing habitat for over 800 species of plants and animals. It connects the Hill Country to the prairie, important riparian habitats up and downstream along the Colorado River, and numerous greenways and bikeways throughout the City. To maintain the current level of service and to move toward the site's full potential, the Trail Foundation, the City, and their partners can strategically allocate resources per the recommendations here to enhance the ecological function and improve the user experience in the urban forest and natural areas of Lady Bird Lake.

The Trail Foundation commissioned this report to proactively look at opportunities and challenges within the 200 acres of natural area and urban forest tied together by Lady Bird Lake and the 10-mile Ann and Roy Butler Trail. The site is clearly loved, and numerous improvements have been made to the site in the last four decades. To maintain and improve it over time, however, additional management and investment is critically needed. To this end, management recommendations are made here based on the ecology of the site, restoration potential, and sustainable land management practices. Over 170 management recommendations are made, to be carried out over the next four years. The first tasks address degradation found throughout the site, including erosion, invasive species, unnecessary mowing, and trail alignments extremely close to the water. As these issues are addressed, restoration of the woodlands, savanna, and aquatic plant communities should be implemented to better meet the aesthetic and ecological potential of the site including:

- 60 acres of woodland enhancement,
- 80 acres of woodland expansion,
- 12 acres of savanna restoration, and
- Aquatic plantings at 23 sites.

Figure 6.1: The Lake, Trail, and natural areas (shown here near Austin High School) are an irreplaceable asset.

The implementation of the recommendations here will result in restored plant communities and wildlife habitat, improved ecological function, increased resiliency, and an enhanced user experience. In addition, the implementation will facilitate greater stewardship and involvement in the natural areas. Success of the project will rely on the use of the best management practices laid out here, regular maintenance and follow-up treatments, and ongoing monitoring as well as an adaptive management approach that recognizes land management and restoration as a dynamic process. Success will be measured by metrics looking at increases in overall canopy, increases in trail shade, number of trees planted, reductions in invasive plant populations, and mitigation of erosion issues.

Some key findings of this report are:

- The site is culturally and ecologically irreplaceable.
- The Butler Trail, Lady Bird Lake, and their associated natural areas and urban forest are an entity to themselves. Though portions of the study area are addressed in numerous plans and actions, strategic management and action addressing the entire area is needed.
- Historic land management of the site and limited resources have resulted in large expanses of underutilized lawn, incomplete plant communities, erosion issues, less shade, lower ecological function, and less habitat.
- The site provides tremendous recreational, ecological, and habitat value that can be substantially improved by the land management and ecological restoration recommendations here.
- Investments recommended here are small in comparison to the overall value of the urban

forest and natural areas of Lady Bird Lake and the Butler Trail.

- The recommendations here are aligned with City policies and work towards over 30 action items recommended in Imagine Austin and 15 performance measures in the Austin Urban Forest Plan.
- The recommendations build on the legacy set by Lady Bird Johnson, Ann and Roy Butler, and others of deeply appreciating and contributing to the aesthetic beauty and ecological function of Lady Bird Lake and the surrounding area.

The path forward for this vital part of the Central Texas cultural and natural environment is at a pivotal point. Through strategic allocation of resources as outlined in these guidelines, including defined management tasks, ongoing best management practices, and monitoring, the site's current value and services can not only be maintained but substantially increased. The end result is a heightened user experience and enhanced ecological function that breeds enjoyment, excitement, interest, and participation for current and future generations.

Figure 6.2: The guidelines build upon the substantial work, such as the addition of the Boardwalk, that has already been done to complete and enhance the Trail.

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Appendix 1

Four Year Management Schedule

The following schedule outlines the management priorities for the next 4 years, divided into the following categories:

{R} Restoration: This category includes activities such as converting an area from lawn to woodland and planting to increase diversity.

{I} Invasive species management: These actions actively or passively reduce a particular invasive species, and include: physical removal, the use of herbicides, out competing, and shading out.

{E} Erosion control and soil restoration: This category includes all activities designed to mitigate erosion impacts or repair damaged soil. Activities address the need for green infrastructure, hard infrastructure, and/or soil restoration and include: bioswale instillation, regrading, culvert instillation, soil decompaction, and mulching.

{U} User experience: This category encompasses a wide range of activities designed to enhance the experience of using the Trail, including: increased aesthetic appeal, improved access to the water, trail improvements, and increased safety.

Fall 2015 to Summer 2016

Entire Site

Type	Task	Priority
R	Mulch under trees in mowed areas that are currently without an herbaceous layer.	High
U & R	Remove any tree safety hazards.	High
U, E & R	Stabilize trail and eliminate crushed granite deposition off-trail.	High
I	Monitor entire site for invasive species	High
R & I	Where tree establishment is occurring, control invasives.	High
R	Initiate Grow Zone land management practices and eliminate mowing in all areas prioritized for woodland expansion and or enhancement.	High
R	Demarcate Grow Zones and ensure coordination of land management activities between PARD and Watershed Protection.	High

Deep Eddy Primary Treatment

Type	Task	Priority
R	Increase area and canopy cover of the woodlands in lower section of Eilers Park.	High
I	Remove catclaw vine at the entrance to Eilers Park.	High
U & R	Cut grape vines off some of the trees south of trail, use this as an opportunity to cut "windows" through the vegetation so that the Lake can be seen from Deep Eddy Pool area.	High
I & R	Remove giant reed along shoreline. This action will necessitate bank stabilization, planting, and seeding in the following years.	Medium
I	Remove Chinese Tallow and Chinaberry in woodland.	Low

Austin High Primary Treatment

Type	Task	Priority
U, E & R	Move edge of Trail inland several feet where feasible to create more habitat for riparian plants. This can be accomplished through a combination of reducing the width of the Trail and moving it inland.	High
E & U	Stabilize Trail and eliminate crushed granite deposition off-trail.	High
R	Plant riparian areas between moved trail and water's edge.	High
U, E & R	Formalize the two major informal trails leading from Veterans Drive to the Trail and restore others with a combination of brushing, soil decompaction, and planting tree seedlings.	High
I	Remove catclaw vine patches	High
I	Remove Chinaberry and Chinese tallow throughout area with special attention to those impacting native trees	Medium

City Hall Primary Treatment

Type	Task	Priority
I & R	Control golden rain tree, Chinese tallow, and Chinaberry. Initial treatment should focus on removal from around native trees. Secondary treatment should include the entire area. Treatment must be coupled with erosion control and restoration plantings due to the extent of the issue.	High
E & U	Stabilize Trail and eliminate crushed granite deposition off-trail.	High
R	Expand woodland throughout area, with species selection meeting height limits set by Austin Energy due to overhead powerlines. Aesthetics and seasonal color should also be considered.	High
E & R	Decompact soils used as a staging area in the western extent of the unit and plant and seed for woodland expansion.	High
E	Stabilize gully west of Congress Avenue Bridge	High
R	Convert areas recommended for savanna restoration to wildflower meadow management to begin transition towards savanna.	High
E & U	Where topography allows, move the Trail inland and allow riparian area expansion.	Medium
U & E	Coordinate with Watershed Protection Department to determine need for and proper location of water access.	Medium
I & R	Remove giant reed. This action will necessitate bank stabilization, planting, and seeding in the following years.	Medium

Waller Creek

Type	Task	Priority
R & I	Ensure island at mouth of creek is protected as plant and wildlife refuge and enhance by increasing plant diversity and managing invasives.	High

Rainey Primary Treatment

Type	Task	Priority
R	Convert underutilized lawn to woodland through planting and seeding west and southeast of the Mexican American Cultural Center and south of East Avenue.	High
E	Install green infrastructure in the western and eastern portions of the study area to retain and slow down stormwater as it moves through the unit.	High
R	Replace and enhance shade tree cover at terminus of Rainey Street.	High
U & E	Add formal water access from base of concrete stairs and restore areas affected by trampling and compaction.	High
I	Remove Chinaberry	High
E & R	Enhance the growing streamlets in the western and eastern portions of the management unit through rock placement and plantings appropriate for small ephemeral streams.	High
U, E & R	Decommission informal trails with a combination of brushing, soil decompaction, and planting tree seedlings.	High
I	Remove giant reed. This action will necessitate bank stabilization, planting, and seeding in the following years.	High
E & R	Stabilize the two principal gullies with green infrastructure that includes a combination of armoring, diversion, swales and retention upslope, and planting.	High

Holly Shores Primary Treatment

Type	Task	Priority
R	Expand woodlands through planting and seeding of canopy, understory, and herbaceous layers with special attention to those areas retired from the Holly Power Plant and lawn that are now planned for passive recreation and natural areas.	High
U, E & R	Reduce the existing trail width to less than 14 ft, stabilize surface, install connecting trail through former Holly Power plant Area and on to Festival Beach unit using standards described in management section.	High
E & R	Remove concrete embankments as feasible.	High
I & R	Continue removal of giant reed along with bank stabilization, planting, and seeding.	High
R & I	Plant canopy trees around giant reed invasion to shade out reed and enhance woodland canopy.	High
I	Remove tree of heaven	High
E	Utilize open areas to install green infrastructure such as swales and rain gardens where feasible to increase absorption and reduce erosion issues.	High
U & E	Coordinate with Watershed Protection Department to determine need for and proper location of water access.	Medium

Holly Shores Primary Treatment (continued)

Type	Task	Priority
E	Decommission informal trails with a combination of brushing, soil decompaction, and plantings with special attention to the steep areas near the Canterbury parking area.	Medium

Southeast Shore Primary Treatment

Type	Task	Priority
E & R	Stabilize eroding banks with erosion control fabric and plant additional trees and herbaceous material.	High
I	Treat Johnsongrass.	High
R	Expand woodland throughout much of the area, with special attention to the areas behind the hostel, the peninsula, the eastern shore, and the area parallel with Lakeshore Drive from the hostel eastward. Shorter species will be needed in some areas to accommodate the overhead powerlines.	High
I & R	Continue removal of giant reed along shoreline. This action will necessitate bank stabilization, planting, and seeding in the following years.	High
R & I	Plant canopy trees around giant reed invasion to shade out reed and enhance woodland canopy	High
E & R	Utilize grading in the upper portions of the unit to retain and slow down stormwater. Plant as appropriate.	High
E	Stabilize gully erosion using green infrastructure where feasible. Armoring may be necessary in some places.	High
R	Convert areas recommended for savanna restoration to wildflower meadow management to begin transition towards savanna.	High
R	Prune live oak groves designated by Don Gardner.	High
I	Remove sweet autumn clematis, with focus on the eastern woodland.	Medium
U & E	Coordinate with Watershed Protection Department to determine need for and proper location of water access.	Medium

The Cliffs Treatment

Type	Task	Priority
I	Treat catclaw vine throughout.	High

Southcentral Shore Primary Treatment

Type	Task	Priority
E & U	Stabilize crushed granite trail to eliminate granite deposition off-trail.	High

Southcentral Shore Primary Treatment (continued)

Type	Task	Priority
I	Remove Ligustrum, golden rain tree, and Chinaberry.	High
U & R	Work with landowners and city planners to expand riparian woodland and reduce hardscape bottlenecks for Trail users.	High
R	Prune live oak grove designated by Don Gardner.	High
R	Expand woodland throughout.	Medium
U & E	Coordinate with Watershed Protection Department to determine need for and proper location of water access.	Medium
R	Increase understory and herbaceous layers throughout.	Medium

Fall 2016 to Summer 2017

Entire Site

Type	Task	Priority
R	Mulch under trees in mowed areas that are currently without an herbaceous layer.	High
U & R	Remove any tree safety hazards.	High
U, E & R	Stabilize trail and eliminate crushed granite deposition off-trail.	High
I	Monitor entire site for invasive species	High
All	Monitor previous work, retreat where necessary, adjust new treatments as necessary.	High
R & I	Where tree establishment is occurring, control invasives	High

Cesar Chavez Primary Treatment

Type	Task	Priority
R	Expand woodland throughout the area.	High
E & U	Stabilize crushed granite trail to eliminate granite deposition off-trail.	High
U & R	Move sections of the Trail away from the shore to create more interesting trail, reduce granite deposition onto the sensitive shoreline area, and allow for a wider riparian zone.	High
I & R	Remove Chinaberry near Shoal Creek restoration project to reduce potential infestation in newly restored areas. May require tree planting and erosion control blankets.	High
R	Amend and decompact soil, plant, and seed areas that were formerly part of the Trail.	High
R	Convert areas recommended for savanna restoration to wildflower meadow management to begin transition towards savanna.	High
I & R	Remove Chinese Lacebark elm. Will require extensive lakeshore tree plantings and erosion control blankets.	Medium

Cesar Chavez Primary Treatment (continued)

Type	Task	Priority
U & E	Coordinate with Watershed Protection Department to determine need for and proper location of water access.	Medium

City Hall Primary Treatment

Type	Task	Priority
R	Expand riparian woodland upslope	High
I	Remove golden rain tree	High
I	Cut grape vine	High
I	Remove common chaste tree	Medium
E	Decommission informal trails with combination of brushing, soil decompaction, and restoration plantings	Medium
R	Add sediment capture structures near existing wetland to encourage its spread	Medium

Waller Creek

Type	Task	Priority
All	Complement restoration and bank stabilization efforts being planned by Waller Creek Conservancy, the City of Austin Watershed Protection Department, and their partners.	High

Festival Beach Primary Treatment

Type	Task	Priority
R	Convert underutilized lawn areas to woodland; leave more utilized lawn areas in current use.	High
I	Remove Johnsongrass.	High
R	Mulch and prune pecan trees near covered pavilion and prune live oak groves designated by Don Gardner.	High
U, E & R	Decommission informal trails and informal water access points with a combination of brushing, soil decompaction, and planting of tree seedlings.	High
I	Remove tree of heaven	High
U & E	Coordinate with Watershed Protection Department to determine need for and proper location of water access.	Medium
E & R	Install bioswales to increase water retention and eliminate numerous erosion issues throughout area while creating small-scale grading changes that increase the diversity of habitat.	Medium
I	Remove and replace Chinese Lacebark elm that has been planted in the mowed areas.	Medium

The Cliffs Treatment

Type	Task	Priority
R	Maintain and expand wetland restoration project at mouth of Blunn Creek.	High
R & I	Maintain new plantings near Boardwalk & keep free of invasive species.	High

Auditorium Shores Treatment

Type	Task	Priority
All	Work with City of Austin to ensure the implementation and ongoing maintenance of the Auditorium Shores master plan is successful and natural area management is aligned with these guidelines to the extent feasible.	High
R	Plant shoreline that is not being utilized for recreation at a density that will discourage informal access and prevent erosion.	High

Butler Shores Woodland Primary Treatment

Type	Task	Priority
E	Repair broken culvert in bank of Barton Creek.	High
E	Stabilize large gully near Barton Creek footbridge with armored banks/gabions if necessary.	High
E & U	Stabilize crushed granite trail to eliminate granite deposition off-trail.	High
I & R	Remove giant reed along shoreline. This action will necessitate bank stabilization, planting, and seeding in the following years.	High
U & R	Trim poison ivy back from the Trail.	High
U & R	Incorporate green infrastructure into Butler Shores Park underutilized areas to reduce stormwater coming into the unit and expand the woodland canopy into these areas.	Medium
U & R	Coordinate with Watershed Protection Department to determine need for and proper location of water access. Remove dilapidated access points and associated infrastructure.	High
I	Remove paper mulberry.	Medium
I & R	Follow up on recent bamboo clearing east of Barton Creek with additional treatment as necessary, planting, and seeding.	Medium
E & U	Decommission informal trails with a combination of brushing, soil decompaction, and planting of tree seedlings.	Medium
I	Remove chinaberry, Chinese tallow and other invasive woody plant species.	Medium
U	Formalize a trail between athletic fields and Butler Trail.	Low
I	Remove Bradford Pear near Lamar Bridge.	Low

Zilker East Primary Treatment

Type	Task	Priority
E & U	Stabilize crushed granite trail to eliminate granite deposition off-trail.	High
E & U	Decommission informal trails with a combination of brushing, soil decompaction, and planting of tree seedlings, especially in the area between Barton Creek and Zilker Park.	High
I	Remove tree of heaven	High
U	Improve water access near Barton Creek footbridge and duck feeding area.	Medium
I	Remove Chinaberry, Chinese tallow, and Ligustrum close to the Trail where feasible.	Low

Zilker West Primary Treatment

Type	Task	Priority
E & U	Stabilize crushed granite trail to eliminate deposition off-trail.	High
E, U & R	Move trail towards bermed landscaping to the south and reduce overall width to allow for greater buffer between trail edge and the steep slope to water's edge. This will require planting and seeding along the downslope side as well as temporary barriers to prevent trampling.	High
E	Install green infrastructure at the northern edge of the overflow parking to reduce the amount and velocity of stormwater entering the natural areas.	High
E	Repair gully erosion east of MoPac. Where repair is not feasible, armor areas to minimize damage to surroundings.	High
I	Remove catclaw vine on both sides of parking area under MoPac.	High
R	Convert areas recommended for savanna restoration to wildflower meadow management to begin transition towards savanna.	High
E	Install green infrastructure, armoring, and/or diversion/dispersal structures at downslope end of culverts shunting water under trail to end erosion downslope.	Medium
E	Restore woodland in underutilized area between Zilker Park and the Zilker overflow parking area.	Medium
I & R	Remove giant reed, Ligustrum, heavenly bamboo, and Chinaberry west of MoPac with additional treatment as necessary, planting, and seeding.	Medium
I	Remove Chinaberry at edge of existing woodlands.	Low

Fall 2017 to Summer 2018

Entire Site

Type	Task	Priority
R	Mulch under trees in mowed areas that are currently without an herbaceous layer.	High
U & R	Remove any tree safety hazards.	High
U, E & R	Stabilize trail and eliminate crushed granite deposition off-trail.	High
I	Monitor entire site for invasive species	High
All	Monitor previous work, retreat where necessary, adjust new treatments as necessary.	High
R & I	Where tree establishment is occurring, control invasives	High

Deep Eddy Secondary Treatment

Type	Task	Priority
E & U	Increase diversity of existing woodland	Low

Austin High Secondary Treatment

Type	Task	Priority
R	Increase woodland diversity with special attention to the more intact areas in the western portions of the management unit.	Medium
R	Plant aquatic species to promote greater aquatic plant diversity.	Medium
U, E & R	Formalize a portion of the trails on the peninsula and decommission other trails with a combination of brushing, soil decompaction, and planting of tree seedlings.	Medium
R	Add sediment capture structures near existing wetland to encourage its spread.	Medium
R	Remove homeless encampment debris on peninsulas.	Medium

City Hall Secondary Treatment

Type	Task	Priority
R	Increase diversity of existing woodland	Low
R	Add sediment capture structures near existing wetland to encourage its spread.	Low
R	Plant aquatic species to promote greater aquatic plant diversity.	Low

Rainey Secondary Treatment

Type	Task	Priority
R	Increase diversity of existing woodland	Medium
E	Use armoring, diversion and/or dispersal to address erosion caused by numerous small culverts that shunt water under trail.	Medium
U & R	Remove old wooden docks.	Low
R	Add sediment capture structures near existing cattail patch to encourage its spread.	Low
R	Plant aquatic species to promote greater aquatic plant diversity.	Low

Holly Shores Secondary Treatment

Type	Task	Priority
R	Increase diversity of existing woodland	Medium
R	Plant aquatic species to promote greater aquatic plant diversity.	Medium
R	Add sediment capture structures near existing cattail patch to encourage its spread.	Medium
I	Remove common chaste tree, Johnsongrass, Chinaberry, and Chinese tallow.	Low

Southeast Shore Secondary Treatment

Type	Task	Priority
R	Install sediment capture structures at edges of existing wetlands and install emergent aquatic plants, using exclosures as needed, as part of wetland expansion pilot project.	Medium
R	Create a pilot area of Gaddy soil savanna under powerlines in eastern part of unit.	Low
I	Remove Chinese tallow, Ligustrum, and common chaste tree.	Low

Southcentral Shore Secondary Treatment

Type	Task	Priority
E & U	Decommission informal trails and informal water access points with a combination of brushing, soil decompaction, and planting of tree seedlings.	Medium

Fall 2018 to Summer 2019

Entire Site

Type	Task	Priority
R	Mulch under trees in mowed areas that are currently without an herbaceous layer.	High
U & R	Remove any tree safety hazards.	High
U, E & R	Stabilize trail and eliminate crushed granite deposition off-trail.	High
I	Monitor entire site for invasive species	High
All	Monitor previous work, retreat where necessary, adjust new treatments as necessary.	High
R & I	Where tree establishment is occurring, control invasives	High

Cesar Chavez Secondary Treatment

Type	Task	Priority
R	Increase diversity of existing woodland	Medium
R	Restore savanna on Gaddy soils just east of baseball field.	Low
R	Restore savanna area under Mesquite grove southwest of the Austin High baseball field.	Low
E & U	Decommission informal trails near Seaholm with a combination of brushing, soil decompaction, and planting tree seedlings.	Low

Hotel Slope Secondary Treatment

Type	Task	Priority
R	Increase diversity of existing woodland	Low
R	Plant aquatic species to promote greater aquatic plant diversity.	Low

Waller Creek

Type	Task	Priority
I	Remove Mexican petunia and elephant ear where feasible.	High
R	Restore herbaceous and shrub layer throughout.	High
I & R	Remove giant reed on western banks of Waller Creek. This action will necessitate bank stabilization, planting, and seeding in the following years.	High
I	Remove woody invasives including Ligustrum, Chinaberry, heavenly bamboo, and common chaste tree on west side of Waller Creek.	Medium
U & E	Decommission informal trails with a combination of brushing, soil decompaction, and planting tree seedlings west of Waller Creek.	Medium

Waller Creek (continued)

Type	Task	Priority
R	Add sediment capture structures near existing cattail patch to encourage its spread.	Low
R	Plant aquatic species to promote greater aquatic plant diversity.	Low

Festival Beach Secondary Treatment

Type	Task	Priority
R	Increase diversity of existing woodland.	Medium
I	Remove Chinese tallow and Chinaberry.	Medium
R	Add sediment capture structures near existing wetland to encourage its spread.	Medium
R	Plant aquatic species to promote greater aquatic diversity.	Medium
E & R	Enhance streamlets in existing erosion channels.	Medium
U & E	Add hardscape around existing bench just east of I-35 to prevent continued erosion and provide a better view of the Lake.	Low

The Cliffs Treatment

Type	Task	Priority
R	Install sediment capture structures and plant aquatic species to increase aquatic plant diversity.	Medium
R	Increase diversity of existing woodland.	Medium
I	Invasive plant control on steep slopes using caution not to create erosion problems.	Medium

Butler Shores Woodland Secondary Treatment

Type	Task	Priority
R	Increase diversity of existing woodland.	Medium
I	Actively restore wetland and emergent aquatic plantings on sediment bar at the mouth of West Bouldin Creek.	Medium

Zilker East Secondary Treatment

Type	Task	Priority
R	Increase diversity of existing woodland inland from Trail	High
U	Remove dilapidated staircase down to the Lake.	Low

Zilker West Secondary Treatment

Type	Task	Priority
R	Increase diversity of existing woodland.	Medium

Appendix 2

Monitoring Forms

Early Detection Monitoring Datasheet

Date:_____ **Recorded by:**_____

Type of Threat:
☐ New Invasive Infestation; Species Name(s):_____
☐ Expanding Invasive Infestation; Species Name(s): _____
☐ New or expanding erosion or denuding of vegetation; describe: _____
☐ New or expanding informal trails; describe: _____
☐ Other; describe: _____

General Location (landscape character area or areas if known): _____

Specific Area: _____ latitude _____ longitude

Disturbance (circle applicable):
Flood Graded Mowing Recently cleared Recreational traffic Storm damage Roadside

Patch Type (circle applicable):
Point (one or few invasives or locations) Linear (erosion or invasives extending along a line) Polygon (of non-linear shape)

Abundance of Invasives if applicable (circle applicable):
Rare (hard to find, other plants more common)
Common (one of the common plants in area)

Notes:

The Trail Foundation Stewardship Activity Log

Date:_____ **Recorded by:**_____

General Activity:_____
(Example include: tree planting, invasive plant inventory or removal, seed sowing, trail maintenance, soil enhancement, monitoring of past activities, monitoring of trail conditions etc.)

General Location (landscape character area or areas if known): _____

Specific Area: _____ latitude _____ longitude

Photos Taken and Attached: Yes No

Activity and/or Monitoring Details:
(examples include: number of trees planted, method of removal, herbicides used, number of volunteers utilized, time spent, etc. For monitoring, examples may include tree mortality or qualitative description of success.)

Appendix 3

Photo Points

The table below shows the coordinates of the 68 photo points that were created with a GPS between July 2014 and April 2015. It is recommended that the photos shown in this section be replicated a minimum of once every two years as part of qualitative monitoring. Comparing the photos over time will show how the area is changing, and the staff can determine whether the changes are positive or negative, and adjust management strategies accordingly.

Photo Point	Latitude	Longitude
1	30.276823	-97.773859
2	30.276647	-97.77379
3	30.276482	-97.773584
4	30.273795	-97.769674
5	30.273137	-97.769037
6	30.271644	-97.768212
7	30.271079	-97.766616
8	30.269509	-97.763732
9	30.265954	-97.755016
10	30.265894	-97.754047
11	30.2646	-97.751434
12	30.264394	-97.750212
13	30.265129	-97.751064
14	30.264365	-97.748961
15	30.263782	-97.746799
16	30.2629	-97.745151
17	30.262408	-97.744522
18	30.261416	-97.743213
19	30.260551	-97.742791
20	30.259696	-97.741109
21	30.260041	-97.740639
22	30.259534	-97.740693
23	30.259019	-97.741238
24	30.25748	-97.740601
25	30.256295	-97.740539
26	30.253316	-97.738317
27	30.251449	-97.735621
28	30.250615	-97.733614
29	30.251083	-97.732477
30	30.248405	-97.727203
31	30.247503	-97.725768
32	30.247864	-97.724933
33	30.247152	-97.725057
34	30.247669	-97.722065
35	30.250651	-97.715369
36	30.250648	-97.715044
37	30.249615	-97.713686
38	30.247785	-97.714625
39	30.245227	-97.716387
40	30.244819	-97.716624
41	30.243529	-97.717635
42	30.243736	-97.719768
43	30.245611	-97.722388
44	30.245341	-97.724848
45	30.245839	-97.726748
46	30.250727	-97.738376
47	30.252291	-97.740298
48	30.252653	-97.740689
49	30.2554	-97.742736
50	30.257451	-97.743023
51	30.257934	-97.743104
52	30.259792	-97.744052
53	30.261126	-97.746605
54	30.26307	-97.750635
55	30.26375	-97.752364
56	30.264236	-97.75508
57	30.26535	-97.757718
58	30.265635	-97.758264
59	30.266182	-97.75953
60	30.265951	-97.762771
61	30.265806	-97.764132
62	30.266559	-97.762964
63	30.267903	-97.76316
64	30.268264	-97.764181
65	30.269401	-97.769624
66	30.272125	-97.771309
67	30.273296	-97.772434
68	30.273522	-97.772447

Photopoint 1 **Direction: W**
Deep Eddy Management Unit

Photopoint 2 **Direction: S**
Deep Eddy Management Unit

Photopoint 3 **Direction: SW**
Deep Eddy managment unit

Photopoint 4 **Direction: NW**
Austin High Forest management unit.

Photopoint 5 Direction: NW
Austin High Forest managment unit

Photopoint 6 Direction: E
Austin High Forest managment unit

Photopoint 7 Direction: S
Austin High Forest managment unit

Photopoint 8 Direction: E
Cesar Chavez management unit

Photopoint 9 Direction: E
Cesar Chavez management unit

Photopoint 10 Direction: W
Cesar Chavez management unit

Photopoint 11 Direction: W
Cesar Chavez management unit

Photopoint 12 Direction: W
Cesar Chavez and City Hall management units

Photopoint 13 Direction: E
City Hall management unit

Photopoint 14 Direction: E
City Hall management unit

Photopoint 15 Direction: E
City Hall management unit

Photopoint 16 Direction: SW
City Hall management unit

Photopoint 17 Direction: E
Hotel Slope management unit

Photopoint 18 Direction: E
Hotel Slope management unit

Photopoint 19 Direction: NW
Hotel Slope management unit

Photopoint 20 (1 of 2) Direction: S
Waller Creek management unit

Photopoint 20 (2 of 2) **Direction: N**
Waller Creek management unit

Photopoint 21 **Direction: S**
Waller Creek management unit

Photopoint 22 **Direction: S**
Rainey management unit

Photopoint 23 **Direction: SE**
Rainey management unit

Photopoint 24 Direction: SW
Rainey management unit

Photopoint 25 Direction: SE
Rainey management unit

Photopoint 26 Direction: W
Rainey management unit

Photopoint 27 Direction: SW
Festival Beach management unit

Photopoint 28 Direction: E
Festival Beach management unit

Photopoint 29 Direction: W
Festival Beach management unit

Photopoint 30 Direction: E
Festival Beach management unit

Photopoint 31 Direction: NE
Festival Beach management unit

Photopoint 32 (1 of 2) **Direction: SW**
Festival Beach management unit

Photopoint 32 (2 of 2) **Direction: SE**
Holly Shores management unit

Photopoint 33 **Direction: E**
Holly Shores management unit

Photopoint 34 **Direction: NE**
Holly Shores management unit

Photopoint 35 Direction: W
Holly Shores management unit

Photopoint 36 Direction: N
Holly Shores management unit

Photopoint 37 Direction: S
Southeast Shore management unit

Photopoint 38 Direction: S
Southeast Shore management unit

Photopoint 39 Direction: N
Southeast Shore management unit

Photopoint 40 Direction: N
Southeast Shore management unit

Photopoint 41 Direction: SW
Southeast Shore management unit

Photopoint 42 Direction: W
Southeast Shore management unit

Photopoint 43 Direction: N
Southeast Shore management unit

Photopoint 44 Direction: E
Southeast Shore management unit

Photopoint 45 Direction:E
Southeast Shore management unit

Photopoint 46 Direction: E
The Cliffs management unit

Photopoint 47 Direction: SW
The Cliffs management unit

Photopoint 48 Direction: N
The Cliffs management unit

Photopoint 49 Direction: SE
Southcentral Shore management unit

Photopoint 50 Direction: SE
Southcentral Shore management unit

Photopoint 51 Direction: SE
Southcentral Shore management unit

Photopoint 52 Direction:SE
Southcentral Shore management unit

Photopoint 53 Direction: E
Southcentral Shore management unit

Photopoint 54 Direction: E
Auditoruim Shores management unit

Photopoint 55 Direction: W
Auditoruim Shores management unit

Photopoint 56 Direction: W
PARD Woodland management unit

Photopoint 57 Direction: W
Auditoruim Shores management unit

Photopoint 58 Direction: S
PARD Woodland management unit

Photopoint 59 Direction: S
PARD Woodland management unit

Photopoint 60 Direction: SE
PARD Woodland management unit

Photopoint 61 Direction: NE
Zilker East management unit

Photopoint 62 Direction: N
Zilker East management unit

Photopoint 63 Direction: E
Zilker East management unit

Photopoint 64 Direction: S
Zilker East management unit

Photopoint 65 (1 of 2) Direction: NE
Zilker West and Southwest Woods management unit

Photopoint 65 (2 of 2) Direction: NW
Zilker West and Southwest Woods management unit

Photopoint 66 Direction: SW
Zilker West and Southwest Woods management unit

Photopoint 67 Direction: W
Zilker West and Southwest Woods management unit

Photopoint 68 (1 of 2) Direction: W
Zilker West and Southwest Woods management unit

Photopoint 68 (2 of 2) Direction: N
Zilker West and Southwest Woods management unit


The Trail Foundation
SIGLO GROUP