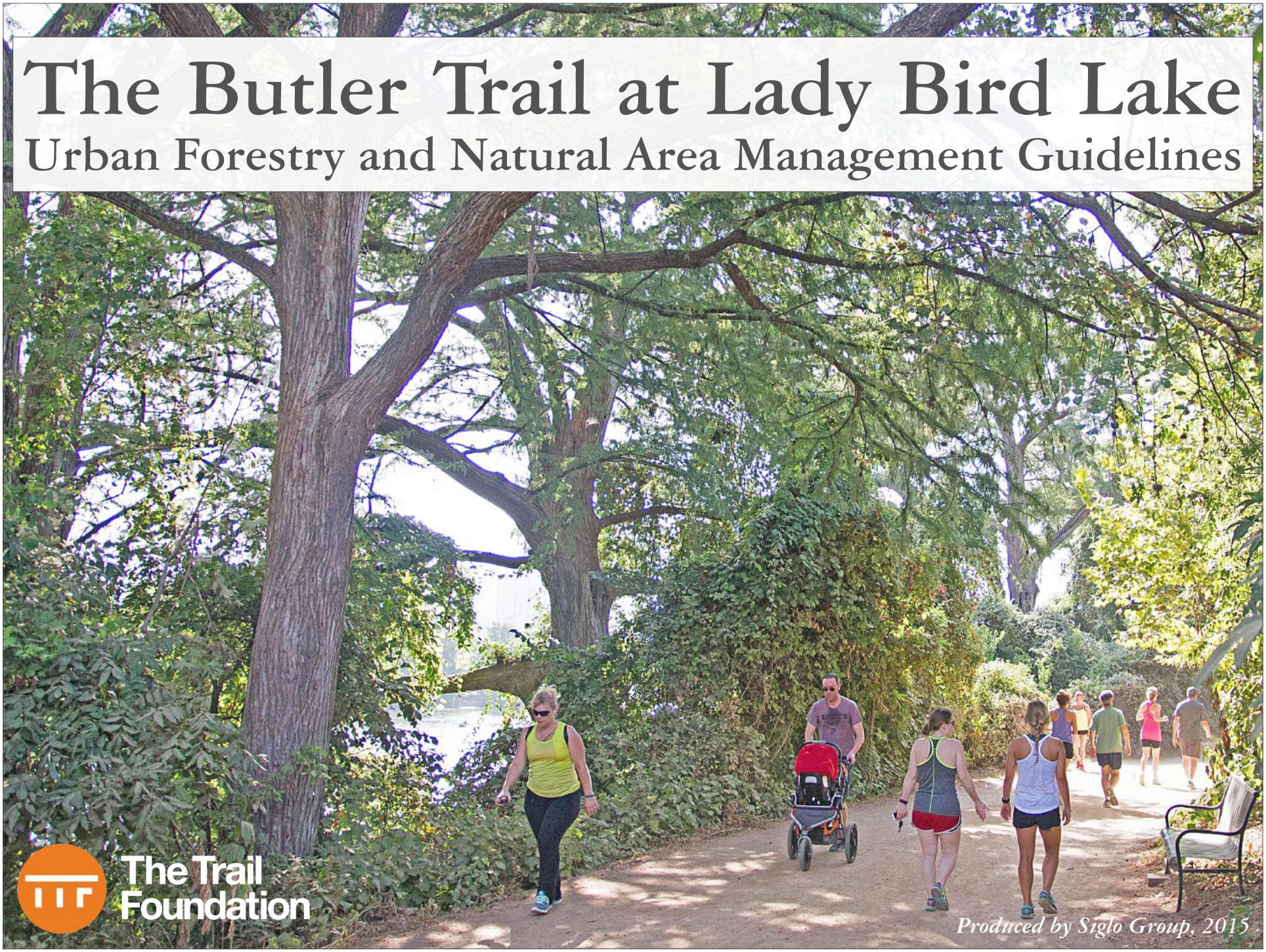
# The Butler Trail at Lady Bird Lake

## Urban Forestry and Natural Area Management Guidelines



The Trail Foundation

*Produced by Siglo Group, 2015*

The Trail Foundation

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.

SIGLO GROUP

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

Integrating Land Use and Natural Systems: Siglo Group uses the power of geographic information to help clients integrate land use with natural systems. Siglo specializes in conservation planning, regional analysis, site assessment, cartography, and spatial analysis. Their work has contributed to land being set aside in perpetuity for conservation, policies and projects that work towards more sustainable land use, good development, and a greater understanding of the attributes and values of land.

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

Generous funding was provided by: The Urban Forestry Fund at the Austin Community Foundation, The Nature Conservancy, Chaparral Foundation, Whole Foods Market Community Giving Day 2014, and the Catto Charitable Foundation; in memory of Heather Catto Kohout.

Thanks to the many individuals who gave input to this project including: Susan Plettman Rankin (TTF), Beth Carroll (TTF), Lucia Athens (COA Sustainability), Johanna Arendt (Siglo Support), Audrey Archer (COA Forester Intern), Brent Bellinger (COA WPD), John Clement (COA WPD), Joe Diaz (COA PARD), Jorge Espinoza (COA PARD Arborist), Manuel Flores (COA PARD Forester), Felix Padron (COA PARD), William Fordyce (COA WPD), Matt Fougerat (Siglo Support), Ana Gonzalez (COA WPD), Alan Halter (COA Forester), Cullen Hanks (Travis Audubon), Angela Hanson (COA Innovation), Roxanne Jackson (COA WPD), Emily King (COA Forester), Barry Lyons (Travis Audubon), Joan Marshall (Travis Audubon), Jill Nokes (Landscape Consultant), Crescent Ogren (Siglo Support), Mike Personette (COA WPD), Rachel Rountree (TTF), Mateo Scoggins (COA WPD), Chris Scheffield (TxCC), and Bob Warneke (Travis Audubon).

# Table of Contents

# 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.

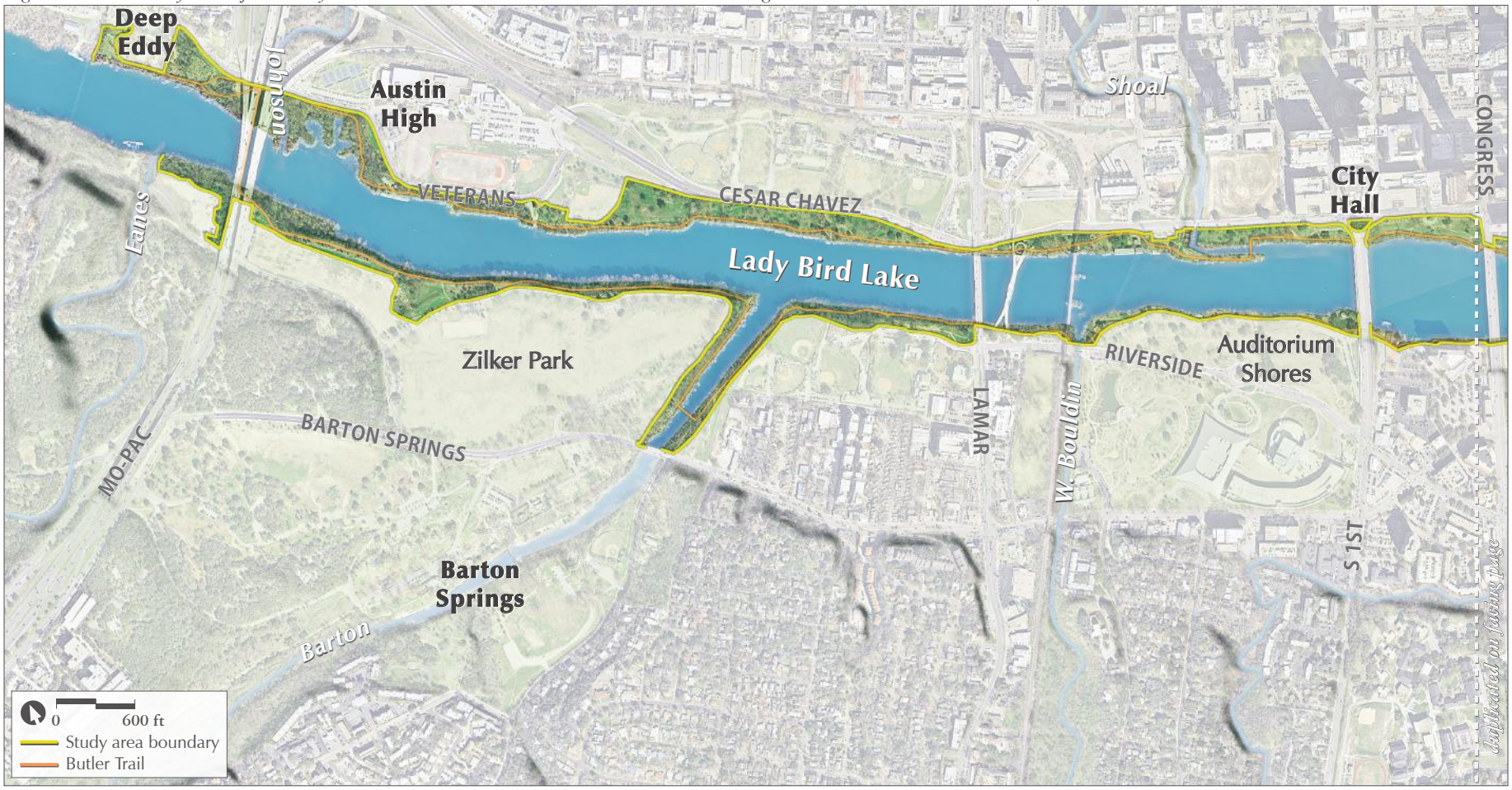
**Facilitate stewardship:**
Catalyze opportunities to appreciate, observe, and care for the natural environment as an ongoing part of people's lives.

## 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.*

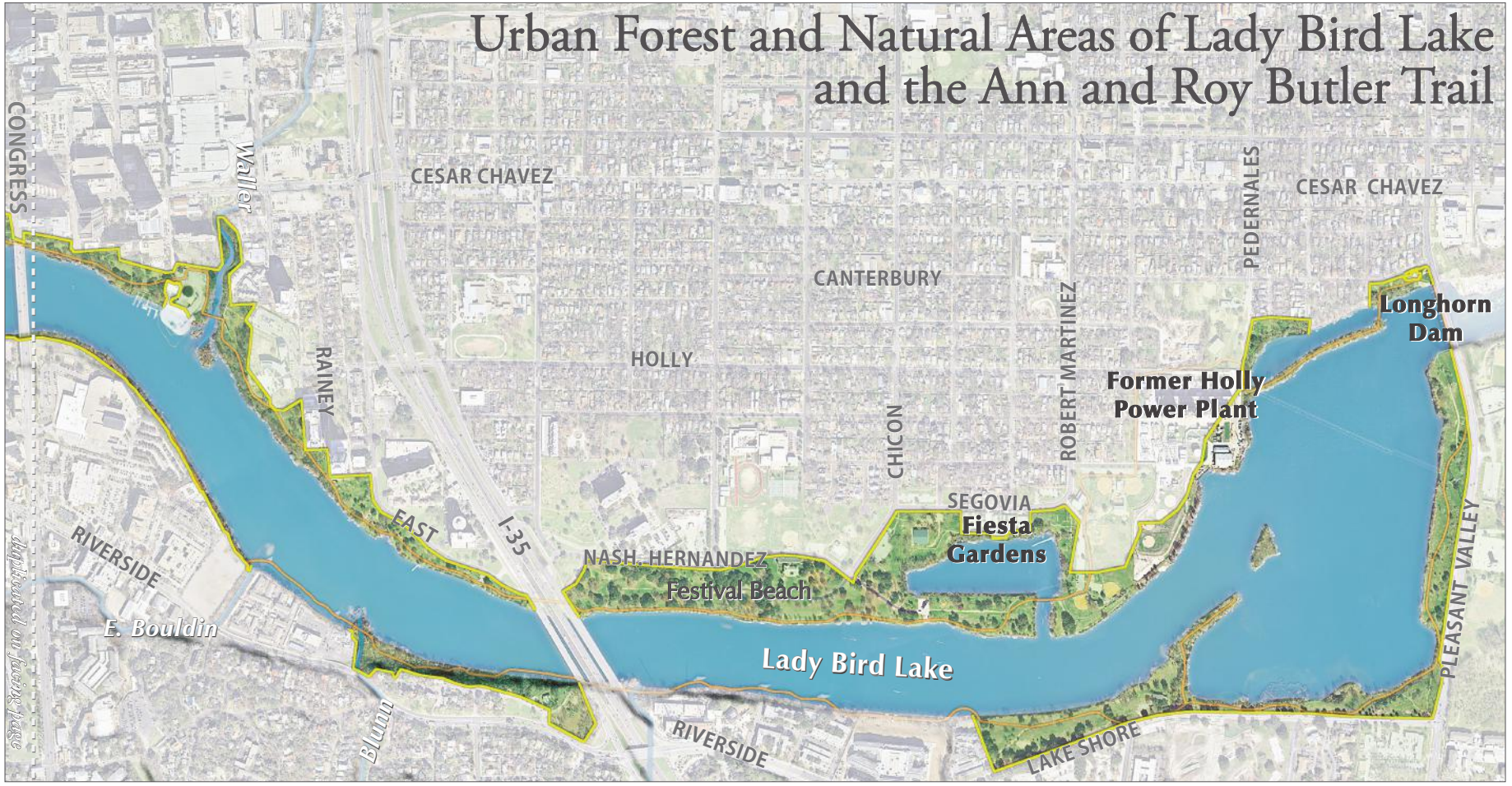


our beloved creeks including Barton, Waller, Shoal, Blunn, and West Bouldin. It connects numerous active recreation facilities. The river corridor is a flyway for migrating and resident bird populations, with popular birding sites both up and downstream of Lady Bird Lake. The site is also home to the 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



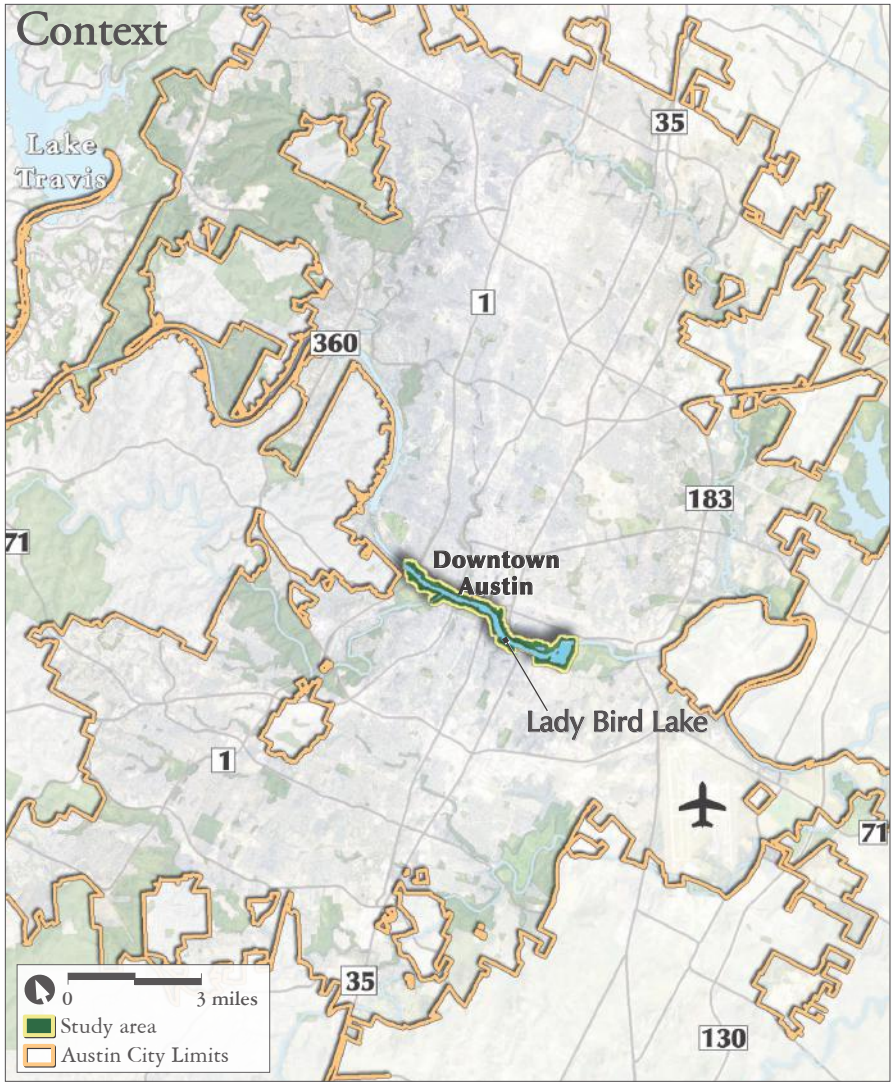



*Figure 1.3: The study area in the heart of Austin forms part of the riparian corridor along the Colorado River.*

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.*

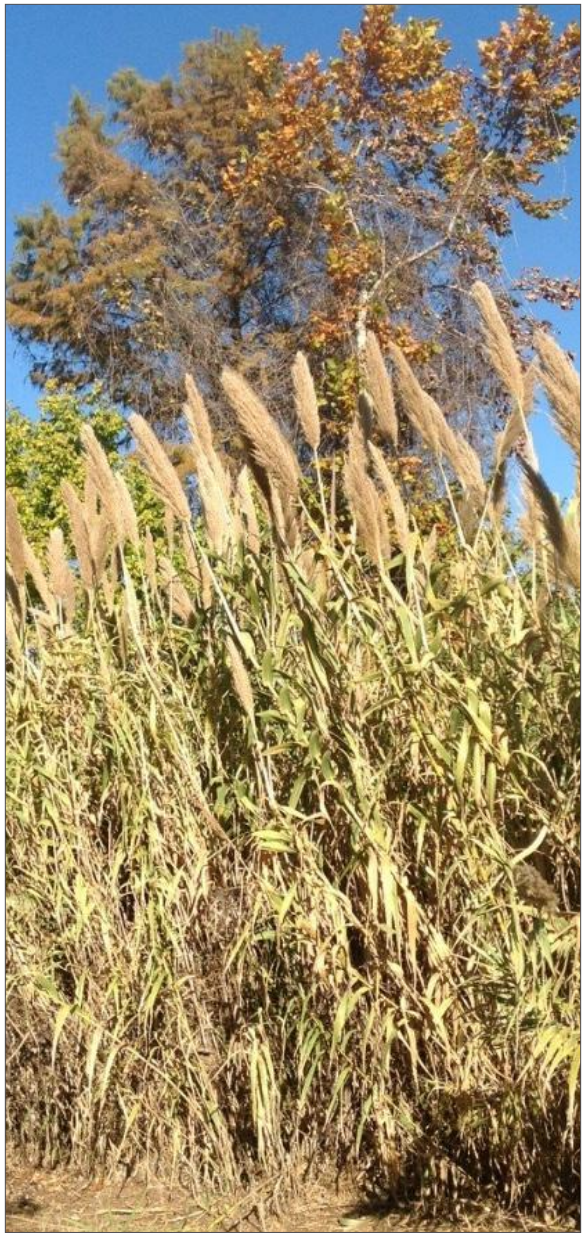


*Figure 1.7: Invasive species, like the giant reed pictured here, are one of the largest threats to the ecological health of the natural areas around Lady Bird Lake.*

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.

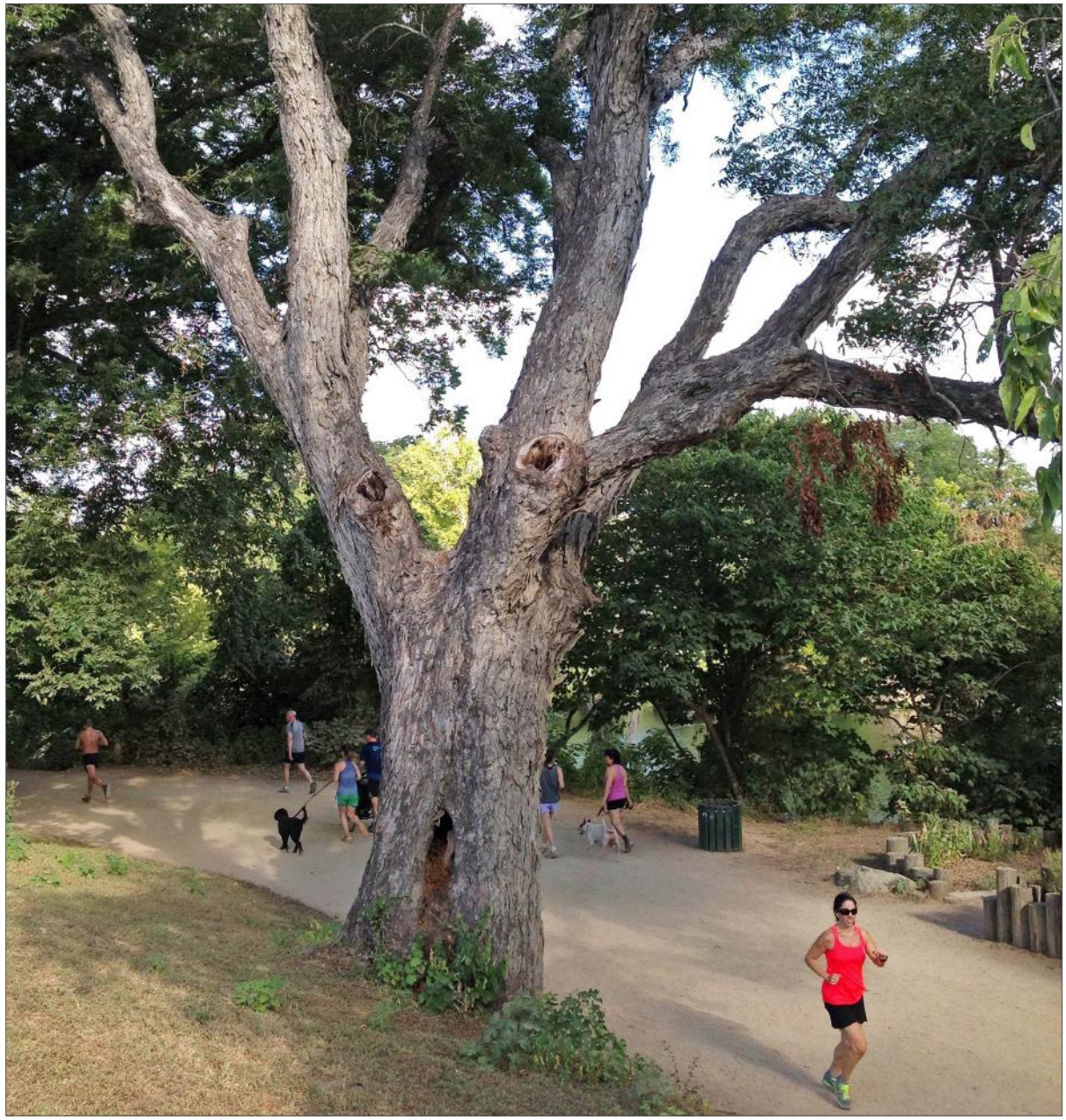
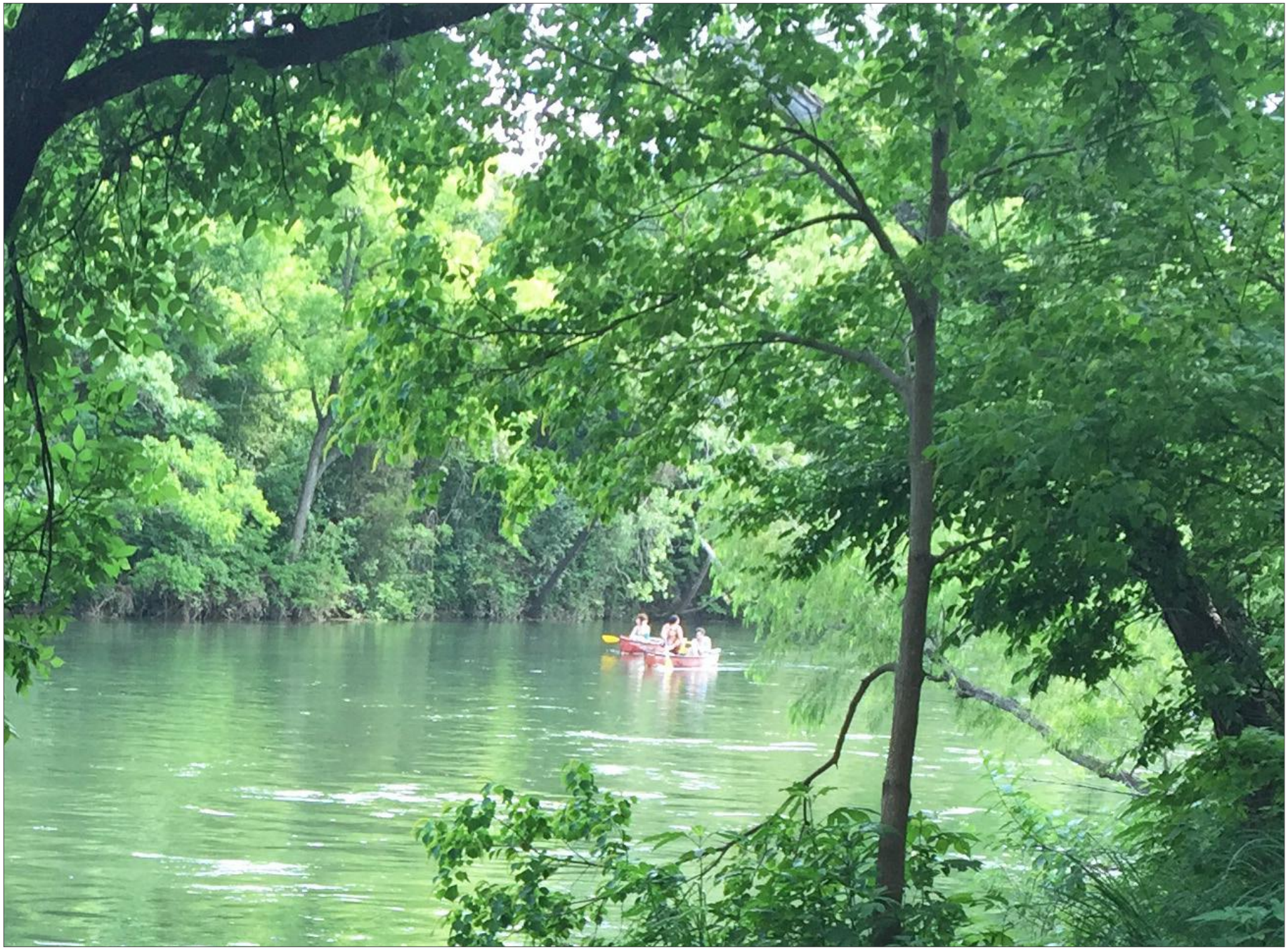


*Figure 1.8: Lady Bird Lake, the Butler Trail, and the surrounding natural areas are central to Austin's character and appeal.*



# 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.

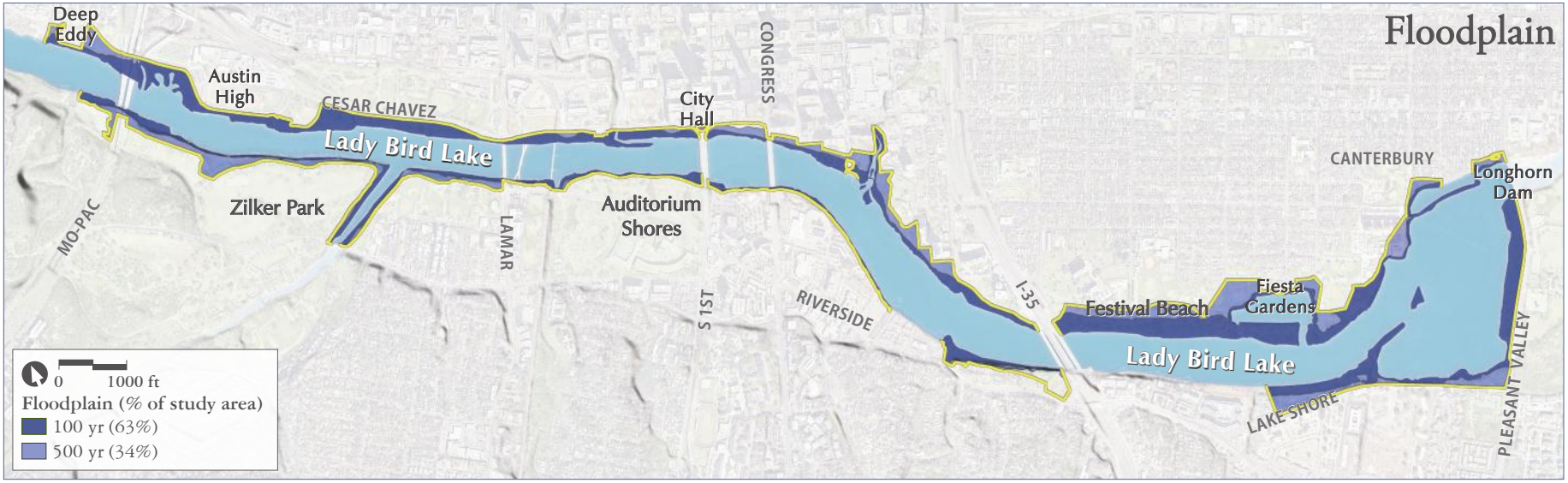
Massive flood events were a regular part of life in Austin until the Highland Lakes were created. The impoundment of the upstream Highland Lakes in the 1930s and 1940s minimized the naturally occurring floodwaters that shaped the floodplain and surrounding areas. The upstream dams stopped natural cycles 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.

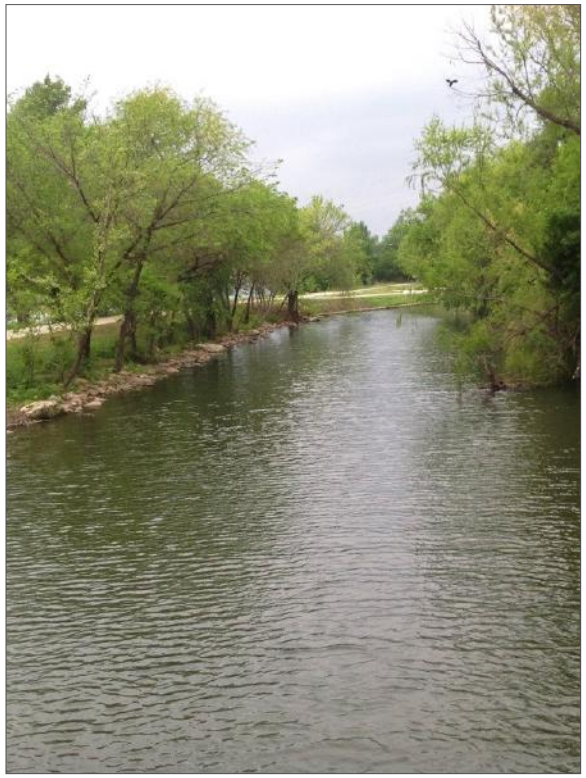
Shoal Creek and Waller Creek are the most impacted watersheds due to urban development and

*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.

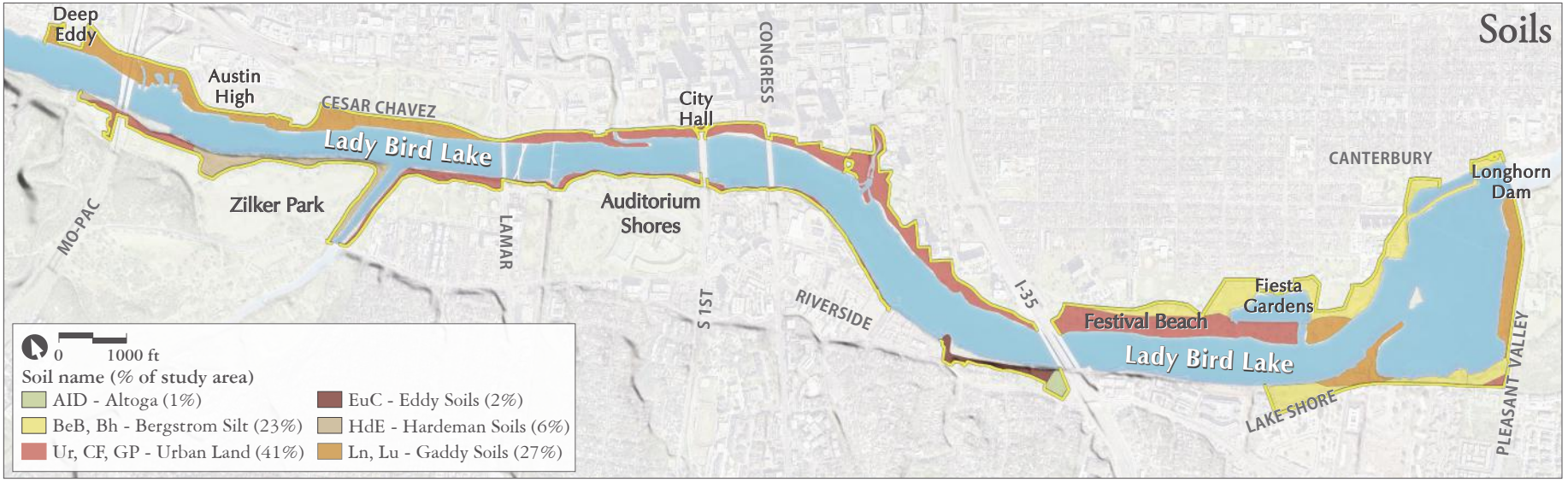
## HISTORIC AND CURRENT LAND USE

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-

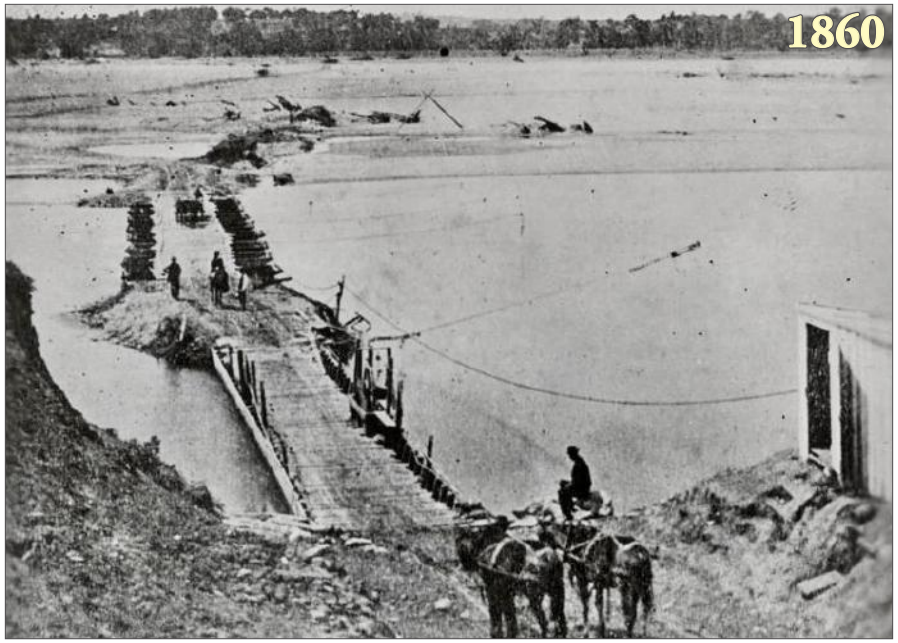
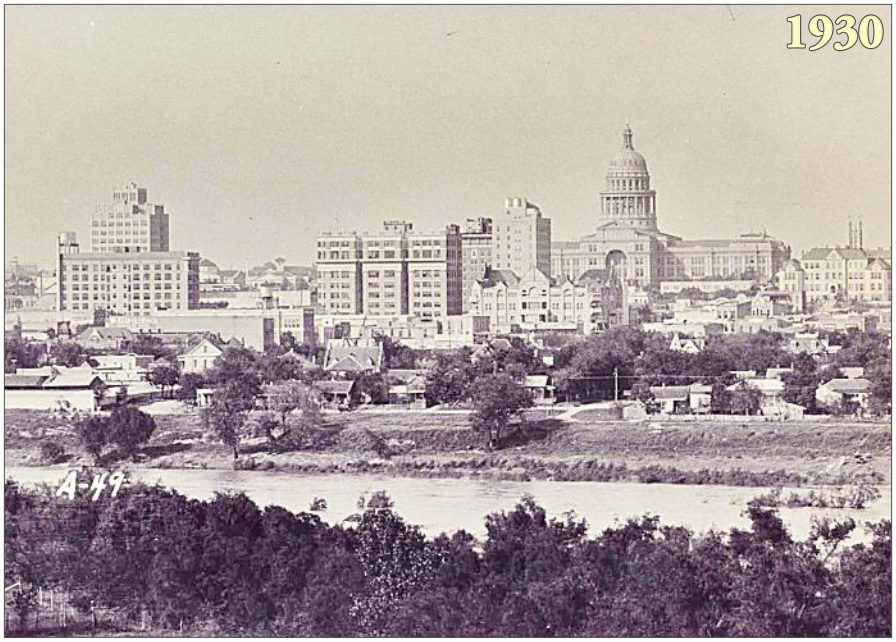
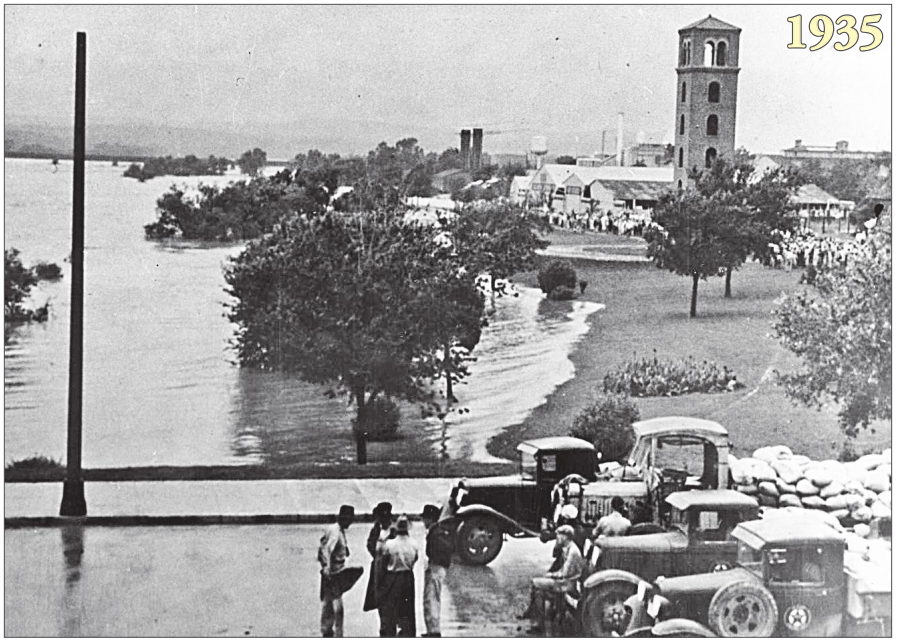




*Figure 2.7 (Above): Pontoon bridge crossing the Colorado River, 1860. Source: The Portal to Texas History (PTH). Figure 2.8 (Below): View towards the Capitol from Congress Bridge, 1910. Source: Portal to Texas History. Source: Ellison Photo Co. via PTH.*




*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.*

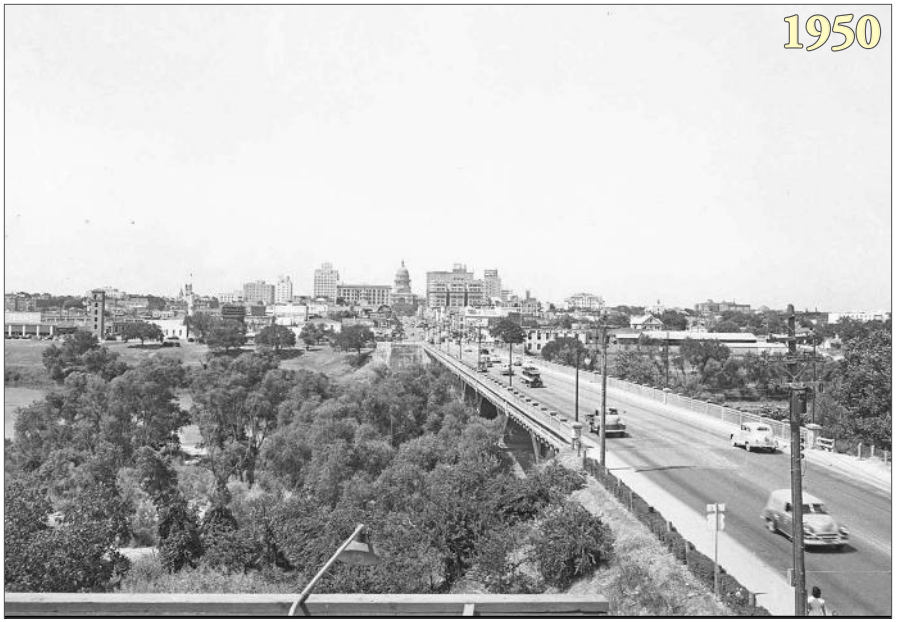
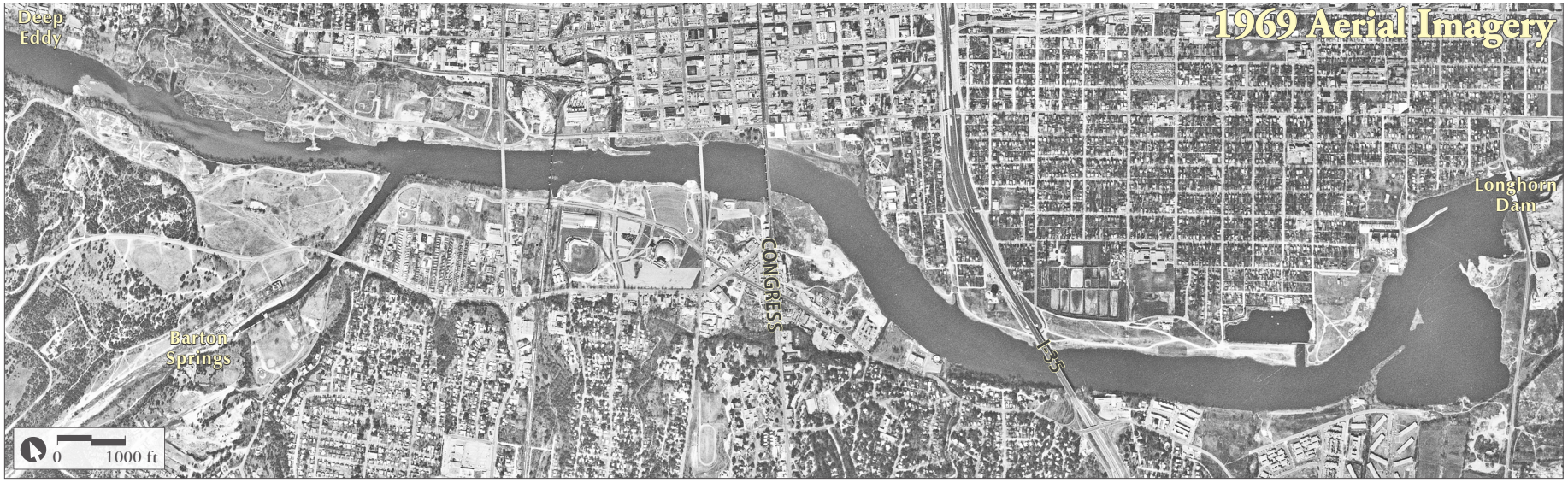




*Figure 2.13 (Above, left): Auditorium Shores and Seaholm Power Plant, circa 1950. Source: City of Austin via PTH. Figure 2.14 (Above, right): More robust riparian woodland near Congress Bridge, 1950. Source: Neal Douglass via PTH. Figure 2.15 (Below, Left): Construction of the Holly Power Plant 1959. 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.*

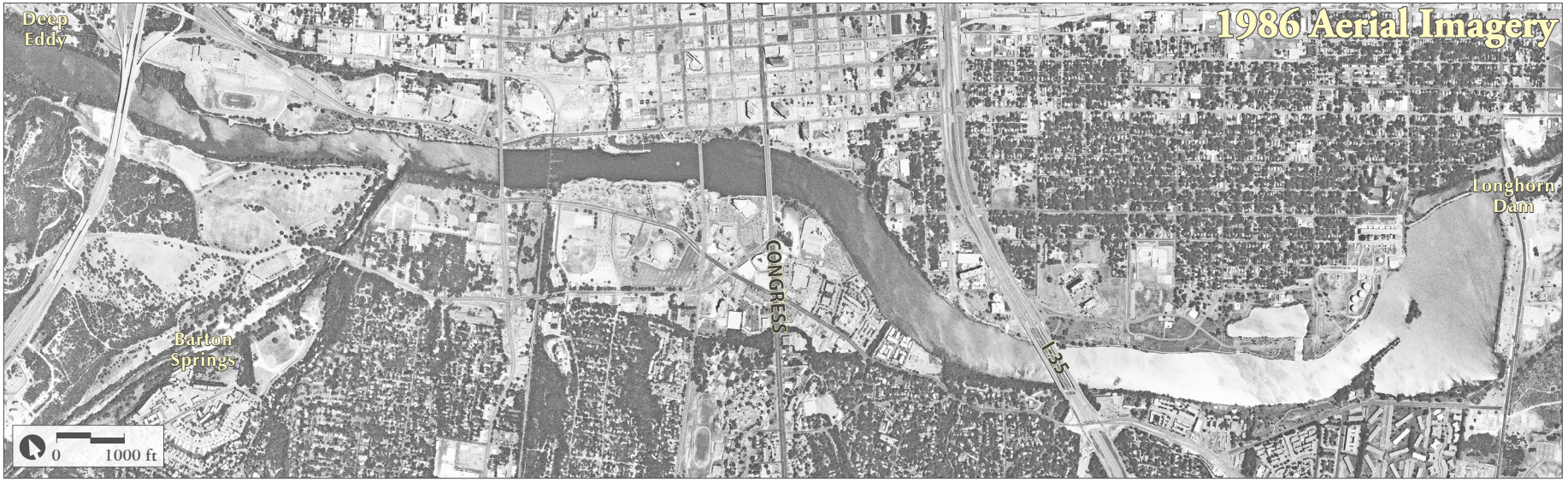



appeal as a recreational amenity.

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.

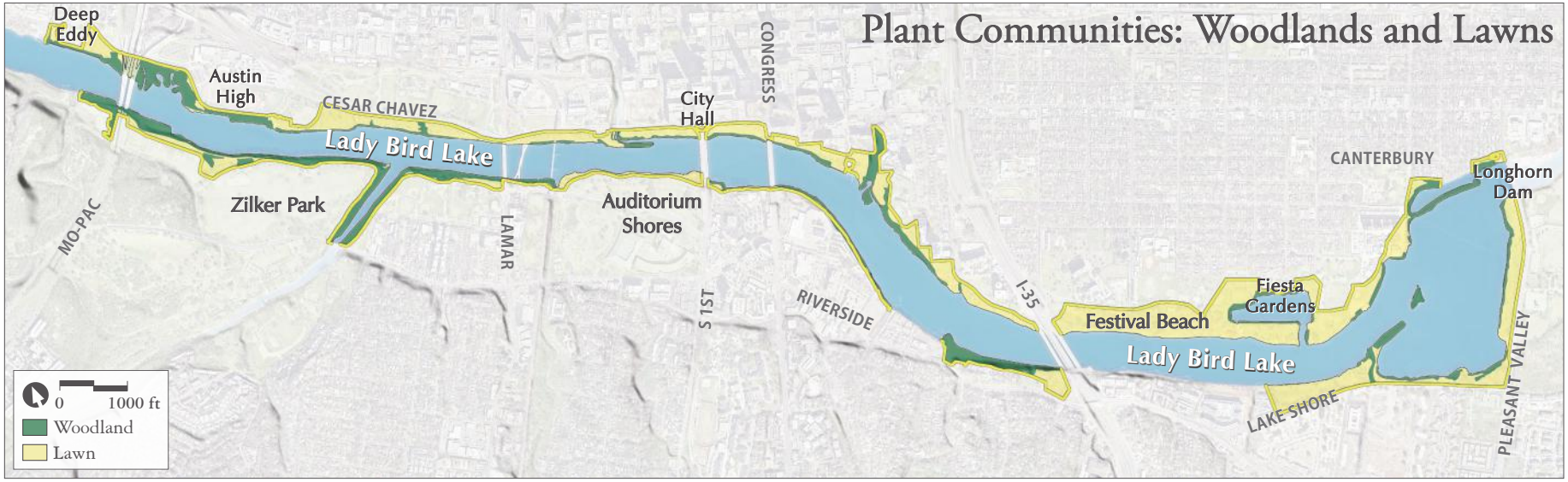
### Plant Species and Communities

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.*

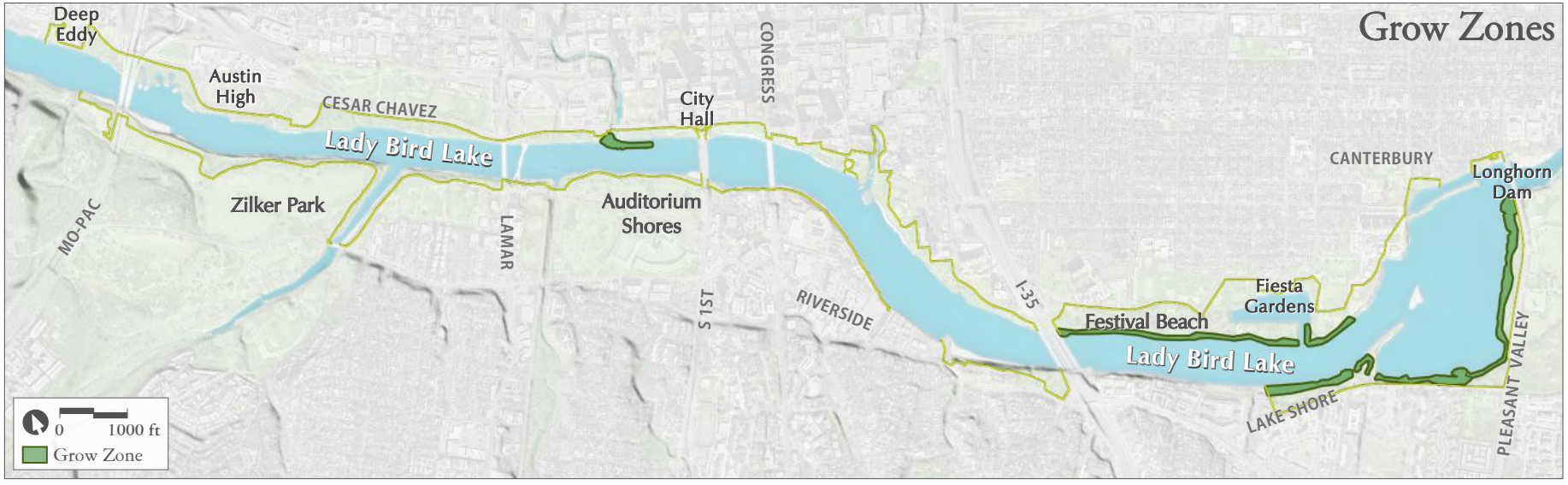


*Table 2.1: Plant species recorded by Bill Carr during a botanical survey of the study area, Fall 2014.*

*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.*

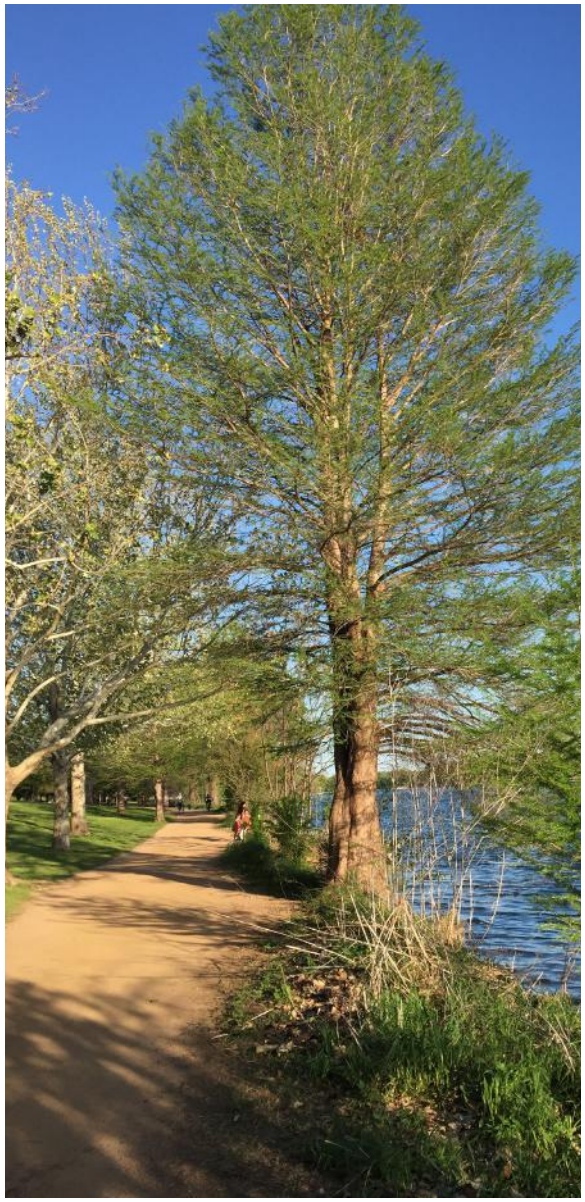


*Figure 2.27: Bald cypress makes up over 20% of the canopy cover in the study area. The majestic trees are one of the defining characteristics of the shoreline of Lady Bird Lake.*

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* | |

| Common Name | Scientific Name | Confirmed |
|---|---|---|
| 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* | |

| Common Name | Scientific Name | Confirmed |
|---|---|---|
| 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* |

| Common Name | Scientific Name |
|---|---|
| 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* |

| Common Name | Scientific Name |
|---|---|
| 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 | |
|---|---|
| Ceratopogonidae | 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.

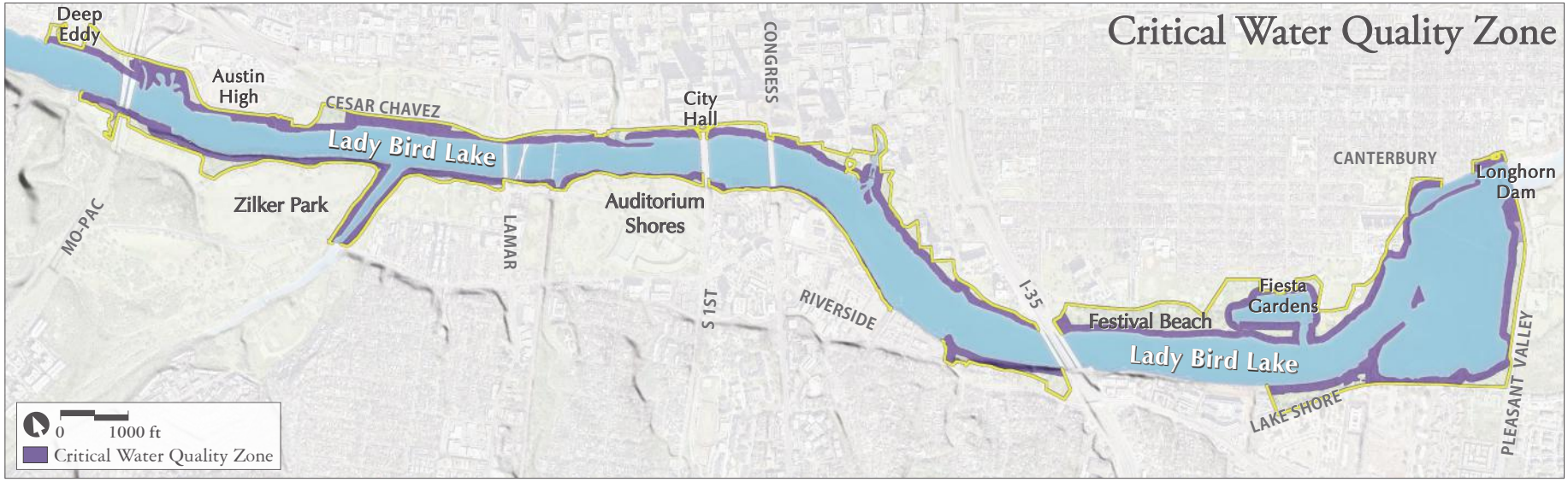
Canyon Rimrocks

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.*

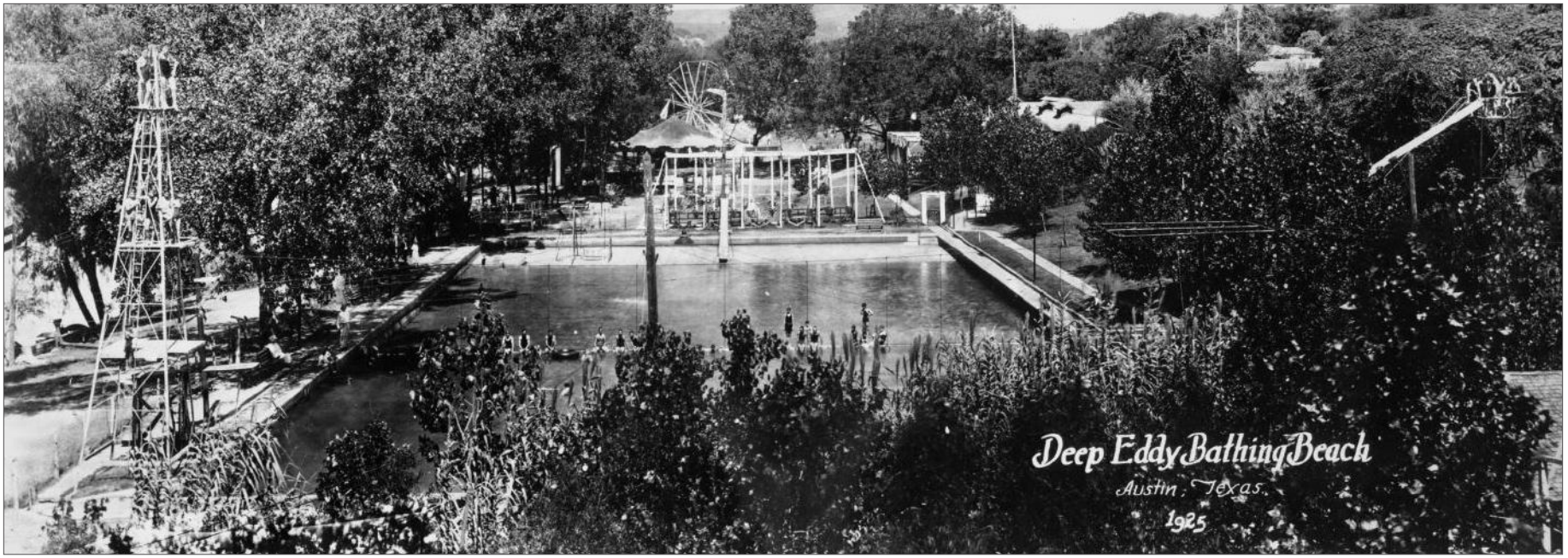



*Figure 2.33 (Above): Giant reed can be seen in the foreground of this 1925 photo of Deep Eddy. Source: PTH. Figure 2.34 (Below, left): Giant reed forms dense monocultures along many sections of shoreline in the study area. Figure 2.35 (Below, right): Though not abundant in the study area, paper mulberry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

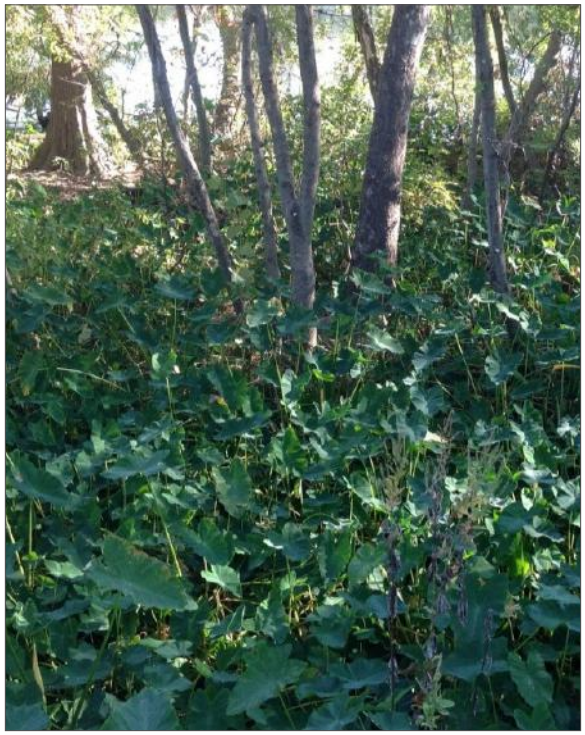
Sweet autumn clematis (*Clematis terniflora*) is a climbing vine that forms dense blankets over trees, shrubs, and other vegetation, blocking vital sunlight from reaching them, as shown in Figure 2.36. Dense patches are common throughout the entire study area. It is not listed as one of Austin's top 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.*

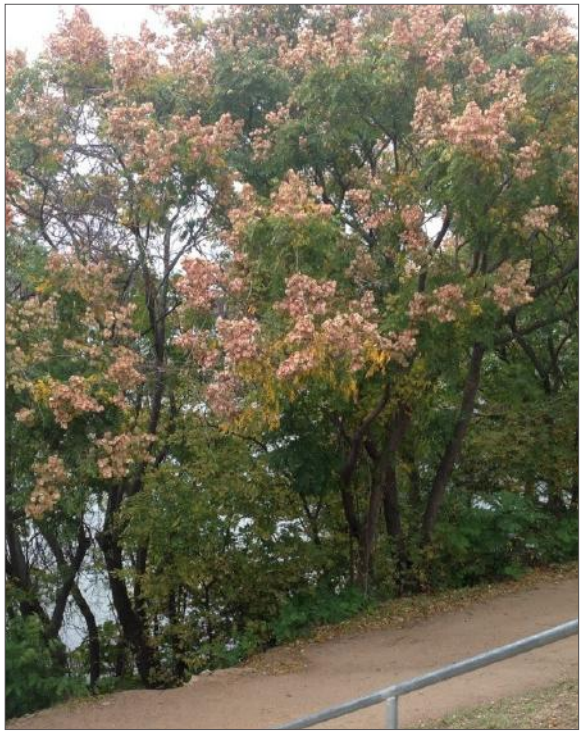
*Elephant Ear*

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.*



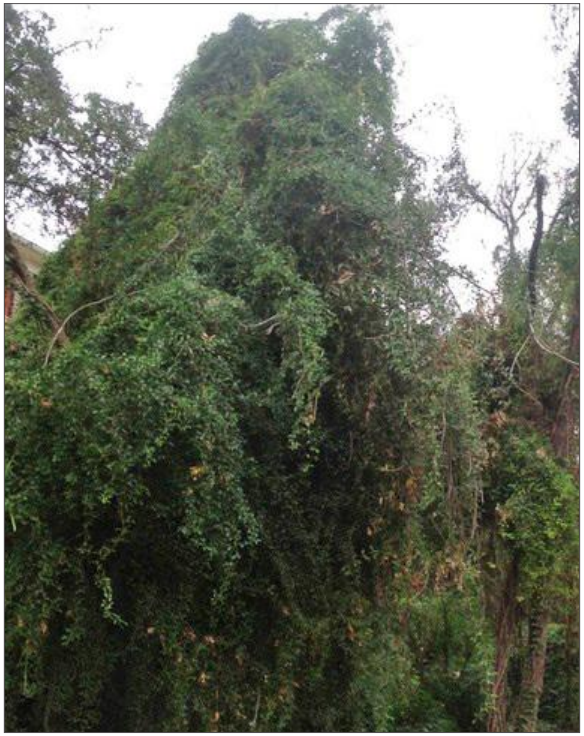
*Golden Rain Tree*

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.

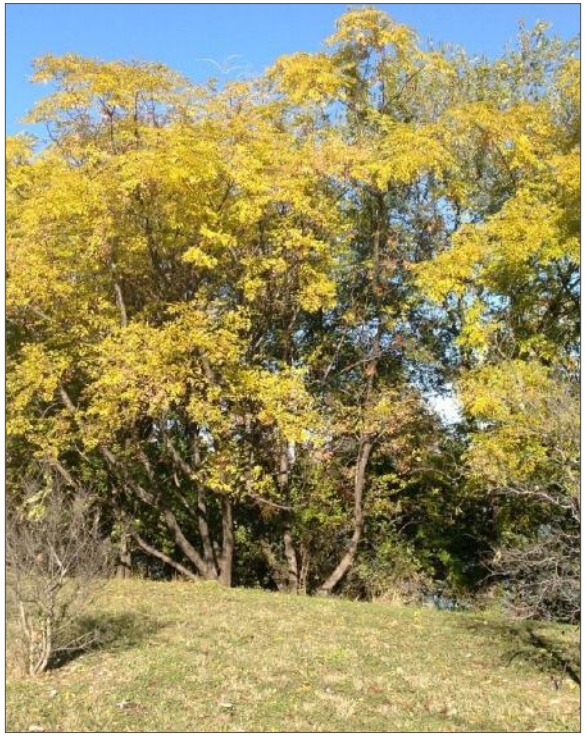
*Figure 2.40 Catclaw vine smothers trees and other plants.*



*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-

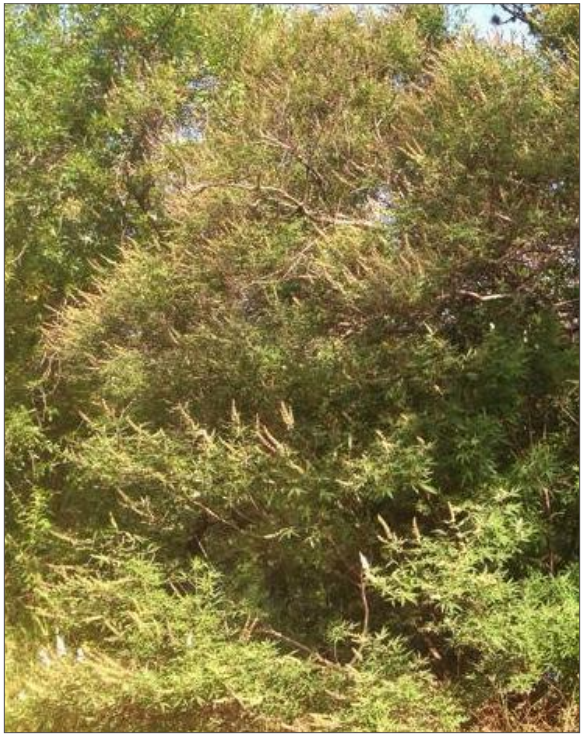
*Figure 2.45: Johnsongrass is abundant in many Grow Zones.*

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

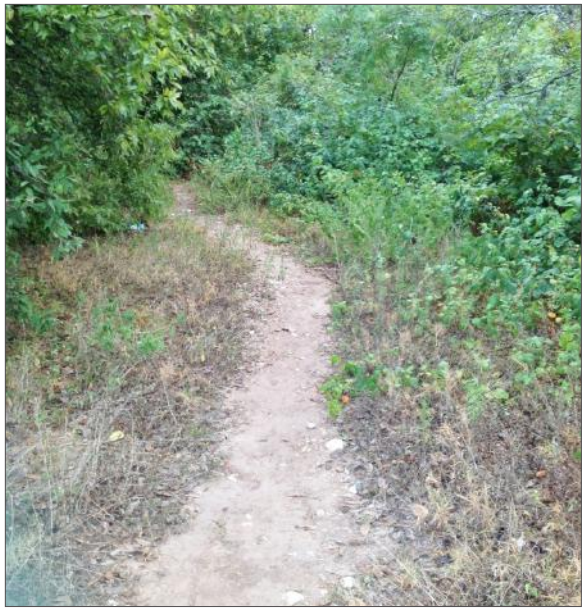
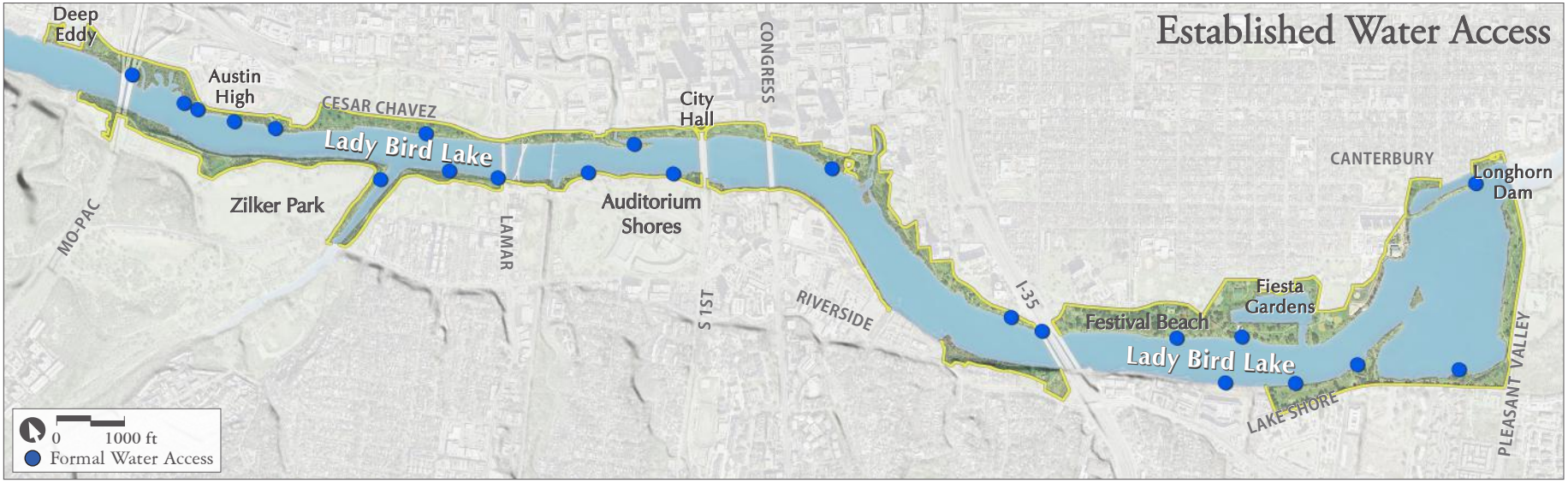


*Figure 2.48: Informal trails have trampled vegetation and compacted soils.*

*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.*