University of Texas – Jackson School of Geosciences/City of Austin Quantification and Correlation of Sediment Microplastics and Nutrients with Population Density in Lake Austin and Lady Bird Lake

Project proposal
prepared by
Marcy Davis, Cornel Olariu, Dan Duncan, Jeff Cullen
Jackson School of Geosciences
The University of Texas at Austin

1.0 Objectives

1.1 The study will focus on Lake Austin and Lady Bird Lake for implementation of a field and laboratory study to evaluate the abundance and distribution of microplastics and nutrients, and to map movement/deposition of sediments throughout the reservoirs. Sediment nutrients are likely a key component fueling excessive plant and harmful cyanobacterial growth, and microplastics are recognized as an emerging risk to use of municipal waterways because of their ability to bind chemicals and pathogens of concern, and injure organisms throughout the food web, including humans. This work supports City of Austin programs to protect community and aquatic health resulting from impairments and loss of beneficial reservoir uses desired by the community.

1.2 Objectives of the proposed work are to assist the City of Austin in the following areas:

1.2.1 Characterize sediment carbon and nitrogen contents and isotopic signatures in Lake Austin and Lady Bird Lake;

1.2.2 Quantify microplastic contents and distribution in Lake Austin and Lady Bird Lake sediments; and,

1.2.3 Map sediment bedforms and vegetation extent in Lake Austin and Lady Bird Lake.

2.0 Background

2.1 Microplastics (MPs) are problematic pollutants, <5 mm in size, that increasingly pose great risk to environmental and human health. Like larger plastics, MPs are closely coupled to human activities and concentrated in urban areas and may last for thousands of years in natural systems. MPs may be primary - manufactured as microscopic-scale plastics (e.g., beads found in personal care products, nurdles), or secondary - resulting from the breakdown of primary macroplastics (e.g., tires, synthetic textiles, fishing materials, consumer packaging) that are not included in the normal trash collection cycle. A significant amount of MPs pollution is concentrated proximally to where MPs are created, especially in urban waterways and lakes. Urban freshwater systems are especially vulnerable to MP pollution due to high population density and human activities. Cities are a common source of MPs as a concentrated source of packaging, paint, transportation, electronics, and construction materials which breakdown to form “city dust” that is spread through improper waste and wastewater management, and surface, storm water.

2.2 Rapid urban development increases impervious cover within watersheds and results in greater runoff during rainfall events. Runoff negatively affects water quality and biological communities by fouling organisms that ingest pollutants, by biomagnifying metals and pollutants through the food web, and by promoting growth of nuisance plants and algae. Excessively polluted urban runoff waterway loading results in a decline in ecosystem services such as recreation, aesthetics, fishing, and provisioning of drinking water. Rivers are natural conveyance pathways for organic and inorganic matter; however, impounded waterways, like Lake Austin and Lady Bird Lake, act as sinks for sediments and the nutrients and pollutants (e.g., heavy metals, carcinogens, and, increasingly, MPs) they carry. As sediments accumulate within a reservoir, desired ecosystem services are negatively impacted. For example, sediment accumulation reduces the total volume of a reservoir and, consequently, the amount of surface water available to a municipality and results in constant, expensive dredging operations to prolong reservoir life. Excess runoff due to watershed development or land use changes will bring with it an abundance of nutrients that directly fuels nuisance plant and algal growth and production, accelerating the "aging" of a waterway in a process called "cultural eutrophication". With eutrophication, water clarity typically declines, and potentially toxic cyanobacteria blooms can develop.

2.3 Bathymetric mapping, sediment transportation, and aquatic vegetation are important as excessive sediment deposition and accumulation reduces the total volume available for municipal uses, and aquatic vegetation is recognized as an essential ecological component that improves water quality, but in excess can impede recreational and municipal uses as well. Lake Austin has previously suffered abundant growth of the non-native aquatic plant hydrilla, and recently, growth of the native aquatic plant Cabomba growth in Lady Bird Lake has raised concerns about impacts to recreational use. Therefore, it is essential to track movement of sediments, where accumulation is occurring, and how hydrology and macrophytes are interacting.

2.3 Because of the high-profile nature of Austin's reservoirs and their use for recreation as well as drinking water purposes, it is essential to understand sediment loading dynamics, the potential inputs of microplastics, and the distribution of aquatic vegetation. As such, we are looking to collaborate with the Jackson School of Geosciences (JSG) to study sediment transport and establish baseline conditions of nutrient and microplastic contents in the reservoirs.

2.4 The JSG group has been carrying out sediment mapping, coring, and nutrient and microplastic quantitation from river and coastal systems across Texas and the United States. Their research staff are well equipped with the tools and methods needed to answer questions about reservoir sediments that WPD does not currently possess.

2.5 This pilot project over a two-year period will collect geophysical data (multibeam bathymetry, sidescan sonar, chirp sub-bottom profiling), and sediment grab samples throughout the reservoirs, focusing on the confluences of stream mouths, and deep (> 3m) cores above the Mansfield, Tom Miller, and Longhorn Dams, to understand spatial and temporal dynamics in sediment transportation and accumulation, and the nutrients and microplastics associated with the sediments.

3.0 SCOPE OF WORK, 2023

3.1 Sediment Analyses: Sediment samples will be collected to determine grains size, and the total amount of Carbon, Nitrogen, and microplastics in surface sediments. In addition, $^{13}C/^{12}C$ and $^{15}N/^{14}N$ isotopic ratios will be determined. A total of 100 samples will be collected between Lake Austin and Lady Bird Lake using a petite ponar.

Additionally, a single deep core will be collected above each of the reservoir dams and sectioned to establish a time-series of nutrient and microplastic accumulation spanning the life of each reservoir.

All analyses described in this section will be performed by faculty and staff of UT JSG. Sediment collection assistance will be provided by City of Austin employees (those costs not included in this Scope of Work).

3.1.1 Deliverable: Report comparing the distribution of carbon and nitrogen total contents and isotopic ratios in addition to microplastic content in sediments across Lake Austin and Lady Bird Lake.

3.2 Sediment and Vegetation Mapping: We will use muti-beam and sidescan sonars to map lake bottom topography in each reservoir. Repeat yearly surveys will allow us to create surface difference maps that track sediment transport changes and as well as how aquatic vegetation boundaries are changing over time.

3.3.1 Deliverable: High-resolution bathymetric maps from multi-beam sonar surveys, and vegetation extent derived from sidescan sonar surveys.

4.0 Tasks

4.1 Task 1. Sediment Nutrient and Microplastic Quantitation (2023)
Objectives: Characterize total carbon and nitrogen contents (mg/kg) and isotopic ratios, and microplastics in surface sediment samples.

4.2 Task 2. Sediment and Vegetation Mapping
Objectives: Provide high-resolution bathymetric maps and the distribution and volumetric abundance of aquatic vegetation.

Funding: FY 2023 --- up to $80,000
Funding for future years is contingent on available budget.

5.0 COST SECTION

Cost Rates and Payment Schedule:

A total of $80,000 is budgeted to cover materials, personnel, equipment, and sample and data processing costs.

UT-JSG will be providing the crew for operating the research vessel that is equipped with the CHIRP, Sidescan sonar, and Multibeam bathymetry sonar. From the UT vessel, as well as the WPD boat when required to access shallow water, surface and deep sediment cores will be collected and transported to the UT-JSG laboratory. In the laboratory, graduate and undergraduate students will be funded to dry and weight sediment samples that will be analyzed for total carbon and nitrogen nutrient contents and isotopic signatures.

Budget Breakdown

Description	**Price**
Instrumentation: CHIRP, sidescan and multibeam sonar	$ 4,100
Sediment carbon and nitrogen nutrients and isotopic signatures	$ 3,200

Staff support	$ 46,790
Incidentals	$ 25,910
TOTAL COST	**$80,000**

5.1 UT-JSG invoicing will follow the relevant terms in Master Interlocal Agreement (ILA) UTA19-000382.

6.0 Term of Contract

The Contract shall commence upon execution, unless otherwise specified, and shall remain in effect for an initial term of twelve (12) months. The Contract may be extended beyond the initial term for one (1) additional twelve (12) month period at the City's sole option. If the City exercises any extension option, all terms, conditions, and provisions of the Contract shall remain in effect for that extension period, subject only to any economic price adjustment otherwise allowed under the Contract.

THE UNDERSIGNED CONTRACTING PARTIES do hereby certify that: (1) the services specified above are necessary and essential for activities that are properly within the statutory functions and programs of the affected agencies of State Government; (2) the proposed arrangements serve the interest of efficient and economical administration of the State Government, and (3) the services, supplies or materials contracted for are not required by Section 21 of Article 16 of the Constitution of Texas to be supplied under contract given to the lowest responsible bidder.

PERFORMING AGENCY further certifies that it has the authority to contract for the above services by authority granted in Article 4413 (32e) V.C.S. and Chapter 105 of the Texas Education Code.

RECEIVING AGENCY further certifies that it has the authority to perform the services contracted for by authority granted in Article 4413 (32e) V.C.S.

7.0 Points of Contact

Marcy Davis
Institute for Geophysics
Jackson School of Geosciences
The University of Texas at Austin
10100 Burnet R., Bldg 196 (ROC)
Austin, TX 78758
512-471-0425
marcy@ig.utexas.edu

Brent Bellinger, Ph.D.
City of Austin – Watershed Protection
505 Barton Springs Rd., Suite 1100
Austin, TX 78704
512-974-2717
Brent.Bellinger@austintexas.gov