

# Biodiversity Mapping within the Urban Space of Pune: A Case of Lakaki Lake

*Master. Aaditya Radheshyam Daga*

T.Y. BArch, Student,  
B.K.P.S. College Of Architecture,  
Savitribai Phule Pune University , Pune.

*Prof. Pradnya Nishad Patki*

Professor, B.K.P.S. College Of Architecture,  
Savitribai Phule Pune University , Pune.

## **Abstract—**

Urban lakes, such as Lakaki Lake in Pune, are increasingly impacted by urbanization, resulting in potential shifts in their biodiversity. Documenting the current biodiversity of these urban water bodies is essential for understanding their ecological state. This study aims to map the biodiversity of Lakaki Lake, to assess the effects of human activities on its ecological health. The objectives are to document the current status of biodiversity, focusing on aquatic flora, fauna, and avian species, including bird populations, within Lakaki Lake, to analyse water acting as bioindicator, to identify potential anthropogenic stressors, and evaluate how these species, particularly birds [Ducks and pigeons], serve as bioindicators of the lake's health. This research employs a live case study approach, conducting field surveys of aquatic flora and fauna and direct observations of avian species at Lakaki Lake. The findings reveal a correlation between human activities, such as pollution and habitat disturbance, and variations in biodiversity distribution. Specifically, changes in avian populations, alongside variations in aquatic flora and fauna distribution, serve as effective bioindicators of the lake's ecological condition. The study concludes that the biodiversity of Lakaki Lake demonstrates measurable responses to anthropogenic pressures, providing a baseline for future ecological assessments.

**Keywords—** Aquatic Flora, Avian Species, Anthropogenic, Ecosystem, Ecological.

## I. INTRODUCTION

Urban lakes play a crucial role in maintaining ecological balance within city environments, serving as habitats for diverse species and providing numerous ecosystem services. However, these water bodies are increasingly threatened by rapid urbanization, which can significantly alter their biodiversity and ecological health. Lakaki Lake, located in Model Colony, Shivajinagar, Pune, presents an interesting case study of an urban lake ecosystem. Originally a stone quarry, Lakaki Lake has been transformed into a nature reserve, supporting a well-balanced ecosystem with various life forms. This transformation makes it an ideal subject for studying the dynamics of urban lake biodiversity and the impacts of human activities on such ecosystems. The importance of documenting and understanding the current state of biodiversity in urban water bodies cannot be overstated. It provides crucial insights into the ecological health of these systems and serves as a baseline for future conservation efforts. This study aims to map the biodiversity of Lakaki Lake, with a particular focus on

aquatic flora, fauna, and avian species. Human activities have a significant impact on the lake's ecosystem. For instance, the feeding habits of both water and land birds have been influenced by the presence of tourists and local residents. Such interactions between human activities and wildlife highlight the need for a comprehensive study of the lake's biodiversity and the anthropogenic factors affecting it. The presence of various species in and around the lake serves as bio-indicators of environmental quality. Sparrows, pigeons, ducks, and butterflies, for example, indicate the cleanliness of the area, the quality of the water, and the freshness of the air. This study will delve deeper into how these species, particularly birds like ducks and pigeons, can serve as effective bioindicators of the lake's overall health. By employing a live case study approach, including field surveys and direct observations, this research aims to provide a comprehensive assessment of Lakaki Lake's current biodiversity status. The findings will not only contribute to our understanding of urban lake ecosystems but also inform future conservation strategies and urban planning decisions to maintain the ecological balance of such vital urban water bodies.

### A. Biodiversity Cycle in Lake Ecosystems :-

At the foundation of a lake's biodiversity cycle are the primary producers - the aquatic plants and phytoplankton. These photosynthetic organisms form the base of the food web, providing energy and nutrients to the higher trophic levels. The aquatic plants, such as submerged macrophytes, floating-leaved plants, and emergent vegetation, play a crucial role in the lake ecosystem. They provide habitat, shelter, and food for a diverse array of aquatic invertebrates, fish, and other organisms. The invertebrates, including zooplankton, benthic macroinvertebrates, and insects, occupy the next trophic level. They consume the primary producers and serve as food sources for larger predators, such as fish and birds. Fish species, both planktivores and piscivores, form an integral part of the lake's biodiversity cycle.

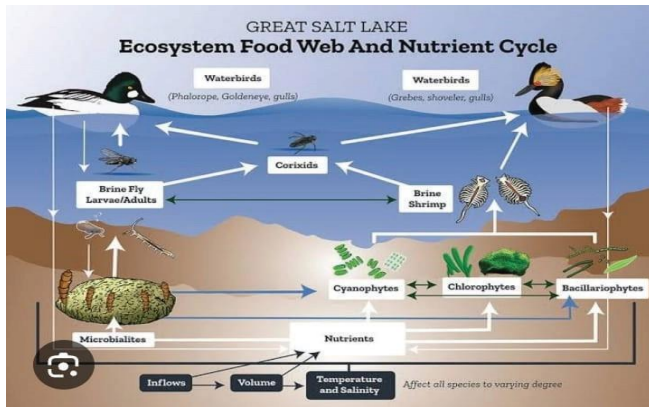


Fig 1:- Ecosystem Food Web And Nutrient Cycle

.Source-<https://wildlife.utah.gov/gslap/wildlife.html>

They feed on the invertebrates and smaller fish, and in turn, provide a food source for predatory birds and mammals. The surrounding terrestrial vegetation, including trees, shrubs, and grasses, also contributes to the overall biodiversity of the lake ecosystem. These plants provide habitat, food, and nesting sites for a variety of bird species and other wildlife that utilize the lake and its shoreline. The interconnections and energy flow between the different components of the lake ecosystem, from primary producers to top predators, create a complex and dynamic biodiversity cycle. This cycle is influenced by various abiotic factors, such as water quality, nutrient levels, and climate, as well as biotic interactions, including competition, predation, and symbiotic relationships. Not only this but the abiotic factors, such as water quality and nutrient levels, have a significant influence on the biodiversity cycle in lake ecosystems.

Here's how these factors can impact the biodiversity cycle:

### 1. Water Quality

The quality of the water in a lake, in terms of parameters like pH, dissolved oxygen, turbidity, and the presence of pollutants, can greatly affect the composition and functioning of the lake's biodiversity cycle. Poor water quality can lead to the decline or loss of sensitive aquatic species, disrupting the food web and overall ecosystem balance.

### 2. Nutrient Levels

The availability of essential nutrients, such as nitrogen and phosphorus, can either promote or hinder the productivity of primary producers (aquatic plants and phytoplankton) in a lake. Excessive nutrient levels, often due to anthropogenic sources like agricultural runoff or sewage discharge, can lead to eutrophication. This can result in algal blooms, decreased light penetration, and depletion of dissolved oxygen, negatively impacting the entire biodiversity cycle.

### 3. Implications for Biodiversity

Changes in water quality and nutrient levels can cause shifts in the composition and abundance of aquatic flora and fauna, leading to the dominance of more tolerant species and the decline or loss of sensitive ones. This can disrupt the food web, reduce overall species

diversity, and compromise the ecological integrity of the lake ecosystem.

Understanding the relationships between abiotic factors and the biodiversity cycle is crucial for developing effective management strategies to protect and restore the ecological health of lake ecosystems.

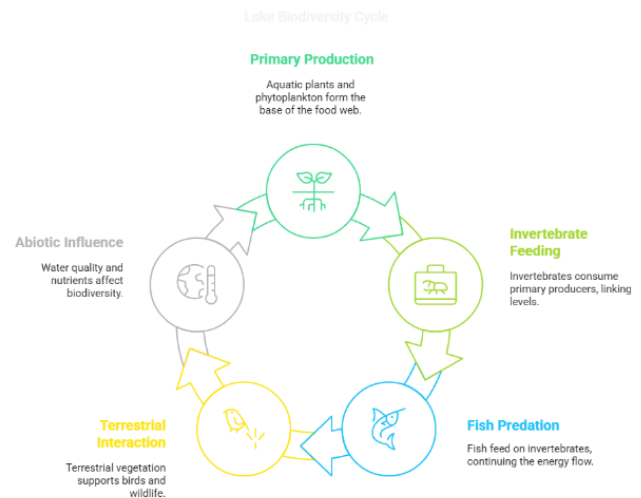


Fig 2 :- Lake biodiversity cycle.

Source- Author

## B. Layers of the Biodiversity Cycle in Water Ecosystems:-

The diagram depicts the interconnected components of the water biodiversity cycle:-

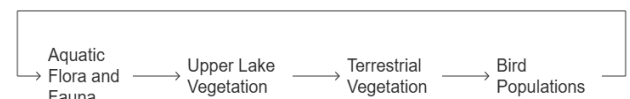


Fig 3:- Biodiversity Cycle In Lake Ecosystem.

Source- Author

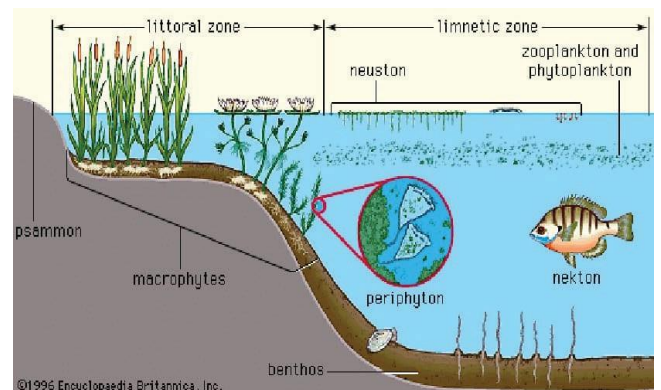


Fig 4 :- Different Zones in Fresh Water Ecosystem.

Source-<https://www.researchgate>.

### 1. Aquatic Flora and Fauna:

At the core of the biodiversity cycle are the aquatic plants and animals that form the foundation of the lake's ecosystem. This includes submerged plants like eelgrass, elodea, hydrilla, and pondweed, as well as the various invertebrates, fish, and other organisms that rely on these primary producers.

### 2. Upper Lake Vegetation:

Building upon the aquatic flora and fauna, the next layer of the biodiversity cycle comprises the upper lake vegetation, such as dutch grass, foxtail, and calotropis. These plants provide additional habitat, food sources, and nesting sites for the diverse array of bird species found in the lake ecosystem.

### 3. Terrestrial Vegetation:

The outermost layer of the biodiversity cycle includes the trees and other vegetation on the land surrounding the lake. Species like banyan, jamun, ber, and bakul contribute to the overall diversity by offering perching, nesting, and foraging opportunities for birds and other wildlife.

### 4. Bird Populations:

The bird species, both migratory and resident, play a crucial role in the water biodiversity cycle, acting as both consumers and dispersers. They feed on the aquatic and terrestrial vegetation, and their movements help to distribute seeds and maintain the diversity of plant life.

ecosystem is evident, particularly in the feeding habits of birds. Tourists and locals often provide food for both water birds (ducks) and land birds (sparrows, pigeons), influencing their behavior and potentially affecting the lake's ecological balance. The presence of certain species serves as bio-indicators of environmental quality. For instance, the presence of sparrows and pigeons indicates low pollution levels, while ducks suggest clean water, and butterflies signify good air quality. The study also notes that the area around the lake has a cooler average temperature compared to the city center, highlighting its role in urban climate regulation. This comprehensive assessment of Lakaki Lake's biodiversity and ecological characteristics provides valuable insights into the functioning of urban lake ecosystems and the impacts of human activities on them.

### 1. Biodiversity Cycle Of Lakaki Lake:-

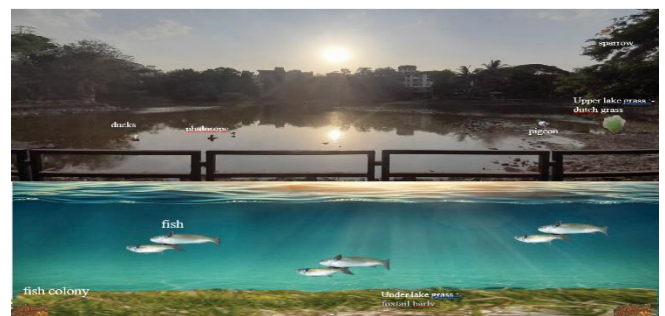


Fig 6 :- Biodiversity Mapping At Lakaki Lake

Source- Author

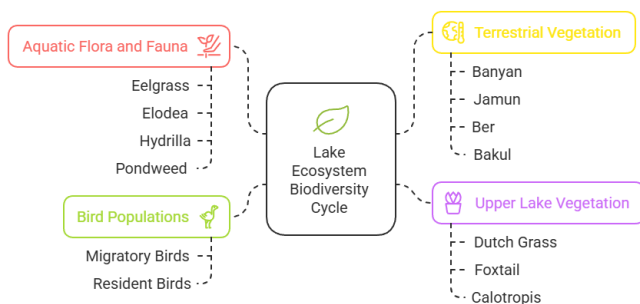


Fig 5 :- Lake Ecosystem Biodiversity Cycle

Source- Author

### C. Case study - Biodiversity Assessment of Lakaki Lake:-

Lakaki Lake, located in Model Colony, Shivajinagar, Pune, serves as an ideal subject for studying urban lake biodiversity. Originally a stone quarry, this lake has been transformed into a nature reserve, supporting a diverse ecosystem. The study area is characterized by various types of vegetation, including lower lake trees (submerged plants like eelgrass and hydrilla), upper lake trees (such as dutch grass and calotropis), and land trees (including native species like banyan and jamun). The lake hosts a rich avian population, with species such as ducks, geese, storks, cranes, and egrets frequently observed. Human impact on the

The diagram above illustrates the biodiversity cycle in Lakaki Lake, showing the interconnections between different components of the ecosystem.

At the center of the cycle are the aquatic flora and fauna, which form the foundation of the lake's ecosystem. This includes submerged plants like eelgrass, elodea, hydrilla, and pondweed that provide food and habitat for various organisms. Building upon the aquatic flora and fauna, the biodiversity cycle incorporates the upper lake trees and land trees surrounding the lake. These trees, such as banyan, jamun, ber, and bakul, serve as nesting sites and perching places for the diverse bird species found in the area. The bird populations, which include migratory species like ducks, geese, storks, cranes, and egrets,

as well as resident birds like sparrows and pigeons, play a crucial role in the biodiversity cycle. These birds act as both consumers, feeding on the aquatic and terrestrial vegetation, and as dispersers, helping to distribute seeds and maintain the diversity of plant life. Human activities, such as feeding the birds and introducing non-native plant species, can disrupt the delicate balance of this biodiversity cycle. The document notes that tourists and locals provide food for both water birds (ducks) and land birds (sparrows, pigeons), which can alter their natural feeding habits and potentially impact the overall ecological equilibrium of the lake.

Understanding the interconnections and dependencies between these different layers is essential for effectively managing and conserving the overall biodiversity of water ecosystems like Lakaki Lake.

## 2. Flora Supporting Biodiversity :-

The plants around Lakaki Lake can be divided into three main categories:

The different layers of vegetation - submerged, upper lake, and terrestrial - play complementary roles in supporting the overall biodiversity and ecological functioning of the Lakaki Lake ecosystem:

### a) Submerged Aquatic Vegetation

The submerged plants, such as eelgrass, elodea, hydrilla, and pondweed, form the foundation of the lake's ecosystem. They provide food and habitat for a diverse array of aquatic invertebrates, fish, and other organisms, serving as the primary producers in the lake's food web.

### b) Upper Lake Vegetation

The upper lake plants, including dutch grass, foxtail, and calotropis, occupy the next layer of the ecosystem. These plants offer additional resources, such as nesting sites and food sources, for the diverse bird populations that utilize the lake environment.

### c) Terrestrial Vegetation

The surrounding trees, like banyan, jamun, ber, and bakul, contribute to the overall habitat diversity of the Lakaki Lake ecosystem. They provide perching and nesting sites for birds, as well as help to maintain the connectivity between the terrestrial and aquatic components of the system.

## 3. Fauna Supporting Biodiversity :-

The Lakaki Lake has rich avian diversity of, which includes both migratory and resident bird species:

- Ducks, geese, storks, cranes, and egrets are some of the migratory bird species that frequent the lake.
- Resident birds like sparrows and pigeons also thrive in the lake environment, taking advantage of the food resources provided by both the aquatic and terrestrial vegetation.

The presence of these diverse bird populations, along with their interactions with the various plant species, is a key indicator of the overall biodiversity and ecological health of Lakaki Lake.

## 4. Ecosystem Functioning:-

The synergistic interactions between these different vegetation layers support a complex and resilient ecosystem. The submerged plants form the base of the food web, the upper lake vegetation enhances the habitat diversity, and the terrestrial trees facilitate the exchange of energy and materials between the land and water. This multilayered vegetation structure helps to sustain a diverse array of species, from aquatic invertebrates and fish to migratory and resident birds, contributing to the overall biodiversity and ecological functioning of the Lakaki Lake ecosystem. Not only this but the ecosystem also has a major role of impacting human presence.

The presence of tourists and local people at Lakaki Lake has influenced the feeding and behavior of the resident bird populations. The document notes that the water birds, such as ducks and geese, as well as the land birds like sparrows and pigeons, have become accustomed to receiving food from humans.



Fig 7 :- dynamics of lakaki lake

Source- Author

### • Feeding by Humans

Joggers and tourists have been observed throwing bread crumbs and grains into the lake, which the water birds and land birds have learned to take advantage of as a readily available food source.

### • Indirect Impacts

It was also observed that some of the ducks were feeding on the algae that had grown in the lake, likely due to the increased nutrient inputs from human activities.

### Potential Concerns

Reliance of the birds on human-provided food sources and the potential for eutrophication due to nutrient inputs could have long-term consequences for the lake's biodiversity cycle. Excessive human interference and disruption of the natural feeding habits and ecosystem dynamics could lead to imbalances in the food web and the decline of sensitive species. Understanding the complex interactions between human activities and the lake's biodiversity is crucial for developing sustainable management strategies that can preserve the ecological integrity of Lakaki Lake.



## II. Observations And Findings About Lakaki Lake:-

### • Observations :-

1. The average temperature of the Lakaki Lake area is much cooler than the core city part.
2. The air quality in the Lakaki Lake area is good.
3. The trees around the lake act as a natural shading for the roads and nearby residences.

### • Findings. :-

1. Lakaki Lake supports a well-balanced ecosystem and diverse life forms.
2. Many migratory bird species, such as ducks, geese, storks, cranes, and egrets, frequent the lake.
3. Resident bird species, including sparrows and pigeons, are also present and thrive in the lake environment.
4. The presence of sparrows, pigeons, and butterflies indicates that the area has low pollution levels and a fresh, clean environment.

These observations and findings suggest that Lakaki Lake is a valuable natural resource that provides a refuge for a diverse array of plant and animal species, while also offering a cooler, cleaner, and more pleasant environment for the surrounding urban area.

- Below are some QR codes containing videos of some lake activities :-



*Hunting Of Fish*

Source- Author



*Pigeons Drinking Water*

Source- Author



*Activities Of Birds In Water*

Source- Author



*Whole Lake View*

Source- Author

The findings and recommendations from the study of Lakaki Lake can be applied to the management and conservation of

other urban lakes or wetlands in the region in the following ways:

### a) Vegetation Management

The insights into the importance of the different vegetation layers - submerged, upper lake, and terrestrial - in supporting the biodiversity and ecological functioning of Lakaki Lake can be used as a model for managing the vegetation in other similar urban water bodies. Restoring and maintaining a diverse array of aquatic, emergent, and riparian plants can help to replicate the habitat heterogeneity and resource provisioning observed at Lakaki Lake.

### b) Nutrient Management

The document's emphasis on addressing nutrient pollution and eutrophication issues at Lakaki Lake can inform strategies for other urban lakes or wetlands facing similar water quality challenges. Implementing measures to reduce nutrient inputs, such as improving wastewater treatment and promoting sustainable land use practices, can help to maintain the ecological balance and prevent the degradation of these valuable ecosystems.

### c) Visitor Management

The visitor management strategies proposed for Lakaki Lake, such as controlled access, designated activity zones, and educational outreach, can be adapted and applied to other urban water bodies that experience high levels of human activity and disturbance. Balancing public access with the protection of sensitive habitats and species is a common challenge that can be addressed through these types of management approaches.

### d) Monitoring and Adaptive Management

The importance of ongoing monitoring and adaptive management highlighted in the Lakaki Lake study can be a guiding principle for the conservation and stewardship of other urban lakes and wetlands in the region. Regularly assessing the ecological health, tracking changes, and adjusting management strategies accordingly will be crucial for ensuring the long-term sustainability of these valuable ecosystems.

By drawing on the lessons learned from Lakaki Lake, local authorities, conservation organizations, and community stakeholders can develop more holistic and effective strategies for managing and protecting the region's urban water bodies, ensuring that they continue to provide essential ecological services and recreational opportunities for the surrounding communities.

- Given below is short checklist to take quick ecological observation of the unknown area. This is also useful for general travelers.

## Checklist

**Date:** 01 -04-2025

**Time:** 4 PM

**Location:** Lakaki Lake , Model Colony , Shivajinagar , Pune .

**Biogeographic zone:** Deccan Plateau

**Area covered:** Line (m) 519.62 m Plot (m<sup>2</sup>/km<sup>2</sup>/acres) 12,432.15 m<sup>2</sup>

**Substrata:** Rock/Murum/Soil (shallow/deep)- Rock

**Land character:**

- Slope: Steep/moderate/gradual
- Plain land: Low lying/elevated plateau

**Climatic conditions**

- Rainfall (Av annual): 669.4 mm
- Current status of climate: Moderate
- Windy/Breeze: 8.3 kmph
- Hot/Cold: Hot
- Cloud cover in %: Scattered/High/Low cloud/Overcast
- Rainfall : Drizzle/Torrential/Normal/No

**Details of water body:** Stream/River/Lake/Well

- Natural/Manmade
- Water: Perennial/Seasonal

**Vegetation:**

- General Character: Perennial cover/Seasonal cover
- Type of cover: Trees, shrubs, grass, herbs, climbers, liana
- Vegetation Name : eelgrass, elodea, hydrilla, and pondweed, dutch grass, foxtail, calotropis, -banyan (Ficus benghalensis), jamun (Syzygium cumini), ber (Ziziphus mauritiana) and bakul (Mimusops elengi),
- Invasive/non native species: Alligator Gar and Wild Boar (Alien plant species)

**Fauna**

- Name, Number, Activity, male/female, Sighting/Call - Ducks, golden ducks, sparrow, pigeon
- Feed/Nesting/Roosting/Courtship/Hunting parties- Human feeding practices

**Other remarks:** The lake supports a diverse ecosystem, including various bird species and the *Gambusia affinis* fish, which helps control mosquito populations.

**Special features (striking) :** lake garden and nature reserve in the middle of a residential colony in pune

Source – Oikos, Ghate K

(Marked in red are the observations seen at the Lakaki lake)

**Flora & Fauna**

Fig 8 :-calotropis

Source- Author



Fig 9 :- Dutch grass

Source- Author



Fig 10 :-  
Briophyllum

Source- Author



Fig 11 :- Banyan

Source- Author

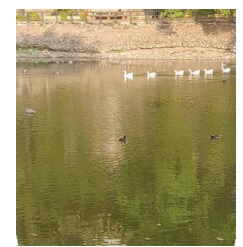


Fig 12 :- Ducks

Source- Author



Fig 13 :- pigeons

Source- Author



Fig 14:- Cassowary

Source- Author

**III. CONCLUSION**

In conclusion, the Lakaki Lake in Pune, India, is a valuable natural resource that supports a rich and diverse ecosystem. The lake's biodiversity is sustained by the intricate interactions between its various vegetation layers, including submerged aquatic plants, upper lake vegetation, and surrounding terrestrial trees. This multilayered vegetation structure provides food, habitat, and nesting resources for a wide range of species, including both migratory and resident bird populations. The presence of indicator species, such as sparrows, pigeons, and butterflies, suggests that the Lakaki Lake environment

maintains low pollution levels and a generally healthy ecological balance. However, the document also highlights the potential impacts of human activities, such as feeding the wildlife and introducing nutrient inputs, which could disrupt the natural biodiversity cycle if not properly managed. To preserve the ecological integrity of Lakaki Lake, a balanced approach is needed, one that combines visitor management strategies, habitat restoration and protection, and nutrient control measures. By implementing these strategies, Lakaki Lake can continue to serve as a valuable natural oasis within the urban landscape, providing both ecological benefits and recreational opportunities for the local community. Ongoing monitoring and adaptive management will be crucial to ensuring the long-term sustainability of this important biodiversity hotspot.

#### IV. REFERENCES

- [1] Mapping Lake Ecosystem Services: A Systematic Review
  - a. Authors: Campagne, C. S., Roy, L.-A., Langridge, J., & Thiébaud, E.
  - b. Published: 2023
- [2] Repeatable Patterns in the Distribution of Freshwater Biodiversity Indicators Across Contrasting Landscapes\*
  - a. Authors: Law, A., Baker, A., Sayer, C.D., et al.
  - b. Published: 2024
- [3] Scientists' Warning to Humanity: Rapid Degradation of the World's Large Lakes
  - a. Authors: Jean-Philippe, J., Anneville, O., Arnaud, F., & Weyhenmeyer, G.
- [4] <https://www.atlasobscura.com/places/lakaki-lake>
- [5] <https://lbb.in/pune/lakes-in-pune-56be81/>
- [6] <https://wildlife.utah.gov/gslap/wildlife.html>
- [7] <https://www.sciencedirect.com/science/article/pii/S2667010024001100>
- [8] <https://essay.utwente.nl/84422/1/anand.pdf>
- [9] <https://www.ravindrabhan.com/model-colony-lake>