

Beaks in The Bronx: Bird Use of Natural & Human-Managed Water Sources at the Bronx Zoo

Vanessa Saavedra, Caroline Adames, Tiwaa Baffour, Sanjay Bissessar, Angelina Gonzalez Teixeira, Jacob Heredia, Mahawa Keita
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Introduction

Urbanization is one of the most significant forms of environmental change, replacing natural habitats with buildings, roads, and other human made infrastructure. These landscape changes affect wildlife by altering habitat quality, resource availability and communities across many taxa. In birds, urbanization often favors generalist species that can adapt to human modified environments while reducing suitable habitat for more specialized species.^{2, 3} In addition, cities provide anthropogenic resources such as bird feeders, garbage, nesting structures, and water features that can benefit species able to exploit these resources. However, these changes may disadvantage species that are more sensitive to habitat disturbance, allowing adaptable generalist and non native species to become more common and potentially outcomplete species with more specialized habitat needs.^{1, 3}

Urban areas also create heat island effects, where developed surfaces retain heat and produce warmer local temperatures than surrounding natural areas. Because of this, urban water sources are essential for birds, supporting drinking, bathing, and foraging, particularly during warmer temperatures. Previous research has shown that undisturbed riparian habitats generally support greater bird richness than highly developed areas.⁴ Vegetation structure, canopy cover, surrounding habitat quality, and ambient noise also influence bird communities by affecting resource availability, habitat use, and behavior.^{3, 4} There is still much to learn about how birds use different water sources within urban environments and how local habitat characteristics influence this use, particularly as climate change continues to impact urban ecosystems.

This study compared bird abundance, diversity, and water related behaviors between natural and human managed water sources throughout the Bronx zoo, an urban park and green space, while evaluating how ambient noise levels and canopy coverage influence bird use of these habitats. Understanding how birds respond to different urban water resources can help improve habitat management and support bird conservation within urban parks, zoos, and other green spaces.

Methodology

Study Sites

This study was conducted at six water sources around the Bronx Zoo, representing a gradient of urban habitat characteristics: canopy cover, ambient noise, and human activity. Natural sites consisted of naturally occurring water bodies along the Bronx River corridor and surrounding streams - Mitsubishi Riverwalk Pond (N1), Mitsubishi Riverwalk Boat Launch (N2), World of Birds Stream. Human managed sites were man-made water sources located within animal exhibits and surrounded by visitor pathways and exhibit infrastructure with the purpose of providing water for exhibit animals or visitor aesthetics - Père David's Deer (H1), Northern Ponds (H2), Gelada Reserve (H3).

Point Count and Ethogram

Bird communities were surveyed using 30-minute fixed-radius point counts conducted at each water source. Upon arriving at a site, observers remained quiet for five minutes to allow birds to acclimate before beginning observations. During each survey, all birds observed within the designated observation area were observed using binoculars and identified to species using a combination of field guides and the Merlin Bird ID application by the Cornell Lab of Ornithology. At exhibit sites, the observation area included all visible birds within the exhibit boundaries, while observations at natural sites extended to the visible limits of the water source.

For each bird observed, species, abundance, and water-related behaviors were recorded. Behaviors were classified using a standardized ethogram (**Fig. 2**). Surveys were conducted between 10:00 a.m. and 12:30 p.m. across 13 field days, and the order in which sites were visited was rotated throughout the study to reduce potential bias associated with time of day, ambient noise, and human activity. To minimize duplicate counting of stationary water fowl such as ducks, geese, and herons, interval point counts were conducted every five minutes throughout each survey. Individuals that remained in the same general location during consecutive intervals were not recorded as new observations unless they clearly left the observation area and later returned.

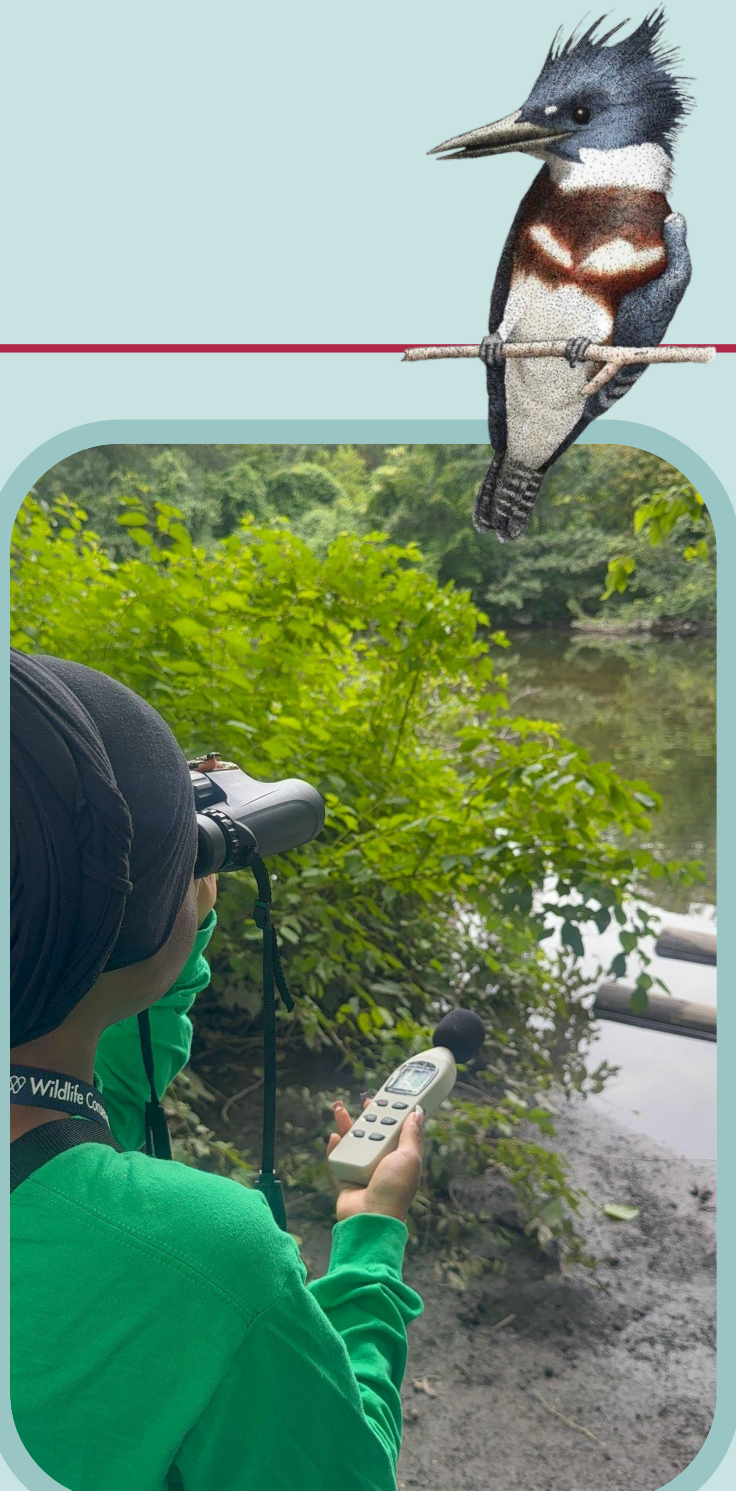


Image 1. Conducting Interval Waterfowl & Noise Ambience Survey at Riverwalk Boat Launch Site



Image 2. Close Up of Extech Digital Sound Level Meter used for interval ambient noise surveys

Ambient Noise

Ambient noise was measured during each point count using an Extech Digital Sound Level Meter. The sound level meter remained on throughout the 30 minute survey, and ambient noise levels were recorded every five minutes in decibels (dB), resulting in six measurements per survey. Because only one sound level meter was available, a mobile decibel meter application was used simultaneously by the second field team to ensure that noise measurements were collected at all study sites.

Canopy Cover

Canopy cover was visually estimated once for each study site using a categorical scale based on the percentage of overhead vegetation. Sites were assigned one of four categories: very sparse (1–20% canopy cover), sparse (21–50%), moderate (51–80%), or dense (81–100%).

Abstract

Urbanization alters habitat quality and resource availability, potentially changing how birds use urban environments. This study examines how birds use natural and human managed water sources and whether ambient noise and canopy cover were associated with bird abundance, diversity, and water-related behavior. Six water sources around the Bronx Zoo were surveyed, including three natural and three human managed sites. Bird communities were sampled using 30-minute point counts over five weeks (13 field days), while ambient noise was measured every five minutes and canopy cover was estimated for each site. A total of 1,259 birds were recorded, with greater abundance at human managed water sources (n = 824) than natural sources (n = 435). Natural sites had higher average Shannon diversity (1.96) than human managed sites (1.75) and exhibited a wider range of water related behaviors. Swimming was the most frequently observed behavior at both site types. Relationships between ambient noise, canopy cover and bird abundance or diversity were inconsistent. These findings suggest that human managed water sources can support high bird abundance, while natural water sources may support greater diversity and behavioral variety. Understanding how birds respond to different water sources and habitat conditions can help inform conservation and habitat management in urban green spaces.

Research Questions & Hypotheses

How does bird abundance, diversity, and behavior differ between natural and human maintained water sources around the Bronx Zoo?

Bird abundance will be higher at human managed water sources, while natural water sources will support a greater bird diversity and exhibit a wider range of behaviors.

Does average ambient noise level and canopy cover have a relationship with bird abundance and diversity at water sources in the Bronx Zoo?

Water sources with lower noise levels and greater canopy cover will have higher bird abundance and species diversity.

Results & Figures

Figure 1.

SITE & ID	SHANNON DIVERSITY INDEX (H)	CANOPY COVER
N1 – RIVER WALK POND	1.85	DENSE (81-100%)
N2 – RIVERWALK BOAT LAUNCH	2.38	SPARSE (21-50%)
N3 – WORLD OF BIRDS STREAM	1.67	MODERATE (51-80%)
H1 – PÈRE DAVID DEER	1.98	SPARSE (21-50%)
H2 – NORTHERN PONDS	1.62	SPARSE (21-50%)
H3 – GELADA RESERVE	1.67	VERY SPARSE (1-20%)

Figure 2.

BEHAVIOR	DESCRIPTION
Vigilance	Bird raises its head and scans the surrounding area for potential threats, temporarily pausing other activities.
Wading	Bird walks or stands in shallow water while searching for food or moving through the water.
Swimming	Bird moves through the water while floating or paddling.
Drinking	Bird drinks water directly from the water source.
Bathing	Bird splashes or immerses its body or wings in the water to clean feathers or cool itself.
Water Foraging	Bird searches for, captures, or handles food in or immediately adjacent to the water.
Eating	Bird consumes food by grasping it with its beak, lifting its head, and swallowing.
Preening	Bird uses its beak to clean, arrange, or maintain its feathers, often after bathing.
Aggression	Bird chases, displaces, or displays aggressive behavior toward another bird at or near the water source.

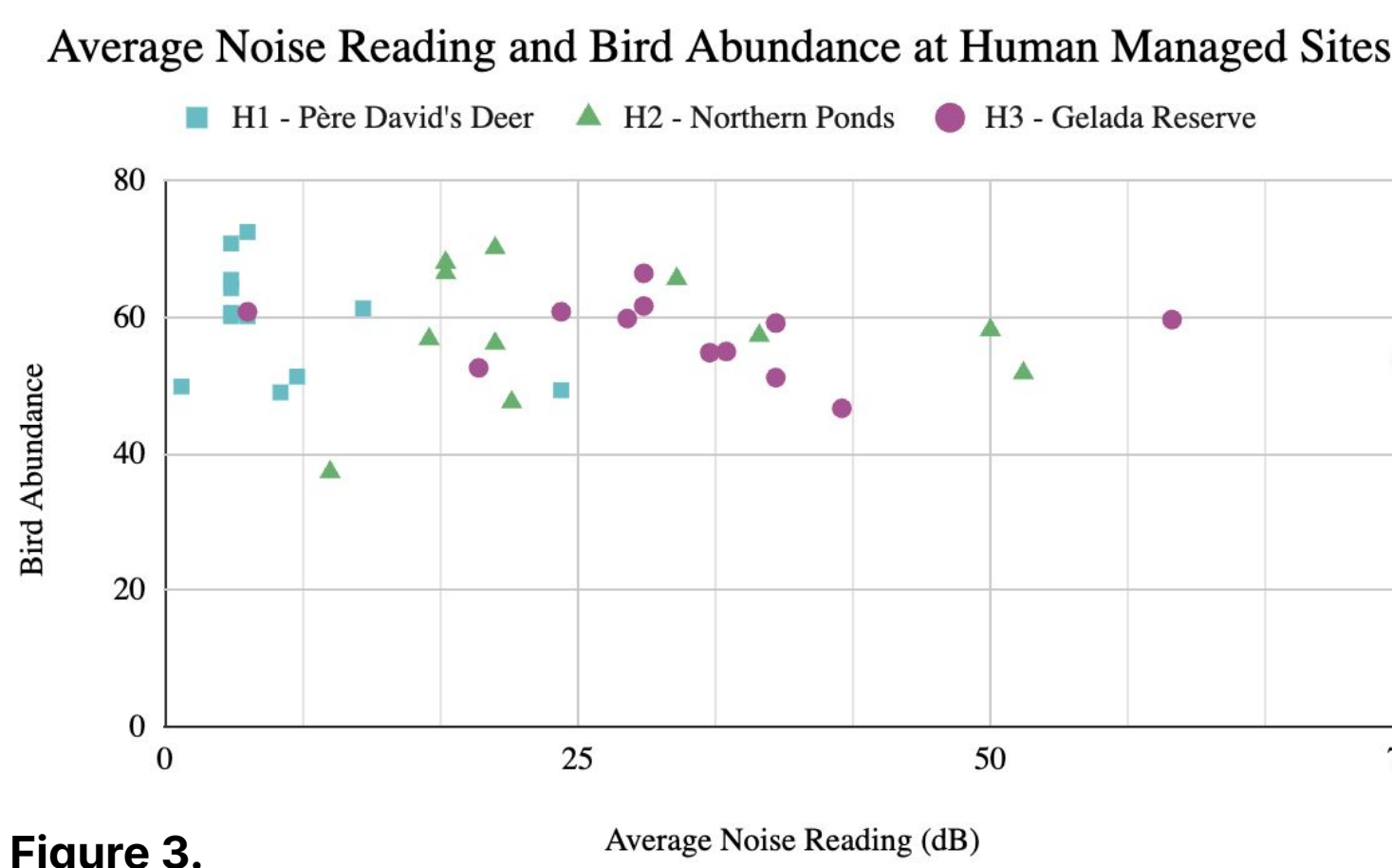


Figure 3.

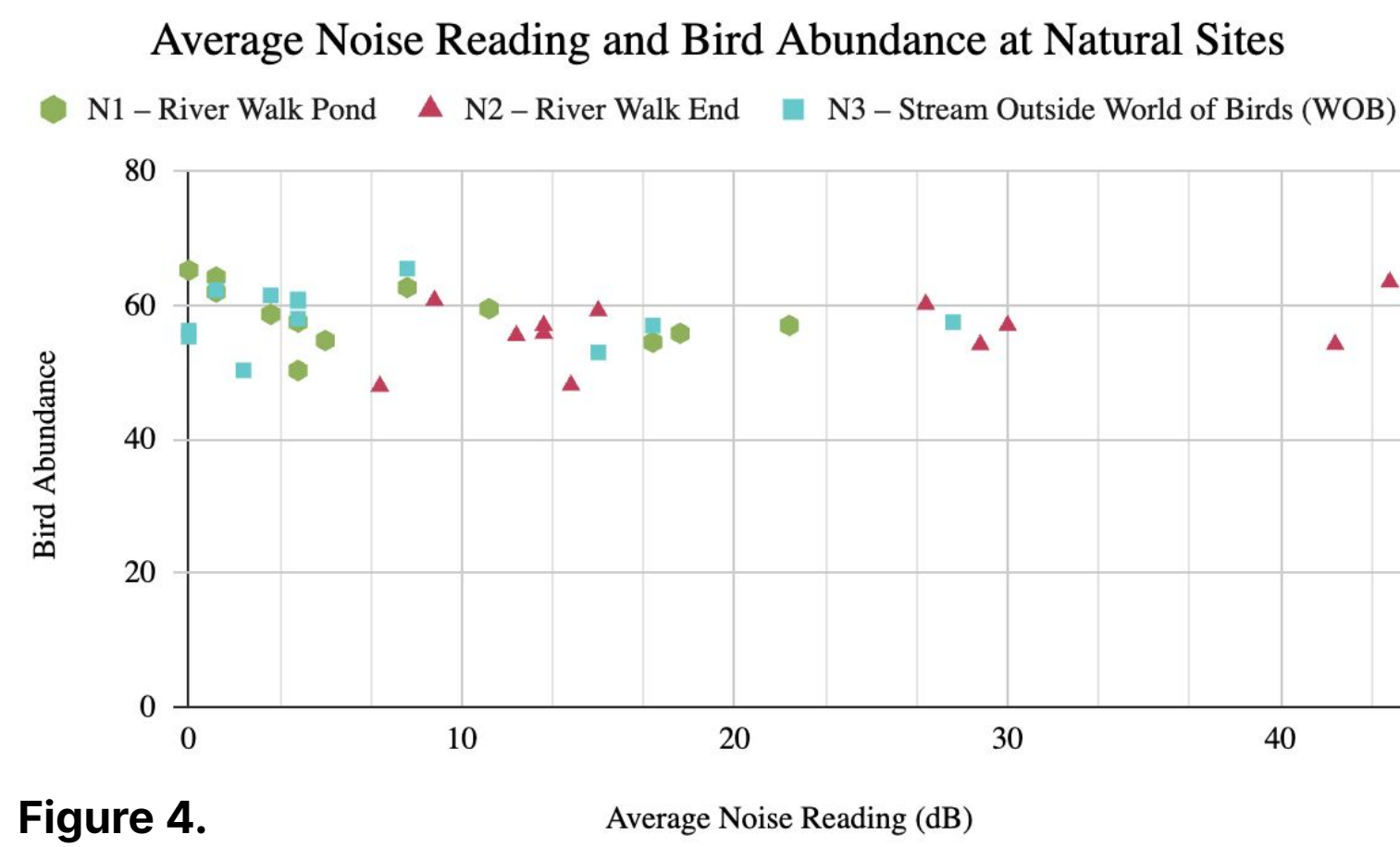


Figure 4.

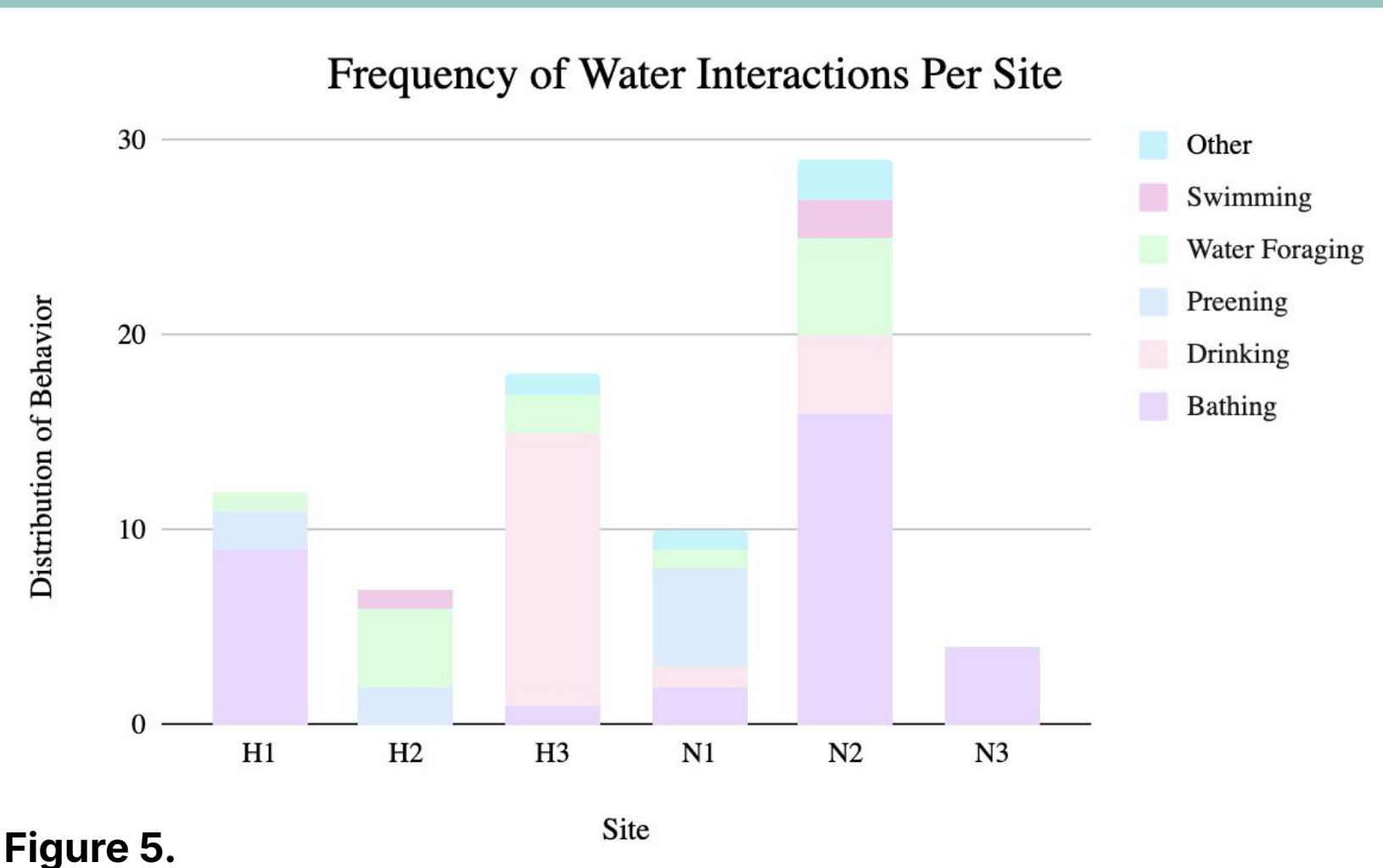


Figure 5.

Figure 1. Canopy Cover and Species Diversity Across Study Sites.

Summary of canopy cover estimated and Shannon Diversity Index (H) across natural and human managed water sources

Figure 2. Standardized Ethogram of Avian Behaviors.

Descriptions of water related behaviors monitored across all six study sites.

Figure 3. Relationship Between Ambient Noise Levels and Bird Abundance Across Human Managed Study Sites

Figure 4. Relationship Between Ambient Noise Levels and Bird Abundance Across Natural Study Sites

Figure 5. Frequency and breakdown of observed bird behavior duration (minutes) across all six study sites.

Image 4. Great Blue Heron (*Ardea herodias*) spotted at the Northern Ponds Exhibit through binoculars
Image 5. Glossy Ibis (*Plegadis falcinellus*) Photo Credit: Todd Olson
Image 6. Green Heron (*Butorides virescens*) spotted at the Pere David Deer Exhibit

Analysis

Canopy cover varied across the six study sites, natural sites generally had greater canopy cover than human managed sites. (**see Figure 1**)

Shannon diversity ranged from 1.62 to 2.38 across sites. Among natural sites, diversity was highest at N2 - Riverwalk Boat Launch (2.38), followed by N1 - Riverwalk Pond (1.85) and N3 - World of Birds Stream (1.67). Among human managed sites, diversity was highest at H1 - Père David's Deer (1.98), followed by H2 - Northern Ponds (1.62) and H3 - Gelada Reserve (1.67).

Bird abundance also varied through sites. The highest abundance was recorded at H3 - Gelada Reserve (381 birds), followed by H2 - Northern Ponds (357) and N2 - River Walk Boat Launch (257). The lowest abundances were recorded at N1 - River Walk Pond (89), N3 - World of Birds Stream (87) and H1 - Père David's Deer (85). House Sparrows, Mallards and Canada Geese were among the most abundant species observed across study sites. N2 also had several less frequently observed species, including Glossy Ibis, Black-crowned Night Heron, Kingfisher, and Spotted Sandpiper, contributing to its higher diversity.

Behaviors performed by water fowl were dominated by swimming, accounting for approximately 72% of observations at natural sites and 71% at human managed sites. At natural sites, the remaining behaviors included preening (9%), eating (6%), drinking (5%), water foraging (3%), bathing (3%), and aggression (2%). At human managed sites, swimming was followed by preening (6%), eating (5%), water foraging (5%), and smaller proportions of drinking, vigilance, bathing, aggression, and other behaviors.

Discussion

Our results partially supported our hypotheses. Human-managed water sources had greater bird abundance, with 824 total birds recorded compared with 435 at natural water sources, supporting our hypothesis that bird abundance would be higher at human-managed sites.

Natural water sources had greater average bird diversity, with a mean Shannon diversity of 1.96 compared with 1.75 at human managed sites. Natural sites also showed a larger amount of water related behaviors, supporting our hypotheses that natural water sources would support greater diversity and a wider range of behaviors.

However, the relationship between ambient noise and bird abundance was inconsistent across sites. Some human managed sites showed changes in abundance with increasing noise, while natural sites did not show a consistent pattern. Therefore, our prediction that lower noise levels would be associated with greater bird abundance was not clearly supported.

Canopy cover also did not show a clear relationship with bird abundance or diversity. Although natural sites generally had greater canopy cover, the site with the highest diversity did not have the greatest canopy cover, suggesting that other habitat characteristics may also influence bird use of water sources.

Some limitations may have contributed to the variation in our results. Birds could have been missed or misidentified during observations, and differences between the mobile decibel application and the sound level meter may have affected noise measurements.



Image 6.

Future studies could build on this research by conducting surveys across different seasons and times of day to determine whether bird use changes throughout the year. Adding water quality and human activity measurements could help explain why birds use some water sources more than others. Comparing these factors together could help determine which environmental characteristics are more strongly associated with bird use of urban water sources.

Overall, human managed water sources supported greater bird abundance, while natural water sources supported greater diversity and a wider range of behaviors. Noise and canopy cover showed more variable relationships with bird use, suggesting that multiple environmental factors may influence how birds use water sources in an urban environment

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