

The Bronx River Eel-Venture:

An Assessment of Habitat Suitability for American Eels

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Introduction

The American eel (*Anguilla rostrata*) is a catadromous species of migratory fish starting its life in a portion of the Atlantic Ocean known as the Sargasso Sea. Like other fish, eels hatch from eggs into their larval form, known as leptocephali.⁹ Their bodies lengthen as they float along the ocean current and out of the Atlantic towards the Gulf Stream, where they make their way into freshwater rivers and may spend up to 30 years growing and maturing. Once sexually mature, they travel up to 2,500 miles and return to the Sargasso Sea to reproduce and die.³

American eels are incredibly unique in their migration patterns, with little to no records of their exact spawning sites and routes of travel from the ocean to further upstream.² Over the past century, the overexploitation of urban rivers has proven to negatively impact these environments as habitats for many species.⁷ Previous studies have shown that eels are less likely to be found above dams compared to below dams.³ The removal and management of dams is an important tool to assist in eel conservation. Eel abundance has been shown to increase after dam demolition, indicating that these structures serve as barriers to successful migration for eels.⁶

The Bronx Zoo has worked closely with the NYC Parks Department to monitor the long-term population trends of American eels in the Bronx River using eel mops, specialized passive traps that mimic sargassum seaweed and are used to capture eels in rivers. Monitoring the Bronx River is vital in understanding how aquatic wildlife responds to highly disturbed and polluted environments. Alongside pollution, predation by birds, mammals, and fish also pose a threat to eel survival rates. Invasive Common carp (*Cyprinus carpio*) may lead to increased rates of predation on young glass eels or elvers in the river because they eat eels. Carp have also been known to dominate entire rivers and streams.⁸ By using visual point count surveys and camera traps, this study sought to assess the presence of predators at or near where eel mops were deployed.

The purpose of this study is to provide further research on the impact of dams on American eel migration, as well as assess the consequences of urbanization on their habitats, in hopes that future researchers will find a more effective approach to facilitate their movement and support their long-term populations.

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Methods

Site Description:

Research was conducted at two sites along the Bronx River: the Twin Dams and the 182nd Street Dam and Fishway. The Twin Dams are a set of dams located at a section of the river within the Bronx Zoo grounds, while the Fishway is located in River Park, a public park adjacent to the Zoo. Eel mops were deployed at each site (Twin Dams, n = 3; Fishway, n = 5). At the Fishway, four mops were deployed below the dam and one was deployed above the dam. All mops at Twin Dams were deployed below the dam.

Eel Mop Surveys:

Eel mops were surveyed three days a week for three weeks. During surveys, mops would be emptied into a plastic basin and thoroughly rinsed to flush out any captured eels. The water was then strained through a net to identify any eels present. If any eels were found, the life stage was recorded based on visual identification before being released above the dam to facilitate migration upstream. Once surveying was completed, each mop was then carefully submerged back into the river.

Water Sampling:

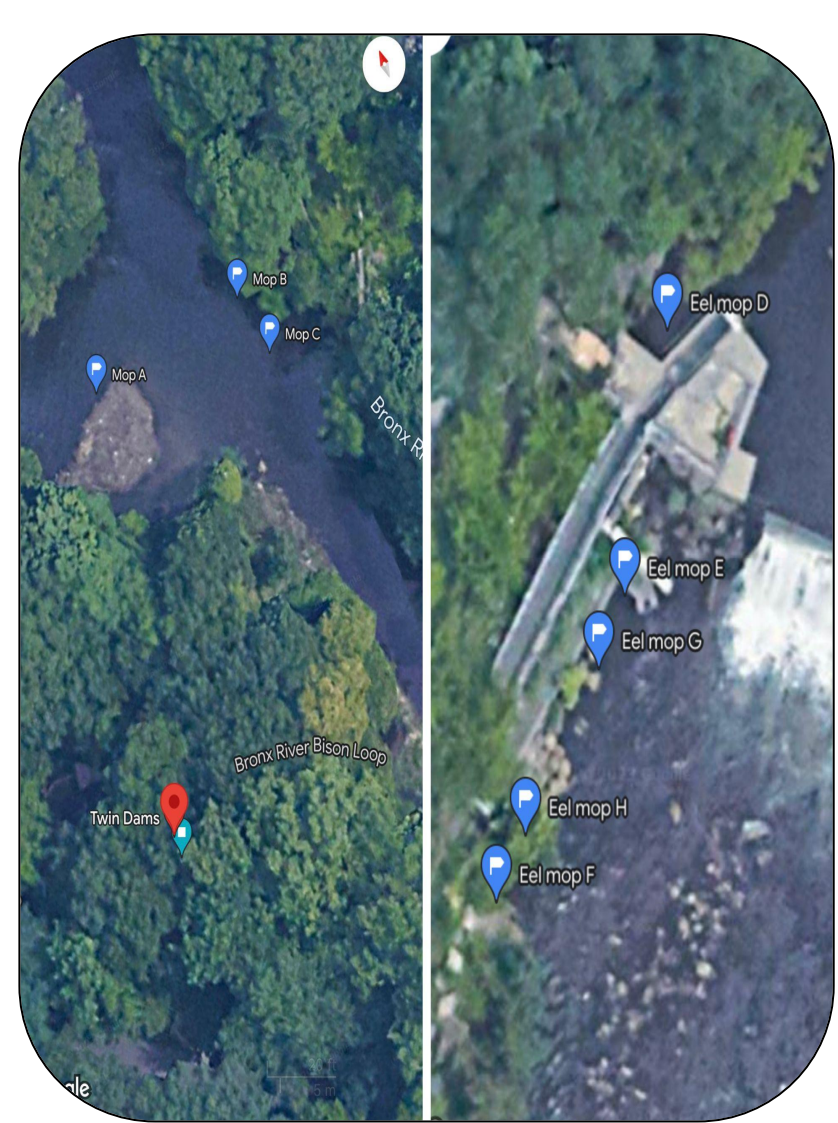
Two water samples were collected in jars at each site from above and below the dams three times a week. In the lab, a LaMotte Fresh Water Aquaculture Kit was used to quantify the pH and a CHEMetrics Kit to quantify dissolved oxygen levels of all four locations. The water temperature was recorded from the United States Geological Survey (USGS) between 11:00-11:30 AM after data collection.

Predator Survey:

Using a visual fixed point count, conducted between 10:00 AM to 12:30 PM, predatory birds and invasive carp (*Cyprinus carpio*) were monitored upstream, downstream, and directly above the river for twenty minutes using binoculars. A total of 10 point counts were conducted over the 3-week study period. Only birds known to predate on American eels were recorded. In addition to point count surveys, two motion-triggered camera traps were deployed at both locations to record any predatory mammals and birds that interacted with the eel mops throughout the day.

Analyzing Data:

All data collected was entered into Google Sheets. Analysis and figure creation was done using Google Sheets, and Excel.



Research Questions & Hypotheses

What is the relationship between habitat suitability and overall eel abundance at different sites in the Bronx River?

Hypothesis: There will be a positive correlation between habitat suitability and abundance of *A. rostrata*.

Results

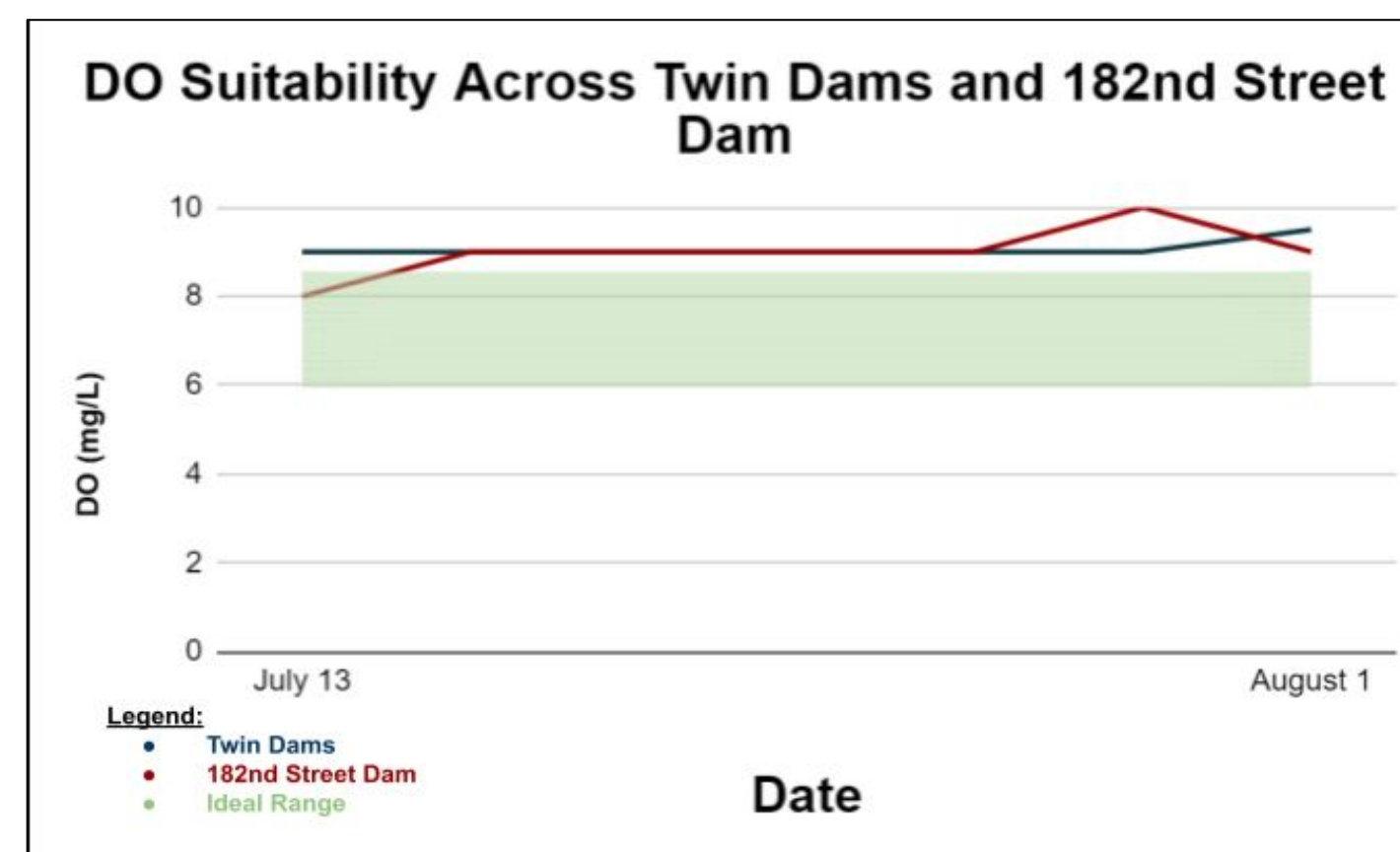


Figure 1. Collected DO (mg/L) at both sites in comparison to ideal DO (mg/L) for *A. rostrata*.

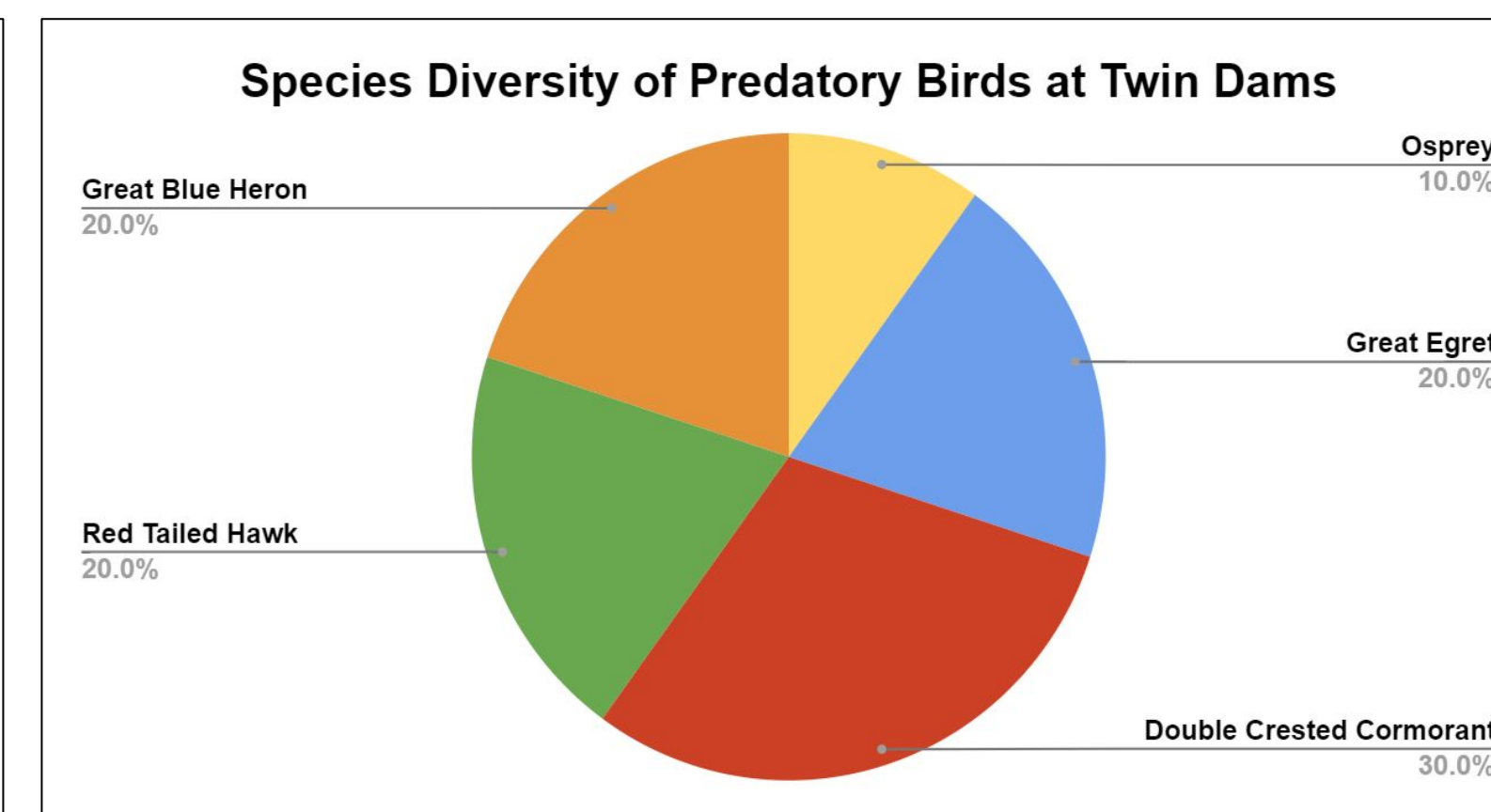


Figure 2. Frequency of all recorded species of predatory birds at Twin Dams.

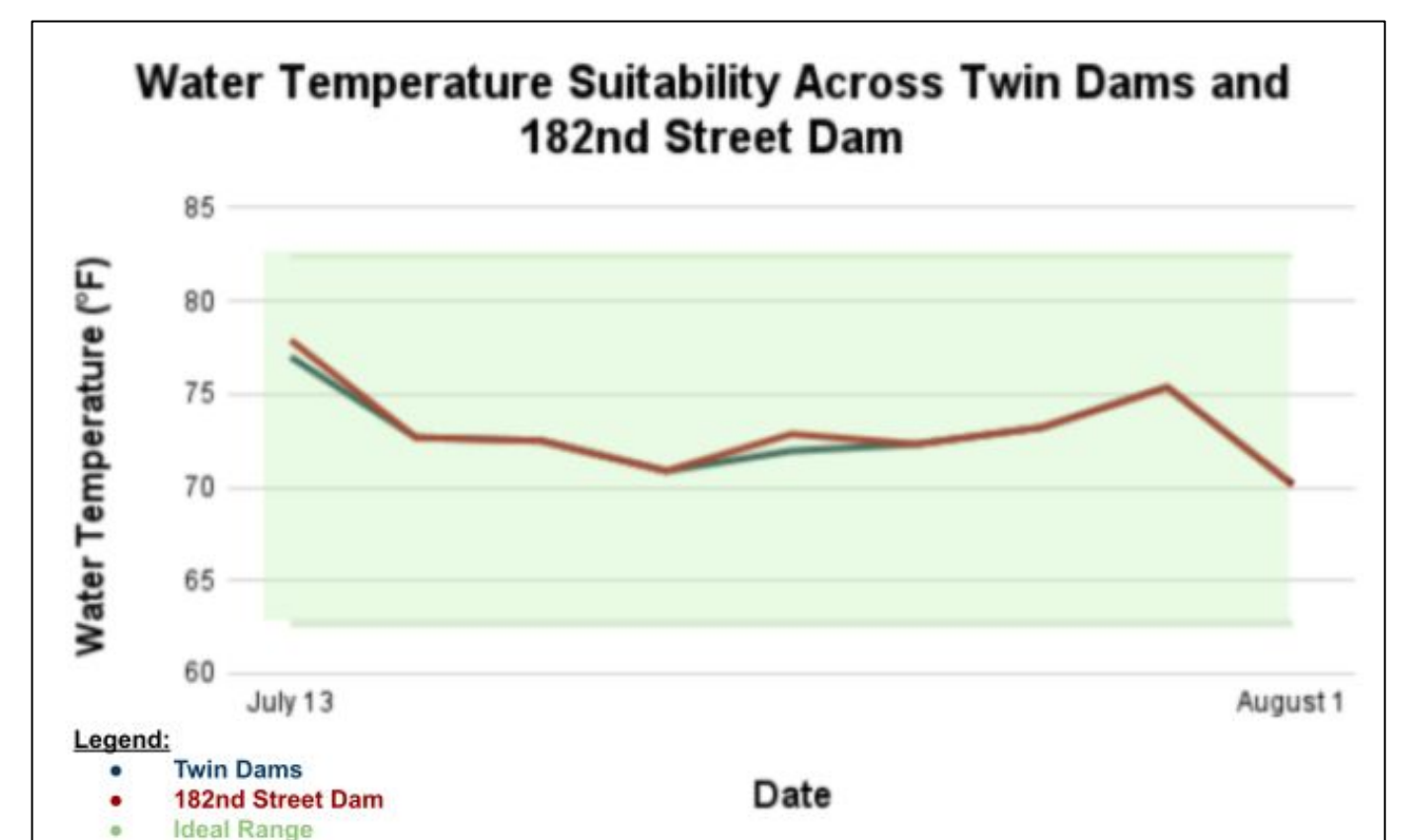


Figure 3. Collected water temperature (°F) in comparison to ideal temperature for *A. rostrata*.

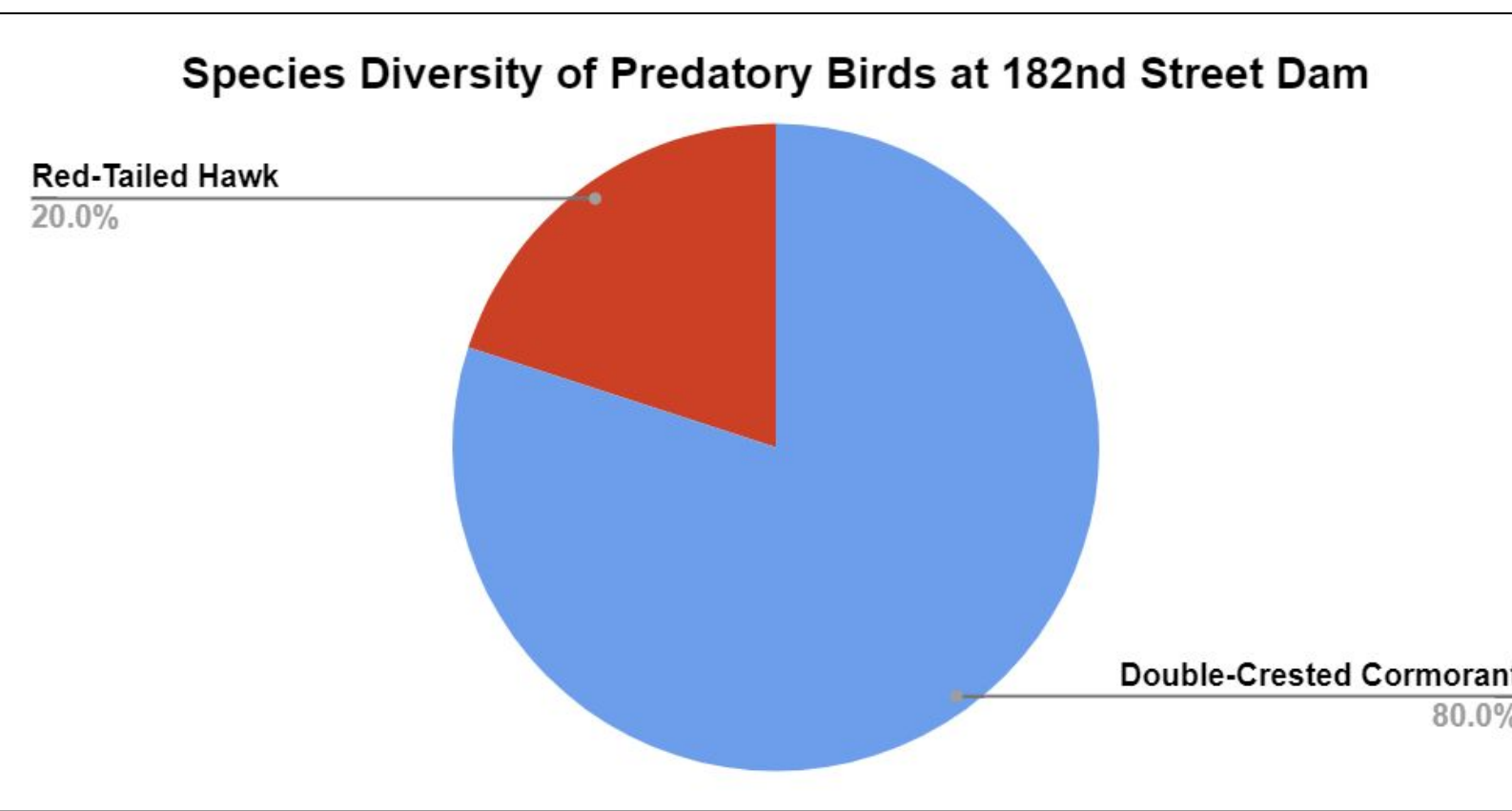


Figure 4. Diversity in all recorded species of predatory birds at 182nd Street Dam.

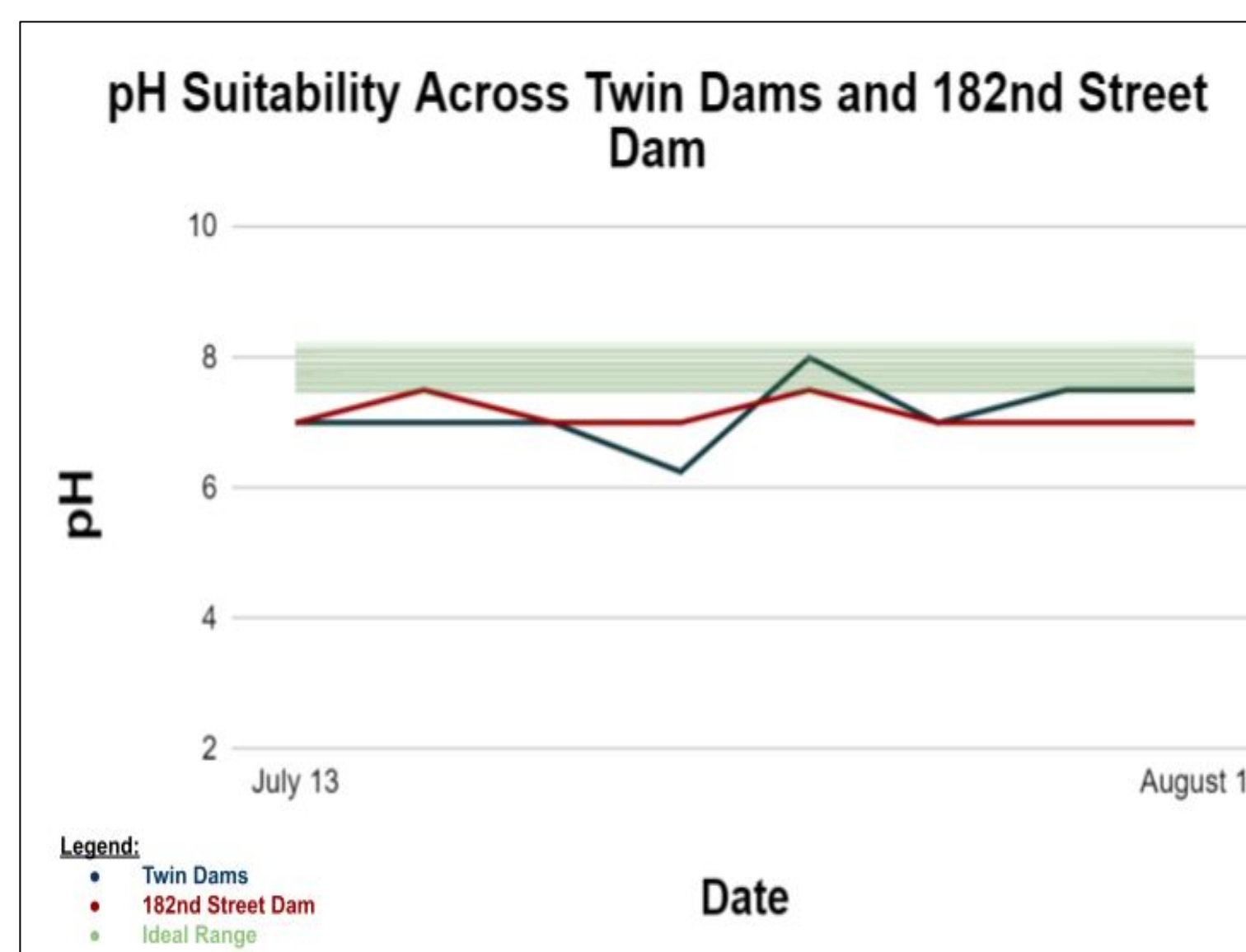


Figure 5. Collected pH at both sites in comparison to ideal pH for *A. rostrata*.

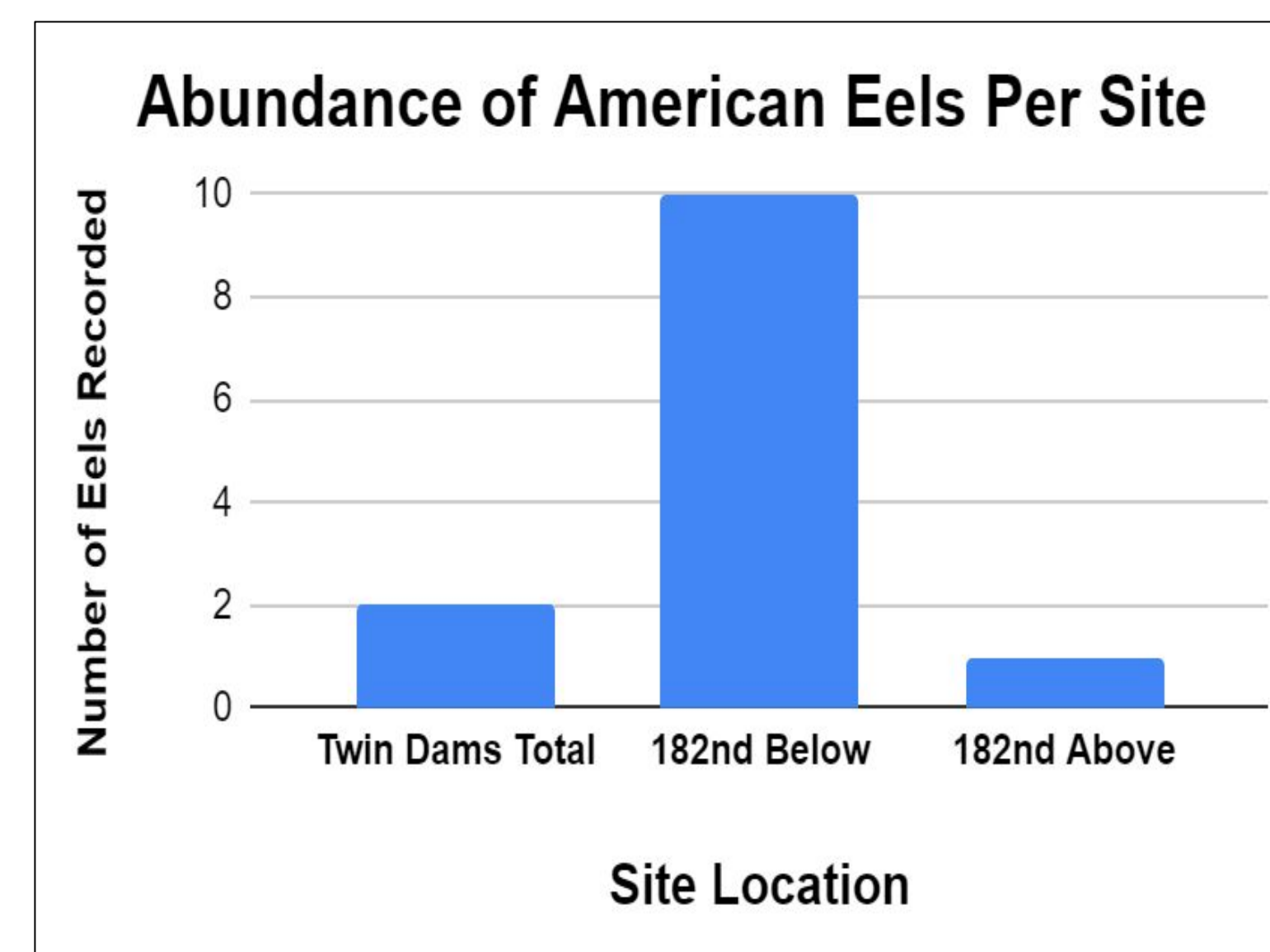


Figure 6. Total *A. rostrata* recorded at both Twin Dams (below the dam) and the 182nd Street Dam (both above and below the dam).

pH	DO (mg/l)	Temperature (°F)	Predators	Habitat Suitability		
				Bad	Good	Ideal
7.5 - 8.2	6 - 8.5	62.6 - 82.4	None			✓
7.16	9.07	72.9			✓	
7.13	9	73.1			✓	

Figure 7. Table comparing recorded habitat data to what is considered ideal for American eels, and ranking the suitability of each site.

Conclusion

pH: During our research period of three weeks, the pH level of the water samples taken from Twin Dams had an average of 7.16. The pH at 182nd stayed relatively stable, with an average of 7.13. The suitable pH for eel survival is 7.5 - 8.2, which suggests that the average pH of the river was slightly lower than what would be ideal for eel habitat.

Dissolved Oxygen: Between July 13th and August 1st, the recorded dissolved oxygen (DO) level at the Twin Dams remained stable, with an average of 9.07 mg/L. At 182nd, the average was 9 mg/L. The suitable DO for eel survival is 6-8.5 mg/L, which suggests that the average DO at our sites was slightly higher than what would be ideal for eel habitat.

Temperature: The water temperature for Twin Dams was initially 77°F (25°C) on the first day, but throughout data collection, it averaged 72.9°F (22.7°C). The 182nd temperature started at 77.6°F (25.33°C) but averaged 73.1°F (22.8°C). Both temperatures steadily decreased by August 1st to 70.16°F (21.2°C). These temperatures fell within *A. rostrata*'s ideal water temperature range of 62.6°F - 82.4°F (17°C - 28°C).

Predators: A total of 17 predatory birds and 4 mammals were observed across all point count and camera trap surveys. The double-crested cormorant (*Phalacrocorax auritus*) was the most frequently observed bird, with a total of 4 observations. Other birds included the great blue heron (*Ardea herodias*), osprey (*Pandion haliaetus*), red-tailed hawk (*Buteo jamaicensis*) and great egret (*Ardea alba*). We detected 4 species of mammals on the camera traps, including coyotes, squirrels, raccoons, and skunks. Carp were not seen very often in the river, with a total of four observations.

Discussion

Based on our study of the eel population in the Bronx River, we found that eel abundance was higher at the 182nd Street Dam in comparison to the Twin Dams. Our findings support our hypothesis that, with a higher habitat suitability, there will be a higher abundance of *A. rostrata*. Habitat suitability was determined using five variables: (1) physical barriers - dams, (2) average water temperature, (3) predator abundance, (4) average pH and (5) average dissolved oxygen (DO).

At 182nd, most of the eels were caught below the dam (n=12), which further supports findings that physical obstructions like dams inhibit eel migration upstream.³ For both sites, the average temperature lay within the suitable range for eel survival.⁴ The presence of predators at both sites may have decreased the habitat suitability, leading to fewer eels being found.¹ More predators were observed at Twin Dams compared to 182nd, which may have contributed to the lower eel abundance. (4) We found that the pH between the two sites had a difference of 0.03, but due to time constraints, we were unable to calculate this statistical significance. A lower pH could be attributed to acid rain. Based on previous studies, elvers were unaffected by pH levels as low as 4.0, which suggests that the increased acidity of the water does not affect the habitat suitability for young eels.⁹ Our average recorded DO levels for both sites were higher than the suitable range for *A. rostrata*.⁴ However, in unpolluted waters, the average dissolved oxygen level can be as high as 10 mg/L, so further research is needed to determine the extent to which suboptimal DO levels affect the health and movement patterns of eels.

Variation in our data points can be explained by errors in data collection. Elevated DO levels could be attributed to the time it took between collecting the water samples and conducting the DO tests back at the lab. Temperature fluctuation could also be a factor, where colder temperatures lead to a higher dissolved oxygen.¹¹ Another challenge was heavy rain, which disturbed the mops, and could have led to a lower eel count. Furthermore, a loss of camera traps due to theft at 182nd may have skewed the predator count.

The variables measured in this study were only four of many that might have affected American eel populations and migration in the Bronx River. In future studies, factors that should be monitored include micro and macro plastics, air pollution, and further effects of urbanization. We hope that this study will serve as a foundation for future research that may eventually build more complex habitat suitability models for American eels in the Bronx River. This information can aid with studying the effect of pollution on aquatic wildlife and how to help them adapt around human disturbance.

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