

Great Blue Heron Foraging Behavior and Strike Rate on San Juan Island, WA

Emily Clark^{1,2}
Kaitlan Harbaugh^{1,2}
Justine Jadallah^{1,2}

Ecology and Conservation of Marine Birds and Mammals
(*Summer 2021*)

¹Friday Harbor Laboratories, University of Washington, Friday Harbor, WA 98250

²College of the Environment, University of Washington, Seattle, WA 98195

Contact Information:

Emily Clark

clarkem797@gmail.com

Kaitlan Harbaugh

kaitl98@uw.edu

Justine Jadallah

jadalj@uw.edu

Authors contributed equally to this manuscript

Keywords: Great Blue Heron, *Ardea herodias*, feeding behaviors, strike, False Bay, Griffin Bay

Abstract

Pacific Great Blue Herons (*Ardea herodias*) are large wading birds with ranges throughout many parts of the coastal United States of America, including off of the Washington coast. Although these birds display a variety of feeding behaviors such as standing and walking slowly that are used for catching different prey types, these behaviors are poorly known in the literature. To address this knowledge gap, we wanted to explore how these behaviors vary with tide height, tide phase, strike frequency and success. To compare behaviors in different habitats we chose two study sites, Griffin Bay and False Bay, which were rocky intertidal habitat and sandy tidal flat habitat respectively. Through our focal individual sampling, we found that at both sites Great Blue Herons spent most of their time standing and walking slowly. At Griffin Bay, the herons we observed both struck more per minute and were more successful at catching prey compared to False Bay, potentially due to the larger invertebrate prey availability in the rocky substrate at Griffin Bay. Additionally when looking at tide heights and phases, we found that the herons struck more in the ebb tidal phase but had lower successful strike rates in ebb tide. Our findings suggest a need for further research into the feeding behaviors of the Pacific Great Blue Herons, specifically with regards to different habitat types and feeding success.

Keywords: Great Blue Heron, *Ardea herodias*, feeding behaviors, strike, False Bay, Griffin Bay

Introduction

The Pacific Great Blue Heron is a subspecies of the Great Blue Heron (*Ardea herodias*), a large wading bird in North America. Their range stretches from Alaska to Washington (Stach 2016). In a study conducted by Vennesland and Butler (2020), they established that during the breeding season these birds forage mainly along the sea coasts in open water and estuarine wetlands, along with occasionally foraging in seaweed patches, though there is little knowledge in the literature about habitat in other seasons. Pacific Great Blue Herons are known to have different foraging strategies for specific habitats when catching different prey items. They stand and walk slowly when trying to stalk prey in order not to disturb the prey. In contrast, they walk quickly and run when trying to flush prey. Studies have shown that these birds walk slowly when trying to catch bottom-dwelling fish and small invertebrates. On the other hand, they stab larger fish with their beaks or hit them against nearby rocks to subdue their prey. For their diet, Great Blue Herons are not limited to fish and small invertebrates. They will eat almost anything within striking distance, including amphibians such as frogs, reptiles such as salamanders, and small mammals (Vennesland and Butler, 2020).

Great Blue Herons eat a variety of different foods and use different foraging strategies for their prey, but their feeding behaviors are not well studied. Given this knowledge gap in the literature, we centered our research on feeding behaviors, specifically looking at strike rates and success rates in different habitats through focal individual sampling. Given that prey availability is influenced by tide heights, we also wanted to look at how tides affected their feeding behaviors. A previous study by Buchanan (1990) established that foraging success for Great Blue Herons isn't influenced by tide height. Additionally, previous student studies confirmed that Griffin Bay had more total strikes and successful strikes and that foraging is more successful

during high tides compared to False Bay. For our study, we wanted to address the gap in the literature related to feeding behaviors in different habitat types and tide behaviors for the Pacific Great Blue Heron.

Methods

Location

We studied Great Blue Herons at False Bay, San Juan Island and at Griffin Bay, San Juan Island. False Bay is a 225-acre area on the west side of San Juan Island consisting of sandy intertidal flats. We chose this site because we wanted to study human disturbance and it is a tourist destination.

Griffin Bay is a large bay on the eastside of San Juan Island. We studied only a small section of the shore from Old Town Lagoon to Jakle's Lagoon where we observed all herons within eyesight. It has a rocky shoreline and is more secluded than False Bay.

Survey Methods

Our study took place from 10–13 August 2021. We spent 11 hours at each site, arriving 2–3 hours before low tide and leaving 2–3 hours after low tide. We used focal animal sampling, in which we numbered the herons and used a random number generator to pick which herons we observed that were within site. When we observed a minimum of two herons during a given sampling period, we had two observers and one recorder. The observers would use either one scope and one pair of binoculars or two scopes at a time depending on the distance between the observers and the heron and the equipment available. We conducted observations using 15-45x spotting scopes and 10x42 binoculars.

We observed each animal for 20 minutes and recorded individual behaviors every 20 seconds. The behaviors recorded were based off a paper detailing different foraging methods for Great Blue Herons (Kushlan, 1976). We also opportunistically recorded successful strikes, unsuccessful strikes, and disturbances at the time they happened to the focal animal. If a heron flew away or we weren't able to locate the heron in a group, we stopped the observation. If we observed the same heron multiple times we waited 20 minutes between each sample. For 36 of the 50 samples we gathered, we recorded an abundance survey at the start of every observation.

Analysis

We assessed the mean percentage of time the herons spent exhibiting each behavior and divided the herons by location. We also analyzed the relationship of mean total strikes to tide height, tidal phase and location. We determined tide information by comparing the time and dates we recorded to the tide charts on National Oceanic and Atmospheric Administration's (NOAA) website. We used Kanaka Bay, San Juan Island as an indicator for tides at False Bay and Friday Harbor, WA as an indicator for Griffin Bay since NOAA does not have data for False Bay and Griffin Bay specifically. We also compared our abundance data with time of day.

Results

Behavior

We gathered 50 samples; 32 at False Bay and 18 at Griffin Bay. Combined, the herons spent $83.8 \pm 26.1\%$ of their time standing or walking slowly. The biggest differences between the two sites was that herons stood 35.7% more at Griffin Bay than False Bay and walked slowly 26.9% more at False Bay than Griffin Bay. At both of the sites they spent very little time walking

quickly. Another big difference was that the herons flew 675% more and performed maintenance 2533.3% more at False Bay than at Griffin Bay (Fig. 1). Although we recorded disturbances opportunistically, we did not gather enough data to analyze the disturbances and draw a conclusion from them.

Strike Rate and Successful Strike Rate

We compared strike rate (mean strikes/min) and successful strike rate (mean successful strikes/min) to tide height, tidal phase, and location. We split the tide height into $< 2\text{ft}$ and $\geq 2\text{ft}$ because it was the median of the tide heights we observed in our study (-0.74 – 4.33 ft). We found that herons had slightly more successful strikes when the tide was greater than or equal to 2 ft (Fig. 2).

We also compared tide phase with strike rate and successful strike rate and found that while herons struck more during ebb tide, they had a higher successful strike rate during flood tide (Fig. 3).

The last variable we considered for strike rate and successful strike rate was location. In this regard the herons at Griffin Bay had higher rates. They struck at more than double the rate of the herons at False Bay and they successfully struck at almost quadruple the rate of the herons at False Bay (Fig. 4).

Abundance

Although abundance was not the main focus of our study, we did abundance surveys for 35 of the 50 observations. We found that as the day continued, there was a slight decrease in the amount of herons present (Fig. 5).

Discussion

Behavior

Our first finding, that herons spent most of their time walking slowly or standing, was expected. Heron foraging behavior, specifically the tendency of herons to stand still or walk slowly toward their prey before striking, explains why we would have seen an abundance of birds standing or walking at foraging sites. The observed 35.7% more standing at Griffin Bay could be related to the type of prey available based on substrate. The section of Griffin Bay that we surveyed has a lot of rocks, which can shelter many invertebrates. The birds use their eyes to sense prey, which means that they may need to stand more still to see any camouflaged invertebrates. Additionally, the uneven ground may have made it harder for the birds to walk smoothly without alerting prey, which could explain the difference in standing behavior between sites. The observed 26.9% more walking at False Bay can also be explained by prey availability. False Bay during the times we observed (late ebb and early flood tides) had a lot of very shallow and sheltered intertidal areas. Nektonic fishes tend to shelter in shallow, isolated areas during lower tides in order to avoid predatory fishes (Rieucan et al. 2015). One reason a heron might walk while foraging is to flush prey from where they are hiding and make them more easy to spot. The birds in False Bay may have been attempting to flush sheltered fish from where they hid so they could forage more efficiently.

The other main behavior difference we saw between sites was an increase in maintenance at False Bay compared to Griffin Bay. While False Bay had a lot of intertidal flats for the herons

to use for foraging, the site also had rocks further away from shore on which the birds spent time. When standing on the rocks, the birds did not spend time foraging and instead were either standing or preening, which we recorded as a maintenance behavior. Great blue herons have been observed differentiating between foraging habitats and non-foraging habitats, in which the non-foraging habitats are used for loafing behavior and social interaction (Buchanan 1990). The same study also noted that loafing behavior consisted mostly of preening, which is what we observed as well. Most likely, the herons use the tidal flats in False Bay as a foraging habitat while saving the rocks as a non-foraging habitat. The lack of non-foraging habitat available at Griffin Bay would explain the discrepancy between the two sites.

We did observe a greater amount of flying at False Bay, but we could not discern the reason behind this difference.

Strike Rate and Successful Strike Rate

When examining patterns between strike rate and success rate between tide heights, we observed the most clear difference between tides that were $\geq 2\text{ft}$, and $< 2\text{ft}$. 2ft was selected as the dividing height because it was the rough median value of our data. While we did observe a slightly greater success rate at tides greater than or equal to 2ft, the mean difference was only 0.03 strikes/minute. It is possible that the higher tide heights had an influence on strike success rate, but it is unlikely to be significant.

The second observation was that while the herons struck more during ebb tides, they had a greater success rate during flood tides. We hypothesize that the ebb tides revealed a greater number of invertebrates as the tide retreated, but the herons may have struggled to catch the invertebrates more than the fish due to invertebrates being smaller and more camouflaged. During flood tides, the rising tide height may have made the foraging area more habitable for fish, which could be easier for the birds to spot and catch because of their size and/or coloring.

Finally, we observed a greater strike rate and a greater strike success rate at Griffin Bay than at False Bay. One possible reason for this difference is the amount of prey available at Griffin Bay. If the site had more prey available for any reason (productivity of the bay, tidal currents and upwelling bringing more prey), then the herons could be more successful. A prey survey between the two sites could provide more information.

Abundance

Although abundance was not the main focus of our study, we did observe a decline in the number of herons during the later hours of the day. We do not have an explanation for this, other than the herons may have been returning to their nesting sites in the afternoon/evening, either related to time of day or tidal current impacting prey availability.

Limitations

The study did have a few limitations. We had a limited amount of time to conduct observations which led to 50 samples collected over four days. A small sample size created large variation between points, leading to a standard deviation that often exceeded the associated mean. A short survey period also means that our data may not be representative of interseasonal

or interannual habits of great blue herons due to influence from the spring-neap tide cycle and moon phase between months (Calle et al. 2016). Finally, wildfire smoke may have complicated the data collection process and could have influenced the herons' behavior in ways we could not account for without further observation.

Conclusion

Future Research

In the future, we recommend this study is replicated over a longer period of time to allow for more samples to be collected and more confounding factors to be considered. Weather conditions, specifically conditions that occlude sunlight, may impact the herons' foraging success (Bovino and Burt 1979). The time of day may also have an impact on the herons' behavior, as other subspecies of great blue heron have been observed foraging at night (Black and Collopy 1982).

A study focusing on prey consumption may also provide greater insight into the foraging patterns that herons exhibit between sites or conditions. Looking at the prey size, as well as the preference between invertebrates and fishes, could reveal some additional correlations between foraging behaviors and site conditions.

As with many species, studying how aspects of global warming impact the birds' ability to survive is crucial to understanding potential changes to the species in the future. Availability of prey, in conjunction with information about prey preference, could be coupled with an energetics model to see if the Junk Food Hypothesis observed in some seabirds and mammals could impact herons (Grémillet et al. 2008). Annual wildfires in the Pacific Northwest create smoky

conditions that could impact birds' survival, and could also contribute to sunlight occlusion that might impact their strike success (Bovino and Burt 1979). Overall, research to see how the herons' can adapt to a changing climate will give a more well-rounded idea of how the species might change over time.

Finally, there have been case studies on individuals of the same or similar subspecies using bread to bait fish, or sticks to lure them in order to increase their strike success (Zickefoose and Davis 1998; Evans and Jackson 2019). These behaviors may not be observed frequently enough to warrant study, but recording observations of unique behaviors may indicate development of strategies using tools in the future.

Acknowledgements

We would like to thank our professors Breck Tyler and Eric Anderson for their guidance throughout the research project. We would also like to thank our teaching assistant Maria Kuruvilla for providing transportation and additional guidance, as well as acting as our advisor throughout this process. Lastly, we would like to thank Friday Harbor Laboratories for providing the equipment, facilities, and other necessary resources we needed to complete this project.

We acknowledge that we gathered and conducted our research on the traditional territory of the Á,LENENEÇ ŁTE (WSÁNEĆ), Coast Salish, Lhaq'temish (Lummi), Samish, S'Klallam, and Tulalip peoples (Native Land).

Literature Cited

- Black, B. B., and M. W. Collopy. 1982. Nocturnal Activity of Great Blue Herons in a North Florida Salt Marsh on JSTOR. *Journal of Field Ornithology* 53:403–406.
- Bovino, R. R., and E. H. Burt. 1979. Weather-Dependent Foraging of Great Blue Herons (*Ardea herodias*). *The Auk* 96:628–630.
- Buchanan, S. C. (n.d.). Habitat utilization by great blue herons (*Ardea herodias*) in Elkhorn Slough, California. M.S., San Jose State University, United States -- California.
- Calle, L., D. E. Gawlik, Z. Xie, L. Green, B. Lapointe, and A. Strong. 2016. Effects of tidal periodicities and diurnal foraging constraints on the density of foraging wading birds. *The Auk* 133:378–396.
- Evans, B. A., and A. E. Jackson. 2019. Artificial lure use by a Great White Heron (*Ardea herodias occidentalis*) in south Florida. *The Wilson Journal of Ornithology* 131:171–173.
- Grémillet, D., L. Pichegru, G. Kuntz, A. G. Woakes, S. Wilkinson, R. J. M. Crawford, and P. G. Ryan. 2008. A junk-food hypothesis for gannets feeding on fishery waste. *Proceedings of the Royal Society B: Biological Sciences* 275:1149–1156.
- Kushlan, J. A. 1976. Feeding Behavior of North American Herons. *The Auk* 93:86–94.
- Native Land. (n.d.). Land Acknowledgement. <https://land.codeforanchorage.org/>.
- Rieucou, G., K. M. Boswell, M. E. Kimball, G. Diaz, and D. M. Allen. 2015. Tidal and diel variations in abundance and schooling behavior of estuarine fish within an intertidal salt marsh pool. *Hydrobiologia* 753:149–162.
- Stach, M. 2016. Abundance and Behavior of Great Blue Herons on San Juan Island. University of Washington. Unpublished.

Vennesland, R.G and R.W Butler. 2020. Great Blue Heron (*Ardea herodias*). Birds of the World (A.F Poole, editor). Cornell Lab of Ornithology, Ithaca, NY, USA.

Willard, D. E. 1977. The Feeding Ecology and Behavior of Five Species of Herons in Southeastern New Jersey. *The Condor* 79:462–470.

Zickefoose, J., and W. E. Davis. 1998. Great Blue Heron (*Ardea herodias*) Uses Bread as Bait for Fish. *Colonial Waterbirds* 21:87–88.

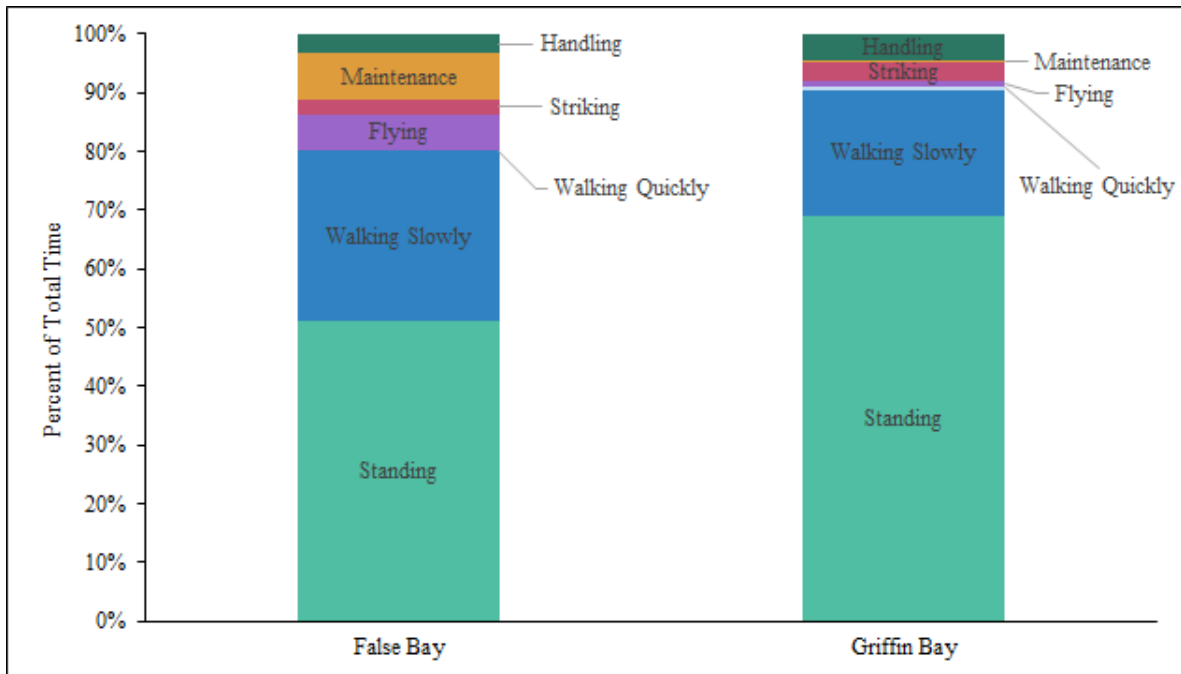


Figure 1. Mean percentage of time Great Blue Herons spent doing each behavior at False Bay and Griffin Bay from 10–13 August 2021.

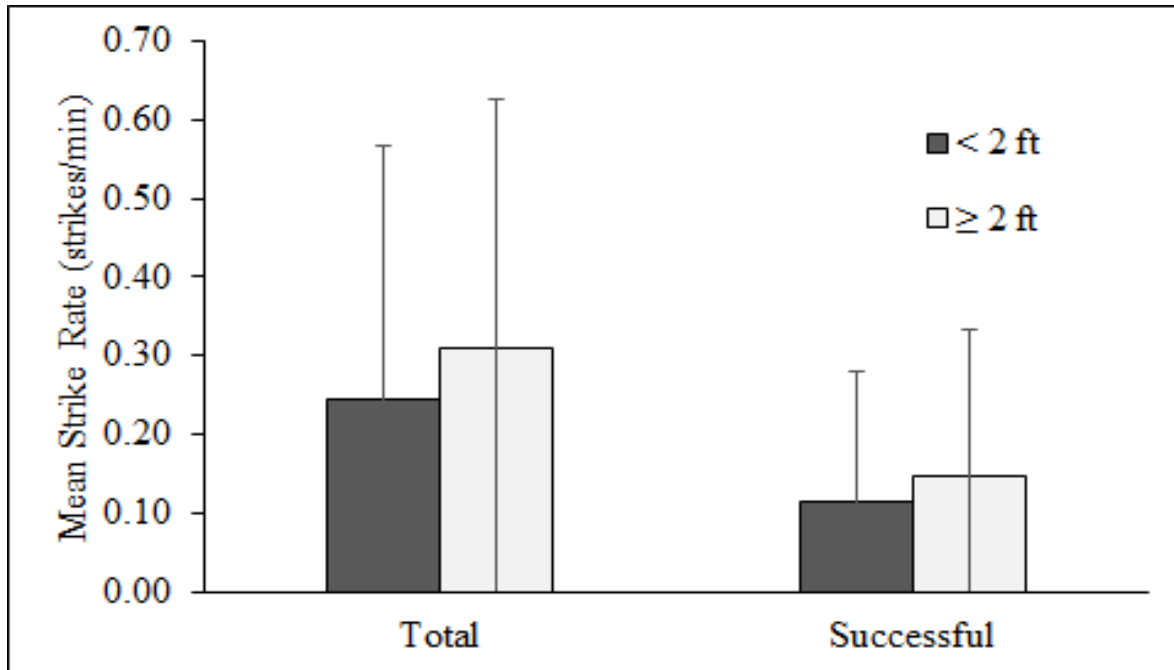


Figure 2. Mean number (± 1 SD) of strikes/minute and mean number of successful strikes/minute at tide greater than 2 feet compared to tide less than two feet. Data combined from False Bay and Griffin Bay from 10–13 August 2021.

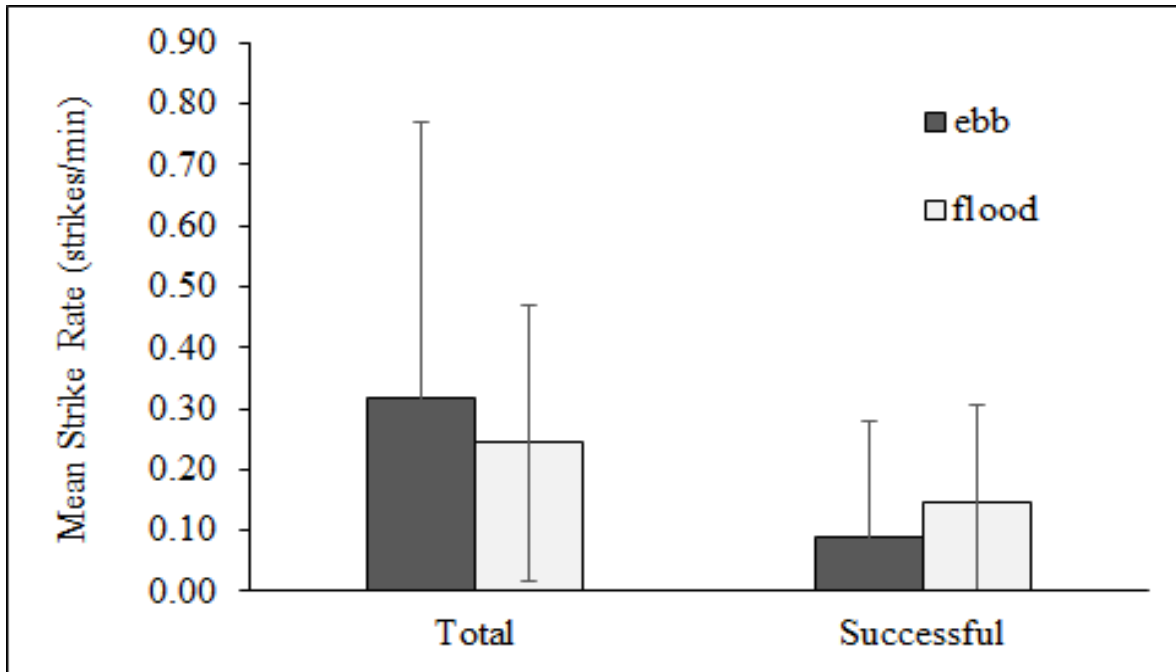


Figure 3. Mean number (± 1 SD) of strikes/minute and mean number of successful strikes/minute at ebb tide compared to flood tide. Data combined from False Bay and Griffin Bay from 10–13 August 2021.

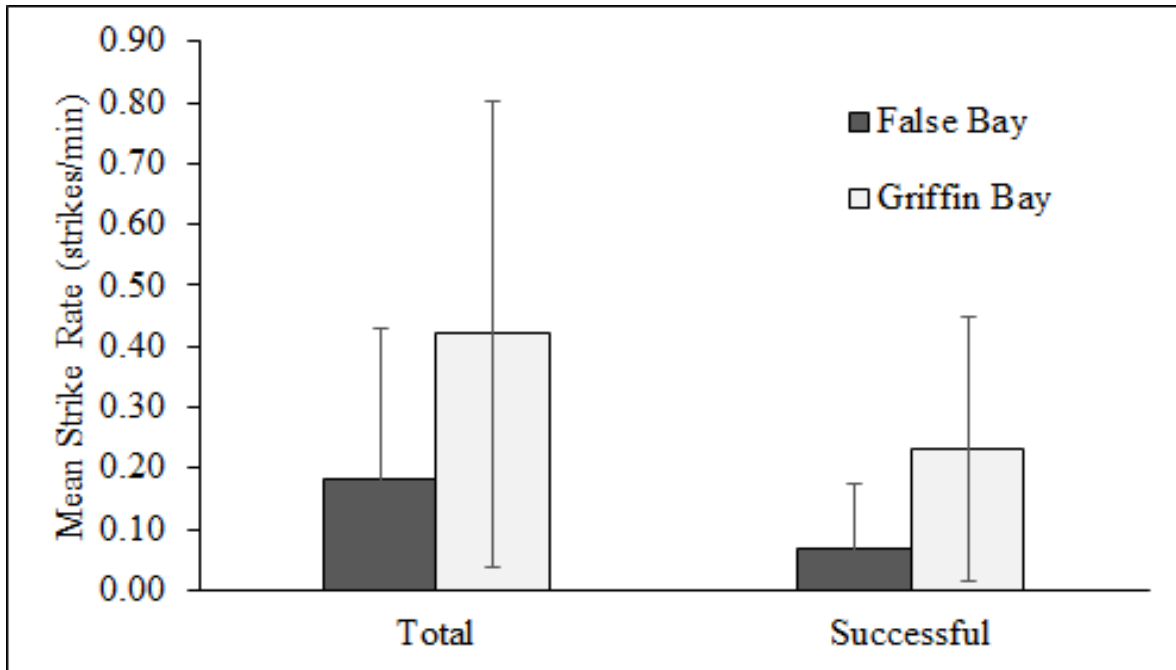


Figure 4. Mean number (± 1 SD) of strikes/minute and mean number of successful strikes/minute at False Bay compared to Griffin Bay. Data gathered from 10–13 August 2021.

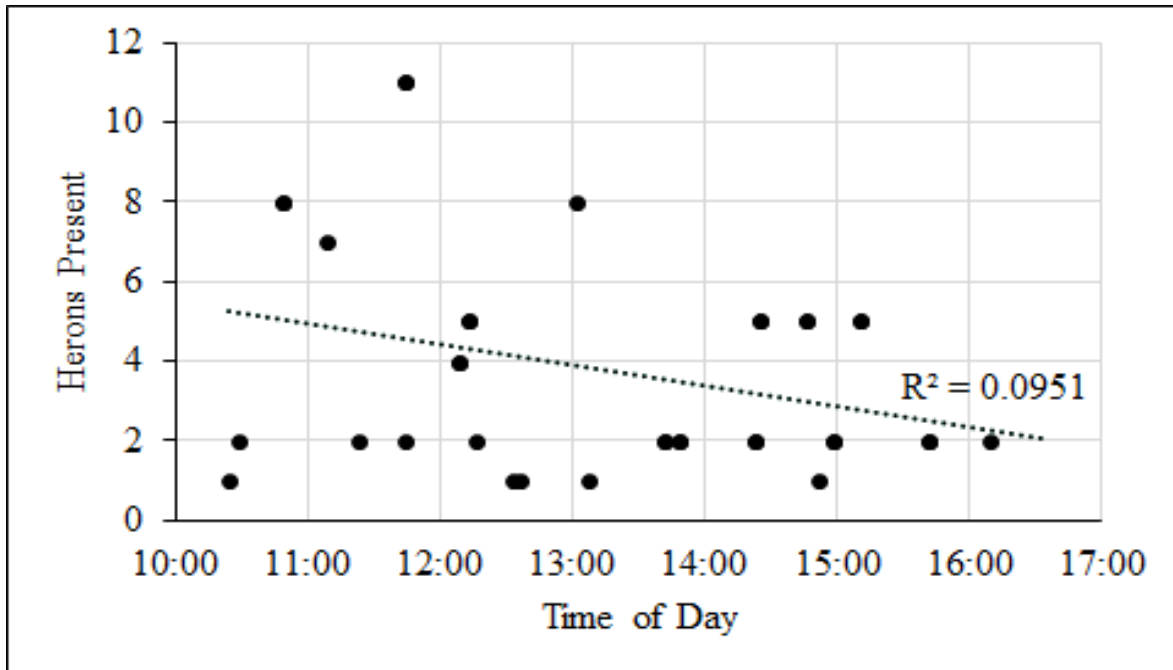


Figure 5. Abundance of herons contrasted with time of day. Data combined from False Bay and Griffin Bay from 10–13 August 2021.