Foraging Behavior and Success in Great Blue Herons (*Ardea herodias*)
at False Bay, San Juan Island

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Ecology and Conservation of Marine Birds and Mammals

(*Summer 2025*)

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Abstract:

The great blue heron (*Ardea herodias*) is a widely distributed marine bird found throughout North America, residing in large colonies. Resident colonies wade in salty and brackish systems, foraging for smaller fish and invertebrates. They are visual hunters, relying on shallow tides to stalk and strike prey. Over the course of three days, we monitored the local colony at False Bay, WA, recording foraging behavior as well as individual strike rates and success. Our results indicate that herons do not engage in cooperative foraging and prefer to feed solitarily. We found that the strike rate was higher in solitary individuals, but success was even between both groups. We suggest this is due to higher intraspecific competition when tidal heights limit foraging opportunities. The energy content of their specific prey may also factor into strike rate, increasing the rate as nutritional density decreases. Great blue heron foraging behavior impacts the estuary through the top-down trophic control, managing the abundance of primary consumers and allowing for eelgrass growth. Lastly, further research is needed to determine whether the False Bay population is a part of a special concern subspecies, *A. h. fannini*. These findings support the conservation efforts focusing on False Bay and the importance of foraging behavior of great blue herons.

Keywords: Great blue heron, *Ardea herodias,* Foraging, Strike Rate, Strike Success, San Juan Island

Introduction:

Great blue herons (*Ardea herodias*) are a large wading bird found throughout North America. They are found on bodies of water, both fresh and salty, commonly near the shores of open water and in wetlands, marshes, swamps (American Bird Conservancy). The Puget Sound is highly productive and holds the highest concentration of great blue herons (GBH) on the West Coast.

During breeding season, these birds form large flocks in reproductive centers, known as rookeries (Eissinger 2007). These centralized locations of herons may serve as information centers, where birds may learn about successful feeding areas. These large aggregations of birds may also serve as an antipredator device, through the swamping effect (Krebs 1974). On San Juan Island, there are no known active rookery sites. However, herons have been observed to form small flocks and roost together at night outside of the central nesting sites. Chapman (1901) described a subspecies of GBH, the Pacific great blue heron (*A. h. fannini*), found from southern Alaska to Washington. In British Columbia, the subspecies is declining and listed as Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Seasonality plays a significant role in their distribution, but herons that forage in saltwater habitats are limited by tidal heights (Peterson & Marzluff, 2025). Since the GBH cannot swim, their foraging is limited by leg length–they stand about 1 meter high, with their legs accounting for a third of their height. They also forage along shorelines exposed by low tide, such as in the algae. A unique foraging habitat of herons on the Pacific coast is the use of kelp beds, which provide a platform the bird can stand on (All About Birds). The GBH has two primary hunting techniques, *stand and wait*, where the bird stands motionless waiting for motion by prey, and *walk slowly*, where the heron moves slowly, stalking prey. They use visual detection to locate prey (Kushlan 1976). Once the bird detects prey, it strikes by extending its neck rapidly in a spear-like thrust to grab prey (American Bird Conservancy). Once the prey is caught, the bird shakes its head to rotate the prey before swallowing it (Krebs 1974).

We chose to study the GBH foraging behavior in False Bay, WA, to understand how birds from the same roosting flock interact when hunting. Because False Bay has been known to host a local flock of herons, we predicted that herons within the same flock would cooperate when foraging. We expect to see larger feeding groups, more herons to be within close proximity of one another, the herons within close proximity have a greater strike success rate, and that we would observe cooperative foraging behavior in some regard. Specifically, we determined how group feeding dynamics impact the foraging success rates in this flock. The specific objectives of our study were (i) determine whether herons forage solitarily or in close proximity groups, (ii) determine whether strike success rate differs between herons in solitary and close proximity groups.

Methods:

Study Site:

We conducted our study from August 11 to August 13 at False Bay Biological Preserve on San Juan Island, Washington. False Bay is a unique environment with a shallow bottom of sand and mud. At low tides, the bay is almost empty, allowing for herons to forage in these conditions (University of Washington). We surveyed the southeastern side of the bay from 48°29'13.0"N 123°04'28.1"W to 48°29'00.6"N 123°04'21.2"W (Figure 1). This part of the bay consisted of silty mud and *Ulva*, a type of green algae. The *Ulva* in this area houses many prey, allowing for GBHs to forage (University of Washington).

Sampling Methods:

The two factors we observed were group dynamics and foraging attempts. We first checked the NOAA tide charts for Kanaka Bay which provided the tidal conditions for the western side of the island. We started making observations roughly an hour before the low tide. We used a Celestron Ultima 80 spotting scope on 60x magnification and a pair of Bushnell 10x42 binoculars. Group dynamics were observed through 2-minute interval scan sampling surveys. A GBH was determined to either feed solitarily or in a group. We used the parameter of 2 heron lengths apart (~2 meters) to group herons in close proximity. Anything greater than 2 heron lengths apart was considered solitary feeding.

Feeding attempts were observed through continuous scan sampling. We recorded all strikes made by the GBHs, both successful and unsuccessful. A strike was successful if the prey was visible in the heron's mouth or if the head shaking behavior was seen. If neither of these factors were observed, we considered the strike unsuccessful.

Data Analysis:

To assess group dynamics, we calculated the mean percentage of GBHs in solo and close groups. Using Excel, we calculated the standard error and ran a t-test with unequal variance. To assess feeding attempts, we counted the number of strikes and calculated the strike rate. We also calculated success rate by counting the number of successful strikes and divided them by the total number of strikes. Like the previous analysis, we calculated the standard error and ran a t-test.

Results:

Solo or Group Feeding:

We found more herons to be feeding solitarily than in a group. Based on our sample of ~3.67 herons a day, we found that 92.57% $\pm$ 2.44 of the GBHs were feeding solitarily, while only 7.43% $\pm$ 2.44 were feeding in close proximity (Figure 2). This result is significant because of the p-value of 3.40 E-57.

Foraging Success:

Strike rate differed between solitary and grouped herons. Solitary individuals had a strike rate of 2.01 strikes/min $\pm$ 0.55 and close group herons had a strike rate of 1.01 strike/min $\pm$ 0.82 (Figure 3). This shows that herons feeding independently will strike twice as much than herons feeding in close groups. A p-value of 0.39 shows no statistical significance.

Finally, we found that solitary herons had a 39% ± 2.86 strike success and close herons had a 39.29% ± 10.71 strike success (Figure 4). This indicates that herons had similar foraging success regardless of solitary or close feeding. Again, the p-value of 0.98 shows no statistical significance.

The number of fish caught per hour also differs between solitary and grouped herons. With 2.01 strikes per hour and a 39% success rate, solitary herons caught 47.03 fish/hour. With 1.01 strikes per hour and a 39.29% success rate, herons in close proximity caught 23.81 fish/hour. Solitary herons caught twice as much fish than those in close proximity.

Discussion:

In regards to the group foraging, our study concludes the great blue heron prefers to engage in solitary feeding. This trend, supported by statistics, is significant and opposite of what we expected due to large congregations that make up nesting sites. The prediction we made focused on roosting behavior translating over to foraging. However, the lack of herons in close proximity to one another, suggests not only the preference of independent feeding but the lack of cooperative behavior among herons. Additionally, our team observed instances of aggressive displays among individuals who were within the 2-heron length parameter. These findings are supported by the intraspecific competition that is placed on the individuals as the tide continues to limit the time period of available feeding (Peterson and Marzluff 2025). Since the herons are limited in feeding time, individuals will opt to feed alone rather than compete with another individual. This is strengthened by social dynamics seen within a colony, some individuals are more dominant and therefore create a hierarchy that translates into the feeding habitat (Forbes and Mcmackin 1984). Feeding independently allows for less competitive individuals to avoid interactions with other herons. Furthermore, this is supported by a previous study in 2019, where solitary individuals were 30% more abundant than those documented in groups and territorial displays of wing flapping were observed with close proximity herons (Aria Garrett and Kyra Woytek 2019) .The trends seen in this study, as well as similar studies, suggest a solitary feeding preference.

We predicted herons in close proximity with one another will have a higher strike and success rate, leading to increased prey capture. However, the consistent success rate regardless of foraging dynamic and increased strike rate in solitary individuals, suggests solitary individuals will catch more prey items. The solitary individuals have the ability to catch 2x the prey per hour. This increased rate of foraging is likely to balance the energetics needed for forage and get the most benefit out of each prey item. The optimal foraging theory explains the possible reasoning for increased strike rate in solitary individuals. The individuals will arrange themselves that takes into account the availability and energetics of the prey (Pyke 1984). The solitary individuals demonstrated a more frequent strike rate, however, this could be due to feeding on smaller less nutrient dense prey. This results in needing to strike more frequently with the same success rate to reach energetic demands. Furthermore, individuals in close proximity with one another could be feeding on larger more nutrient dense prey. In turn, handling time increases and the frequency of strike per minute decreases (Pyke 1984). Interestingly, two previous studies in 2019 and 2023 found similar strike success rates, ranging from 33 - 48 %, among individuals in both solitary and close proximity groups (Aria Garrett and Kyra Woytek 2019, Phoebe Berghout et al. 2023). However, in 2019, solo herons struck only 10 times per hour and groups struck 24.4 times per hour (Aria Garrett and Kyra Woytek 2019). This difference could be due to the energetics and prey availability in False Bay during that year. It is important to note, the majority of the feeding dynamic in 2019 was dominated by solitary feeding even though strike rate is slower. This flipped relationship seen in 2019 justifies the need for further studies on prey abundance and distribution within False Bay.

The resident population of great blue herons is essential to the trophic structuring within False Bay. In ecological mudflats, herons are secondary consumers and act as a top-down control on the smaller consumers such as crustaceans and small fish (Huang et al. 2015). These species feed on the developing eelgrass within False Bay that has been struggling to recover (Hoekendorf 2021). The great blue heron keeps populations of these lower-level consumers in equilibrium and maintains the trophic structuring of the system. Therefore, it is important to understand the foraging behaviors of the great blue heron to determine the population health and the future health of False Bay. Additionally, understanding the feeding of great blue herons is important to quantify the success of the population and possible threats of decline. As previously stated, the population of herons in this study may possibly be a subspecies of special concern local to the pacific northwest. Through studies conducted in British Columbia, it is understood the population of this particular subspecies is declining (Krebs 1974). Further research is needed to determine if this population in False Bay belongs to the subspecies. Considering the possibility, understanding foraging and behaviors exhibited between individuals allows conservation to be focused on the important aspects of energetics. From our study and supporting studies, it is understood individuals prefer to feed independently and do not engage in cooperative feeding. Therefore, social foraging does not need to be a consideration for conservation. Rather, resources of conservation should be placed on prey availability and habitat stability to support the recovery of the population.

Acknowledgements:

We acknowledge the Lumni, Tulalip, Samish, S'Klallam, Cayuse, Umatilla, Walla Walla, Semiahmoo, and W_SÁNEĆ nations, as well as the Hul’qumi’num Treaty Group, whose traditional lands we conducted our research on.

We would like to thank Breck Tyler for advising our research and for guiding us throughout this project. We would also like to thank Eric Anderson for his support throughout this quarter. Finally, we are grateful to the University of Washington and to the Friday Harbor Laboratories for allowing us to conduct our research and complete this project.

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Figures:

Figure 1: Map of False Bay Biological Preserve on San Juan Island, Washington. The circle shows the southeastern side of the bay where we surveyed GBHs. The blue dots indicate the exact sites where GBHs were observed.

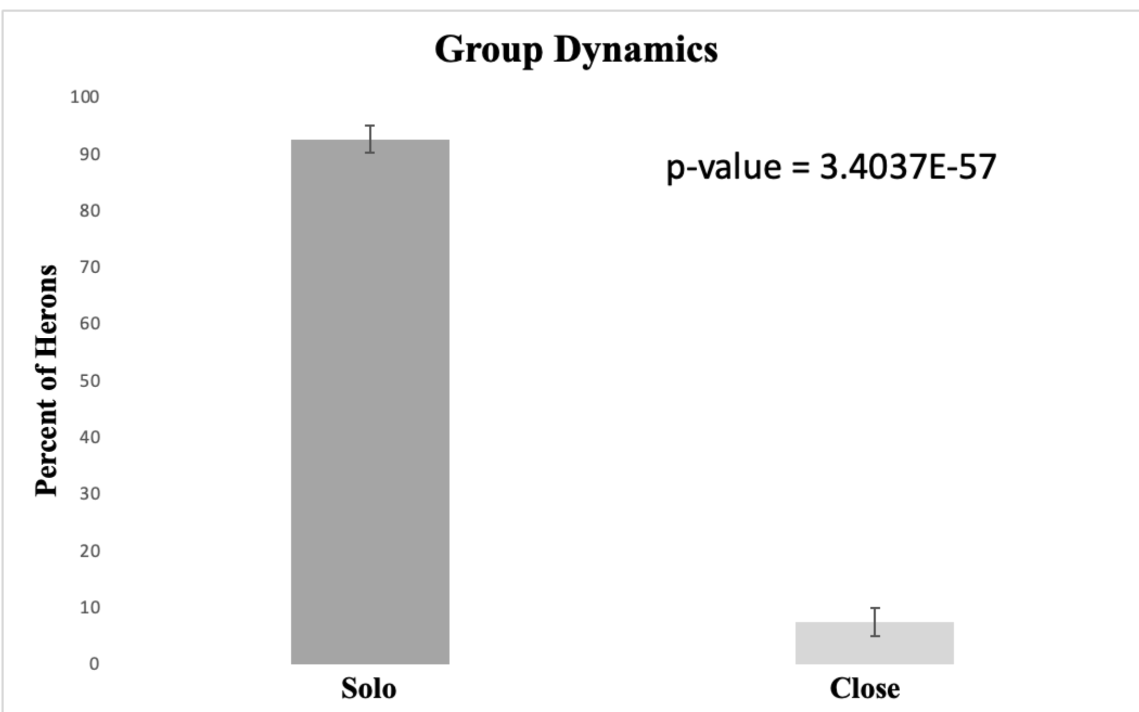

Figure 2: Group dynamics (95% CI) of GBHs in False Bay. 92.57% of herons foraged solitarily while 7.43% foraged near other herons.

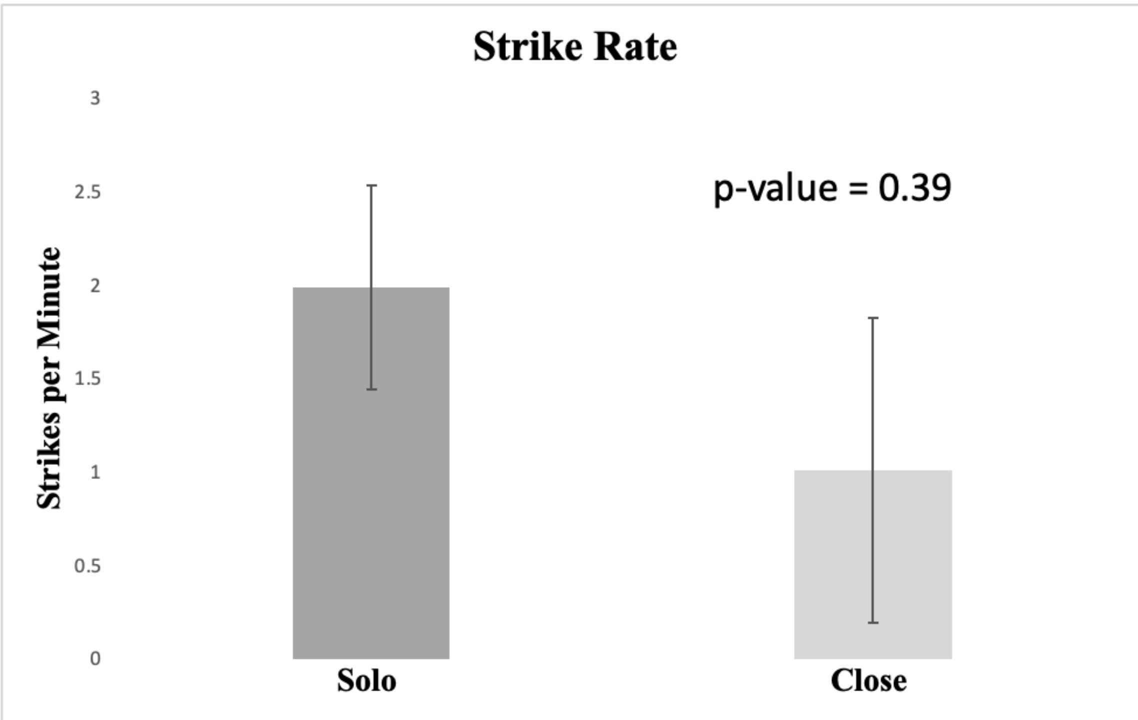

Figure 3: Strike rate (95% CI) of GBHs in False Bay. Solitary herons had a strike rate of 2.01 strikes/min. Herons in close proximity had a strike rate of 1.01 strikes/min.

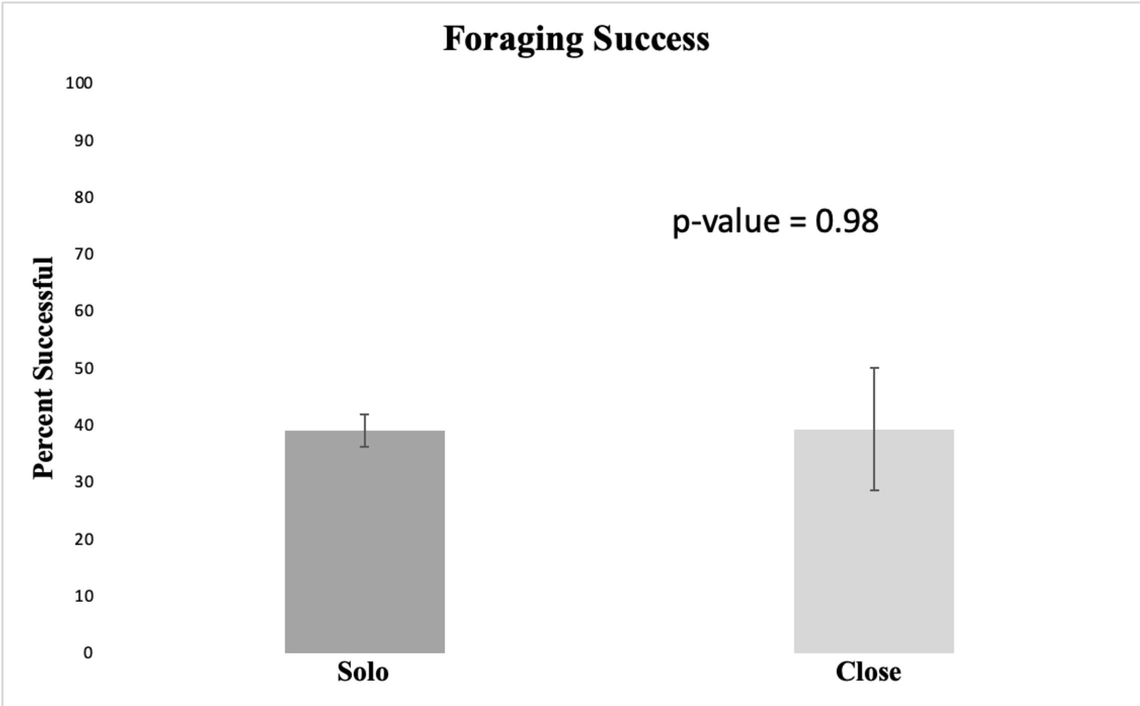

Figure 4: Foraging success (95% CI) of GBHs in False Bay. Solitary herons had 39% strike success. Herons in close proximity had a strike success of 39.29%.