Pigeon Guillemots as a Model of Maritime Urban Adapters

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Introduction

As the human population surpasses 8 billion and development encroaches at the edges of remaining wild areas, wildlife and humans are increasingly finding themselves in conflict for the same resources and, at times, even space. In the face of the sixth mass extinction, many species are being pushed to the edge of their tolerance of human presence. A paradigm has been introduced to describe three prominent categories of wildlife response to urban encroachment: urban avoiders, which cannot adapt to habitat significantly altered by humans, urban adapters, which may frequently occupy habitat overlapping with human use, and urban exploiters, which are primarily or exclusively found in conjunction with human populations (Rodewald & Gehrt 2014). Persisting in altered urban environments may place certain species under highly specific and amplified selective pressures that could alter their behavior and morphology over a short period of time (Marzluff 2012).

The Avoider-Exploiter paradigm has been applied extensively to birds (Marzluff 2012). However, this system has not been thoroughly applied to seabirds who primarily, though not exclusively, interact with humans along coastline habitat and through conflict with the fishing industry. Seabirds have been identified as ecosystem sentinels due to their high trophic level and may be an ideal taxa to study to gain insight into human impacts on coastal ecosystem functioning due to their vulnerability to the effects of bottom-up forcing (Parrish & Zador 2003). Compared to other avian taxa, seabirds are declining at an increased rate, which has been attributed partially to bycatch in commercial fisheries (Zydelis et al. 2013). Longline fisheries primarily affect seabirds

that dive into the water from the air, such as albatrosses, fulmars, shearwaters, and gulls, while gillnet fisheries primarily affect benthic diving birds of the family Alcidae, in particular the Common Murre (*Uria aalge)* (Zydelis et al. 2013, Melvin et al. 1999).

Seabirds of the family Alcidae are particularly common in the Northeast Pacific, including the Salish Sea encompassed by the state of Washington and the province of British Columbia. The San Juan Islands are located at the northern end of the Salish Sea in an area bordered by the Strait of Juan de Fuca and Vancouver Island. Strong currents and nutrient rich water originating from Alaska support a diversity of fish such as herring, salmon, and variety of benthic fish that exploit the islands' coastal habitat. This abundance also supports a commercial salmon gillnet fishery, which most often captures non-breeding Common Murres and breeding Rhinoceros Auklets (*Cerorhinca monocerata)* (Melvin et al. 1999). Another alcid native to this area, Tufted Puffins (*Fratercula cirrhata)*, are listed as Endangered in the state of Washington and have abandoned all of their nesting colonies in the San Juan Islands (Hanson & Wiles 2015). Tufted Puffins and Rhinoceros Auklets breed on small, uninhabited islands and forage offshore, typically avoiding the most densely populated island of San Juan and the tourist-filled port city of Friday Harbor. However, another species, Pigeon Guillemots (*Cepphus columba*), may be found raising chicks on the cliffsides of public parks and even within the docks of highly trafficked marinas, indicating that in contrast to other alcid species in the area, it may be an urban adapter rather than an urban avoider.

While other alcids in this area typically forage on forage fish such as sand lance and herring, Pigeon Guillemots prefer to feed on demersal fish such gunnels, pricklebacks, and sculpins (Emms & Verbeek 1991, Bishop et al. 2016). Additionally, they nest in relatively

dispersed, low-density colonies and produce broods of two eggs rather than the typical one (Emms & Verbeek 1989). These differences in life history may contribute to the highly divergent tolerances for human disturbance amongst the alcids of the San Juan Islands. In order to further investigate what behavioral and ecological factors may be influencing the willingness of Pigeon Guillemots to exploit habitat shared with humans, several of their nests were observed at three locations on the Island of San Juan. To examine if this exposure to human presence is affecting the behavior of these birds, observation locations occurred across an urban gradient from a heavily trafficked marina to the cliffsides of a county park. We predicted that the pressures of accommodating human presence would result in urban guillemots nesting in lower densities due to the suboptimal man-made habitat, returning to the nest with food at lower rates due to frequent human interruption, and altered temporality of food deliveries due to patterns of human activity.

Methods

Data was collected from June 24th, 2025 through July 25th, 2025 on 32 separate days via direct observation of nest sites. Several locations across the island of San Juan were scouted for the presence of active nests, and final selected sites were San Juan County Park, the Friday Harbor Marina, and the docks located at Friday Harbor Laboratories (FHL). These sites were chosen for nest presence and accessibility, though it became unclear if the pair of birds at FHL had successfully maintained a nest, and they were subsequently removed from the final analysis. Monitoring additional sites would not have been feasible due to the length of observations and the small number of observers. Observations occurred in the morning

and evening for one to two hour intervals, with morning observations commencing between 8:00 AM and 10:00 AM and evening observations commencing between 2:00 PM and 4:00 PM. As parents delivered prey items to nests, data was collected on nest ID, time of delivery, and prey type, if identifiable. At the San Juan County Park location, nests were observed from a cliff overlooking the bay from which parents accessed nests. The other two locations could only be observed from the floating docks adjacent to the nests, resulting in the observer being in full view of the parents. Due to the frequent use of these areas by pedestrians and other researchers, the use of a blind was not possible. These nests were frequently exposed to pedestrians at the same proximity as the observer, so it was assumed that any behavioral alterations would already be the standard at this location.

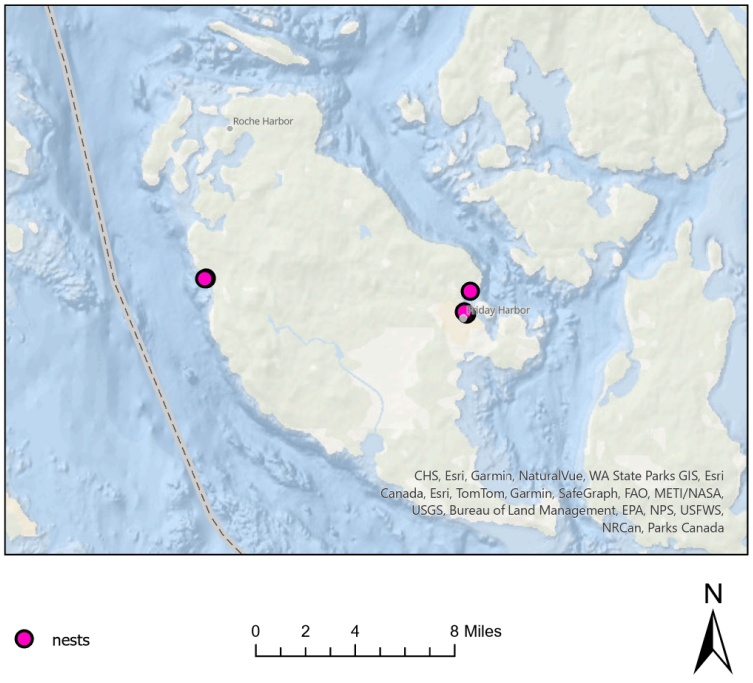


Figure 1. Map of nest locations on the island of San Juan.

Nest sites were divided into two categories of exposure to human activity. The site at San Juan County Park, located just across from Low Island, experienced limited activity from motorized watercraft, as most boats remained further offshore in Haro Strait. Rarely, a large ship would produce a swell in the coves adjacent to the nests. A small beach was located near two of the nest sites at this location, which were only accessible by foot during low tide. Human presence at this beach was variable, but generally increased throughout the month of July. Four nests were located at this location in total. The nest sites at the Friday Harbor Marina were exposed to a much greater degree of human activity. The presence of humans on the docks where nests were established was frequent, and boat traffic in the foraging grounds of the parents was typically high. The Washington State ferry passed both nesting locations and docked directly adjacent to one nest site at the Friday Harbor Marina, often contributing significantly to sound disturbance. That same nest was also located next to the temporary docking area, and was occasionally blocked from the ocean on all sides by either people or boats. The nest was accessible to parents during these instances, but this required an altered flight path in which the parent would fly between private boats and the ferry, a significant feat of dexterity for a somewhat ungainly flier.

	Marina	County Park	Total
Morning	14	18	32
Afternoon	4	11	18
Total	18	29	

Table 1. Number of observations per location and time frame.

Results

For each observation period, rate of delivery per hour was calculated for each nest from the length of observation and the number of deliveries. Nests that were not observed to receive a delivery but known to be active were assigned a delivery rate of zero. Nests were considered to be inactive after more than three observation sessions with no deliveries. Delivery rates for each nest proved to be erratic over time, with frequent jumps between high rates of delivery and no deliveries at all.

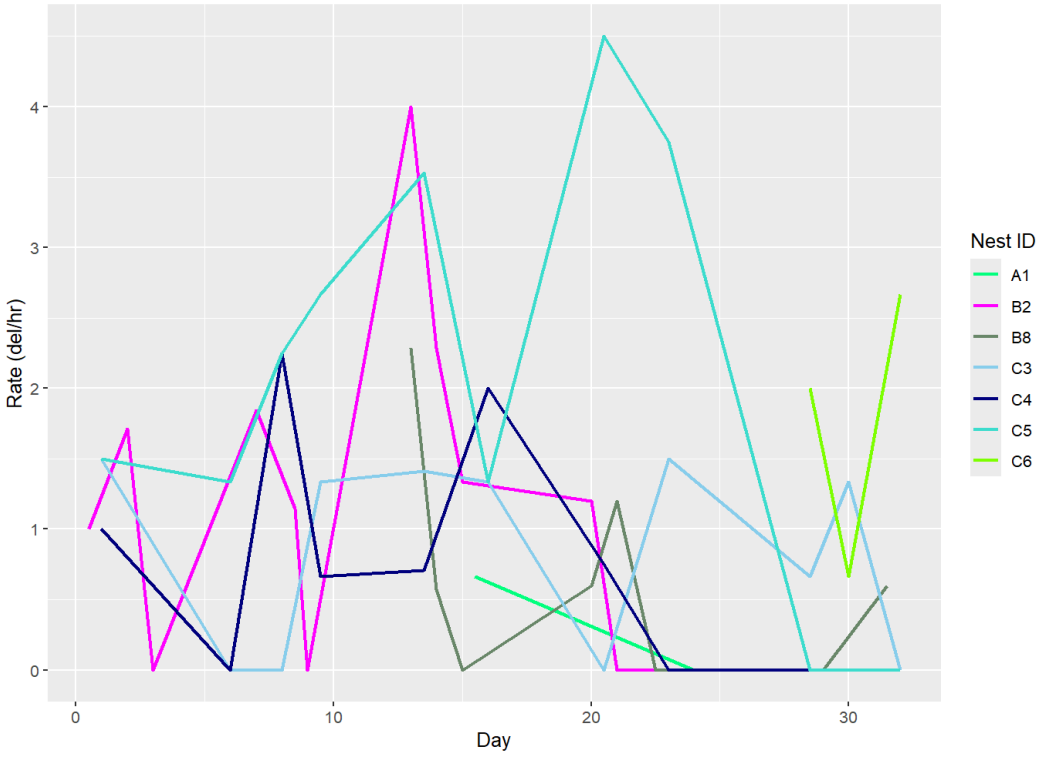


Figure 2. Graph of delivery rate per nest over time. Nests beginning with the same letter were located at the same location.

When considering nests between all locations and observation times, delivery rates over time were not distributed normally. Therefore, a non-parametric Wilcoxon rank sum test was performed to test for a difference in average rate of delivery between nests at the Friday Harbor Marina and San Juan County Park. A p-value of $\alpha = 0.186$ was not significant given an alpha value of 0.05. Tests were then run to compare times (afternoon or morning) at each location and to compare locations at each time. Each of these four groups (FH Marina morning, San Juan County Park afternoon, etc.) was normally distributed, so a t-test with equal variances was used. None of the resulting p-values were significant, though the test comparing delivery rate between marina and park nests in the afternoon only did produce a low p-value of $\alpha = 0.0697$, with the rate of delivery at park nests being higher.

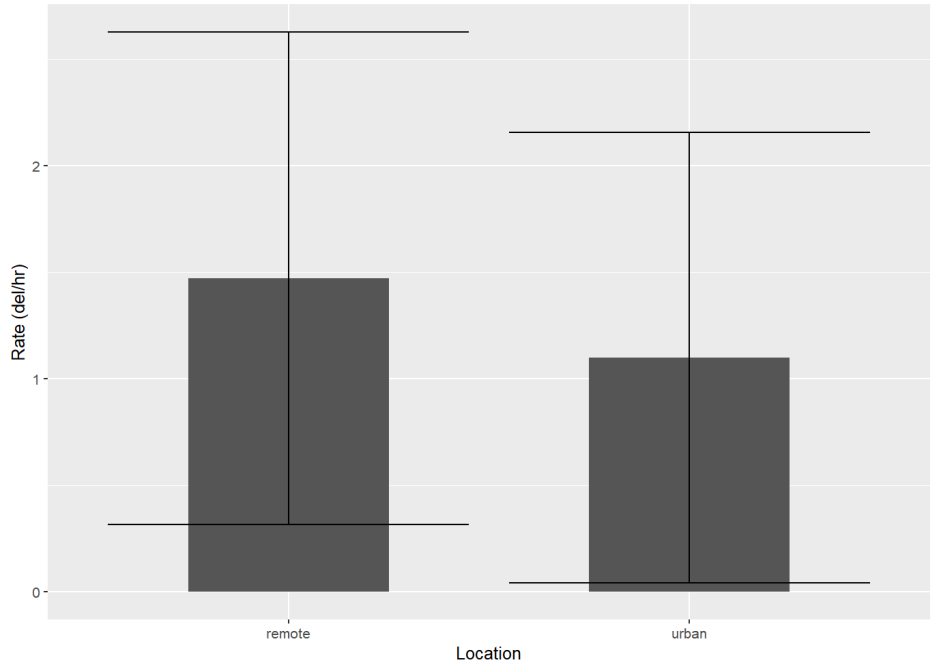
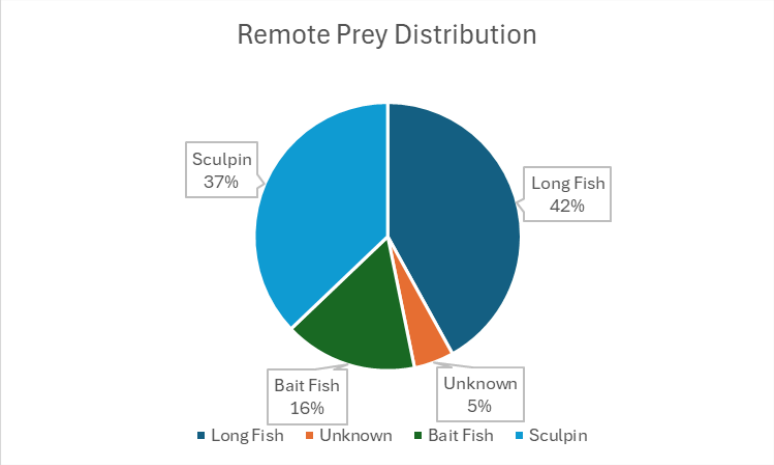


Figure 3. Bar chart of average rate across two locations with error bars representing standard deviation.

Type of prey item was calculated as a percent of total deliveries at each location. Fish species such as gunnels, snake pricklebacks, and eelpout were lumped together due to their similarities in morphology and the difficulty of differentiating them at range. Forage fish such as herring, sardines, and sand lance were also compiled for this reason. Birds at the marina delivered a greater diversity of species, and only at this location did parents deliver shrimp to their nest. Forage fish made up a greater portion of the diet of birds at the county park. Though not the focus of this study, high counts of birds present at each nesting site were occasionally taken and were observed to differ. A maximum of 25 birds were seen at once at the county park, whereas a maximum of 10 birds were seen at the marina.



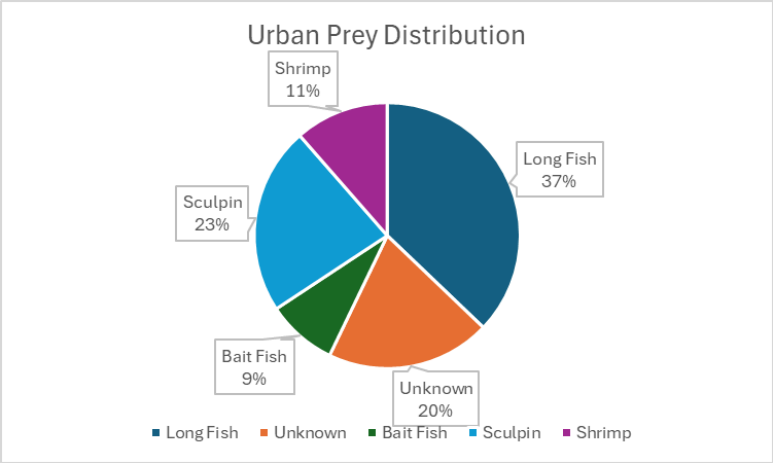


Figure 4. Pie charts represent percent of deliveries represented by each prey type.

Discussion

Not all observations in this study were equal, as nest sites varied in distance from and visibility to the observer. Out of the six nests routinely observed, one at each location was notable further away, and these nests were generally recorded as having lower rates of delivery. This may have been caused by observer failure to spot all nest deliveries, which had the potential to occur very rapidly, as parents occasionally flew to the nest directly from foraging grounds and settled only briefly to drop the fish in the mouth of a chick. If the delivery rates of these nests were underestimated, it would result in a reduced difference between the two locations, as depressed rates would make up half of the nests at the marina and only a quarter of the nests at the county park. Therefore, adjusting for possible missed deliveries should make the average rate of delivery more similar between locations, which should not disrupt the results. Additionally, time of nest observations was heavily restricted

by the schedules and prior commitments of the observers. One problem that arose was a smaller number of afternoon deliveries being recorded at the marina, an issue that was compounded by a nest at that location fledging following a period of majority morning observations. This bias may have contributed to the near significant difference between delivery rates at the two nest locations during the afternoon. If more observations occurred during the afternoon before the first nest fledged, the average delivery rate almost certainly would have been higher and the difference between the two locations lower.

Animals encroaching on human spaces encounter a variety of novel challenges and may have to adjust their behavior in order to "expand the range of foods they eat, adjust their response to human activity, avoid dangerous anthropogenic settings (e.g., roads and buildings), breed and migrate in synchrony with new foods, temperatures, and photo-regimes, recognize new predators, avoid the masking effects of low-frequency noise on their vocalizations, and nest in unique places" (Marzluff 2012). Pigeon Guillemots nesting at the Friday Harbor Marina are certainly beholden to all of these pressures, including avoiding boats, being heard by their mates over the cacophony of tourists and the Washington State Ferry, and navigating human built structures that require new landing strategies – one bird was observing failing a dozen times to land in a prospective nest site under a wharf. When faced with an altered environment, "subdemographic parameters" that result from short-term decision making, such as delivery rates and diet composition, should be the first behaviors that are observably altered (Parrish & Zador 2003). That no such difference between remote and urban nests was observed in the results of this study could indicate that the life history of Pigeon Guillemots is such that their primary behaviors may be carried out

in spite of human disturbance. Further analysis of the general confidence of the species, the ability of their vocalizations to carry in loud environments, and the diversity of nest characteristics in natural environments may reveal a species already well adapted to a variable environment and the specific challenges of urban living. The results of such enquiries could help predict which species are most likely to tolerate sharing space with humans in the future, which may aid in identifying species of conservation concern before they are imperiled.

In the family Alcidae, sociality is highly influential in the establishment of new breeding colonies. Parker et al. (2007) was able to successfully reestablish a Common Murre nesting colony at Devil's Slide Rock in California thought to be abandoned due to a combination of sub-optimal environmental factors associated with an El-Nino Southern Oscillation event, bycatch mortality in gillnets, and mortality from oil spills (*Apex Houston* 1986 and *Puerto Rican* 1984). After the cessation of human disturbance, the habitat became once again suitable for seabird nesting, but went unutilised due to the lack of social safety associated with colonization. The sociality of Common Murres was manipulated in order to entice prospective breeding adults to consider the site once more due to the presence of decoys, mirrors, and call playbacks (Parker et al. 2007). It has been posited that seabird colony size may vary between species based on feeding habit, in which birds that feed far out to sea form large, dense colonies while birds that feed near shore nest coastally in small, dispersed colonies (Cairns 1980). The species composition of prey delivered to chicks over the course of this study validates this principle, as the smaller colony of inshore birds relied less on forage fish than the large colony exposed to further offshore foraging grounds. Of

Black Guillemots (*Cepphus grylle*), which are closely related Pigeon Guillemots and share a similar life history, Cairns (1980) notes that their unusual lack of sociality compared to other alcids makes them "not well adapted for colonial nesting" and Emms & Verbeek (1989) observed that Pigeon Guillemots did not utilize colonies as information centers for foraging locations. The lack of obligate sociality in Pigeon Guillemots may make their patterns of coloniality more flexible, enabling them to more easily colonize new breeding locations in addition to or resulting from the loss of current nesting sites. This flexibility could contribute to their willingness to exploit new human-built environments such as wharves and may result in populations being more resilient in the face of coastline alteration.

In a chapter of Urban Evolutionary Ecology, John Marzluff (2012) theorizes that small populations of animals may display lower evolutionary capacity in urban environments due to their vulnerability to extirpation via stochastic events. This suggests that successful populations of urban adapters and exploiters should trend towards being larger, as smaller populations fail to find a foothold in the face of new pressures. Indeed, many urban populations of wildlife such as raccoons and crows exhibit a higher population density in cities than in rural areas (Rodewald & Gehrt 2014). However, with colonial seabirds, which rely heavily on population numbers for colony persistence (Zador et al. 2009), space in urban environments becomes a significant limiting factor. Pigeon Guillemots, on the other hand, appeared in this study to be able to successfully nest in comparatively small numbers in urban locations. Though this low density could make them vulnerable, it may also be key to their ability to share space with humans, as it gives them the flexibility to move in small numbers throughout the habitat mosaic created by humans.

Wildlife that encroach upon human spaces in large numbers may come to be considered an inconvenience, and subjected to efforts at removal. For instance, several docks in Friday Harbor, WA that were exploited by Pigeon Guillemots had many crevices boarded up to discourage the nesting of feral pigeons. Another example is the former Double-crested Cormorant (*Nannopterum auritum*) colony on East Sand Island in the mouth of the Columbia River, which was forcefully dissolved at a size of 15,000 mating pairs due to conservation concerns over juvenile salmonids (Strong & Tidwell 2023). Ten years later, to the dismay of many, the remnants of this large colony have relocated up the river to a single bridge in Astoria, OR where they are now considered a significant public nuisance due to the damaging effects of bird guano on the bridge and the hazards of flying birds to motorists (Stewart et al. 2023). Similarly, in Northeast England, a large colony of Black-legged Kittiwakes (*Rissa tridactyla*) were once significantly despised by townsfolk, who viewed them, as well as other species gulls, as "trash animals" (Wilson 2022). In that same vein, the Australian White Ibis (*Threskiornis moluccus*) has received the moniker "bin chicken" thanks to its remarkable ability to adapt to urban environments (Wilson 2022). Populations of large, colonial birds must walk the fine line between being so novel that they attract unwanted attention and being so ubiquitous that they become pests. It appears the Pigeon Guillemots of San Juan successfully balance their level of imposition on the consciousness of humans while simultaneously meeting their social, spacial, and nutritional needs.

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