Shorebird Behavior at Two Sites on San Juan Island,

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Abstract

Shorebird species have habitat preferences and feeding adaptations that help them reduce competition. The San Juan Islands support many of these shorebird species with its resources. We aimed to study and compare various aspects of shorebird behavior at Jackson Beach and False Bay, two locations on San Juan Island. We recorded abundance and species composition, as well as substrate use and behavior through focal animal sampling. We also compared high and low tide differences at Jackson Beach. Killdeer (*Charadrius vociferus*), western sandpipers (*Calidris mauri*), and greater yellowlegs (*Tringa melanoleuca*) were the most abundant species. Low tides at Jackson Beach had a higher abundance in greater yellowlegs and killdeer, while western sandpipers showed no major preference. Greater yellowlegs were found most often wading, whereas western sandpipers preferred algae, and killdeer used all substrates roughly the same amount. Lastly, the sandpipers at Jackson Beach and False bay spent most of their time foraging, while the killdeer spent most of their time standing at both sites. These findings suggest that killdeer use False Bay and Jackson Beach as a resting site, whereas the sandpipers are there to forage.

1. Introduction

Shorebirds are marine animals that consume marine prey but they do not have the ability to swim. The main groups of shorebirds are the sandpipers (*Scolopacidae*), plovers (*Charadriidae)*, and oystercatchers (*Haematopus)*. Each of these species groups have different habitat preferences (such as substrate) and feeding adaptations that can reduce competition and help partition resources. Differences in feeding adaptations include bill length and leg length. For example, western sandpipers (*Calidris mauri*) have short legs and bills so they stick to the

shorelines and peck at food in the sand (Norazlimi and Ramli 2015). Greater yellowlegs (*Tringa melanoleuca*) on the other hand, have long bills and long legs which allows them to wade a bit deeper into the water and take advantage of the prey there (Norazlimi and Ramli 2015). Lastly, killdeer (*Charadrius vociferus*) have short bills and large eyes so they have a sit and wait or a run and grab method of feeding and they focus on spotting food on land (Eberhart-Phillips 2016).

The San Juan Islands ecosystem has a wide variety of birds that rely on its resources. The islands support a total of 72 birds that depend on its intertidal and marine habitat (Gaydos and Pearson 2011).

In this study our overarching goal was to understand shorebird resource partitioning by studying the various aspects of shorebird feeding in San Juan Island during the summer. Specifically, we wanted to look at: 1) the abundance and species composition of shorebirds at two locations, 2) the substrate preference and behavior differences among selected species, and 3) the effect of tides on the abundance and behavior of the shorebirds.

2. Materials and Methods

2.1. Study locations

We conducted our studies at Jackson Beach Park, on the east side of San Juan Island, and False Bay to the south (Figure 1a). The surveyed portion of Jackson Beach was Argyle Lagoon, an area split into two portions by a narrow strip of land (Figure 1b). Observations at False Bay were made along the northern shore near the road.

We surveyed each location on three days between August 8 and August 13, 2021, alternating days between the two. We went to Jackson Beach twice per day, once at high (1.4 m to 2.4 m) and once at low (-0.43 m to 0.27 m) tide ranges. The same was not done for False Bay;

shorebirds at this location are too spread out at low tide to make meaningful observations. Only at high tide were the birds concentrated enough for us to observe.

2.2. Observations

We spent 1.5-2 hours at the study locations for each survey. This duration would vary based on visibility, as high tide surveys often coincided with sunset time. Our observations were made either through 20-50x zoom standing scopes, 8-10x zoom binoculars, or the naked eye if the birds were close enough to us.

Upon arrival at a study site, we carried out relative abundance surveys by scanning the area through binoculars or scopes. For each survey, we recorded the maximum number of individuals seen from a given species. This was repeated at 15 minute intervals for the duration of our time there. Only shorebird species were included in our counts.

We performed focal animal behavior sampling for the rest of our time at each site. Once an individual had been located in the scope, we observed it for a total of 3 minutes, recording a specific behavior at 20 second intervals. We divided behavior recordings into seven initial categories: feeding, preening, standing, walking, vigilance, resting, and flying. Feeding was recorded for birds dipping their heads down and pecking at whatever substrate they were occupying. Standing and resting were designated as separate behaviors. We defined the former as being in an upright and neutral position, while the latter was recorded for birds that were either sitting on the ground or tucking their head into their wing, seeming to be asleep. Vigilance was defined as a bird swiveling its head, surveying the area either for prey or potential dangers.

At the start of each behavior sampling, we also recorded the substrate we found the bird on. We started with four categories of rock, mud, algae, or water (i.e. wading). This was expanded as we observed some birds occupying substrates that didn’t fit into these categories.

We added the categories “vegetation” for birds found on land plants, and “log” for those first observed on dead trees scattered around the two locations.

2.3. Data analysis

Data we obtained in these surveys were compiled onto an Excel spreadsheet. Using the program’s built-in formulas, we calculated mean relative abundances of every species observed at both locations, mean proportions of each species occupying a given substrate, and mean proportions of behaviors recorded. The sizes of all error bars were calculated using standard deviation values.

3. Results

3.1. Adjustments to data analysis

Due to significantly fewer data points for resting, vigilance, and flying, we decided to omit these behaviors altogether and focus on the other four categories. We also combined the feeding and walking behaviors into a new category of foraging, realizing that there would be little reason for the birds to expend energy walking if not searching for food.

During this study we observed 7 species of shorebirds: Baird’s sandpiper (*Calidris bairdii*), greater yellowlegs (*Tringa melanoleuca*), killdeer (*Charadrius vociferus*), least sandpiper (*Calidris minutilla*), sanderling (*Calidris alba*), semipalmated plover (*Charadrius semipalmatus*), and western sandpiper (*Calidris mauri*) (Table 1). Due to much higher mean abundances across both locations, we decided to focus most of our study on killdeer, greater yellowlegs, and western sandpipers. Additionally, we omitted data on western sandpipers at Jackson Beach, and on greater yellowlegs at False Bay. We did this because of too small a

sample size; only two focal animal samples were done on greater yellowlegs at False Bay, and only one on western sandpipers at Jackson Beach.

3.2. Abundance and tides

At Jackson Beach the most abundant species were killdeer, greater yellowlegs, and western sandpipers (Table 1). Whereas at False Bay the most commonly recorded species was the western sandpipers (Table 2). The greater yellowlegs and killdeer were also seen at False Bay but they did not have as high an abundance as they did at Jackson Beach (Tables 1,2). Killdeer and greater yellowlegs had a higher mean abundance at lower tides at Jackson Beach compared with higher tides (Table 1).

3.3. Substrate

For each species there were differences in substrate preferences. Greater yellowlegs at Jackson Beach showed a preference for wading in the water (Figure 2a). The western sandpipers were most often observed on the algae at False Bay (Figure 2b). Killdeer on the other hand, tended to have less of a preference for substrates at Jackson Beach (Figure 2a). Whereas at False Bay the killdeer are generally more on algae (Figure 2b).

3.4. Behavior

The sandpipers at Jackson Beach and at False Bay spent most of their time foraging while the killdeer were standing. The greater yellowlegs at Jackson beach and the western sandpipers at False Bay were most often feeding (Figure 3a,3b). Killdeer however, did forage but not as much as they were standing at both locations (Figure 3a,3b).

During low tide most species spent more time foraging. At Jackson Beach the greater yellowlegs and the killdeer were spending a higher percent of time foraging than compared to low tide (Figure 4a,4b). The western sandpipers at False Bay during high tide also had a higher foraging percentage than the killdeer at both locations (Figure 4a,4b).

4. Discussion

Our data suggests western sandpipers do not have any major preference for tidal heights at Jackson Beach. The other two species, particularly killdeer, have a clear preference both for low over high tides and for Jackson Beach over False Bay. These differences may be explained by substrate availability at each location. When not found wading, yellowlegs were found most often on rocky shores that would only be exposed at lower tides. While killdeer do not have any major trend in substrates at Jackson Beach, their substrate use is also much more varied at this location. They may prefer this location because it provides them with a greater range of niches to occupy than False Bay.

The distinct downward trend in western sandpiper abundance at False Bay over the course of our studies does not have a clear explanation. We hypothesize that the air quality on our final day at False Bay may have had some influence on the birds' behavior. Smoke from wildfires in California and Oregon had made its way to the San Juan Islands by this time, creating a significantly different atmosphere for all species in the archipelago. This may also explain a significant drop in the overall number of birds observed during our survey, though the true reason for the decrease remains unclear.

Patterns of substrate use by our surveyed bird species can generally be attributed to their general feeding habits. Greater yellowlegs are considered probing feeders, sifting through sands or shallow water in search of small fish or benthic organisms as prey (Elphick and Tibbitts,

1998). Finding most individuals of this species wading in shallow waters aligns with the location of their preferred prey species. Western sandpipers spend much of their time on algae consuming its coating of biofilm, estimated to make up about half of their total diet (Kuwae et al., 2008). As they showed a distinct preference for nearshore algae at False Bay, this species also seems to choose its substrate based on optimal foraging conditions. These ideas are reinforced by our data on foraging behavior, with both species spending more than 70% of our observation time foraging (Figure 4).

Killdeer are the only of our focal species for which foraging does not seem to influence their substrate preferences. Individuals observed at Jackson Beach have no distinct pattern whatsoever in regards to their substrate choices. While the killdeer we saw at False Bay were most often seen on algae, most of the substrate available to shorebirds at high tide on False Bay is algae, meaning birds found there have limited options for substrate to begin with. Killdeer are a species which can occupy a much wider range of habitats than other shorebird species, including dry and even inland areas (Jackson and Jackson, 2000). Combining this knowledge with our data, it may be that killdeer are much more generalist feeders than either of the other two species and do not require a specific substrate for their foraging.

Alternatively, killdeer may not even visit these locations to feed, using them instead as roosting sites. Considering the minimal amount of foraging behavior we observed for killdeer at these locations, especially compared to the number of times they were recorded as standing, they may instead use the two locations more as roosting stops. Our observation that killdeer spend less of their time foraging at Jackson Beach is also consistent with previous studies on the area (Aitoro et al., 2017; Gentilhomme and Haymond, 2016). However, current research on killdeer

habitat preferences is still quite limited. We recommend that more time be put into determining these preferences.

Due to the fast-paced nature of this study, time for data collection was relatively limited and consequently decreased the number of birds we were able to observe. Even when birds were visible, various factors outside our control could hinder any potential observations of them. A given individual may sometimes fly away for undetermined reasons or move behind an object, preventing any further behavior recordings. Our aforementioned decrease in western sandpipers seen at False Bay is also important to consider in this regard. We cannot control the behavior of these organisms, so any potential disturbances could potentially skew data for specific individuals. To account for such intricacies, future studies should survey these locations over a much longer time period. A larger sample size is even more important to determine the species' behavioral patterns and substrate preferences at both of these locations.

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Appendix

a)

b) c)

Figure 1: **a)** A map of San Juan Island, courtesy of San Juan County LandBank. The two study sites are marked by boxes and labelled. Image found on sjclandbank.org. **b)** An overhead photograph of Argyle Lagoon at Jackson Beach Park, courtesy of the State of Washington Department of Ecology. The top portion of the lagoon is connected via a narrow channel to the bottom portion, which then flows into the nearby North Bay. Image found on portfridayharbor.org. **c)** An overhead photograph of the False Bay survey site at low tide, courtesy of the San Juan County Assessor's Office. The image is compiled from several screenshots. Observations at the site were made along the northern edge of the bay. Image found on faculty.washington.edu.

Table 1: A table summarizing relative abundance recordings taken at Jackson Beach across our three days of study. The values in each column are the maximum number of each species seen at a given survey, with the final column showing mean values from across the three days. Each day is separated into high and low tide to represent all surveys carried out.

	Maximum abundance (Aug 8)		**Maximum abundance (Aug 10)**		**Maximum abundance (Aug 12)**		**Mean abundance**	
Species	**High tide**	**Low tide**	**High tide**	**Low tide**	**High tide**	**Low tide**	**High tide**	**Low tide**
Baird's Sandpiper	0	0	0	0	0	1	0	0.3
Greater Yellowlegs	2	6	0	5	8	6	3.3	5.7
Killdeer	4	6	1	10	7	12	4	9.3
Least Sandpiper	0	0	1	0	0	1	0.3	0.3
Sanderling	0	0	0	0	0	1	0	0.3
Semipalmated Plover	0	0	0	0	0	1	0	0.3
Western Sandpiper	6	3	10	0	0	9	5.3	4

Table 2: A table summarizing relative abundance recordings taken at False Bay across our three days of study. The values in each column are the maximum number of each species seen at a given survey, with the final column showing mean values from across the three days.

Species	**Maximum abundance (Aug 9)**	**Maximum abundance (Aug 11)**	**Maximum abundance (Aug 13)**	**Mean abundance**
Greater Yellowlegs	0	0	1	0.3
Killdeer	3	0	4	2.3
Least Sandpiper	3	1	0	1.3
Semipalmated Plover	1	0	4	1.7
Western Sandpiper	53	20	1	24.7

a) b)

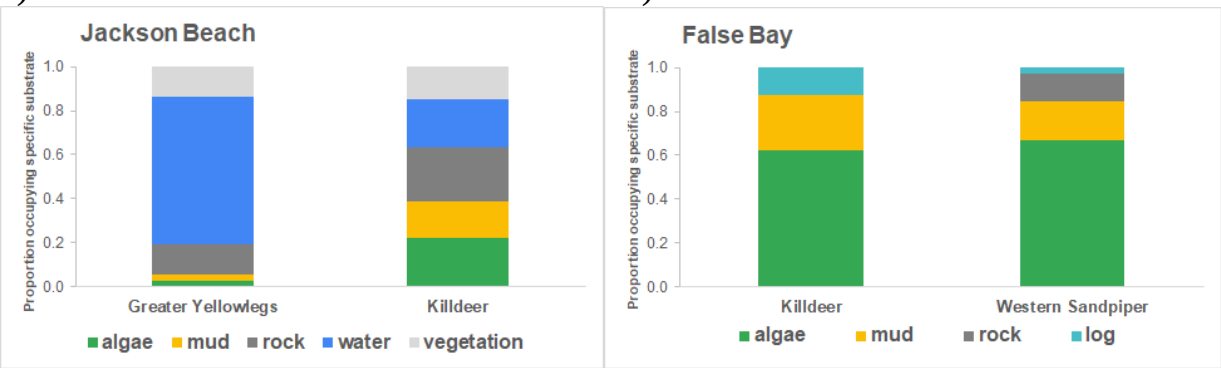

Figure 2: Stacked bar charts showing the proportion of individuals of focal species found on a given substrate type at Jackson Beach (a) and False Bay (b). Greater yellowlegs at False Bay and western sandpipers at Jackson Beach are excluded due to limited sample size.

a) b)

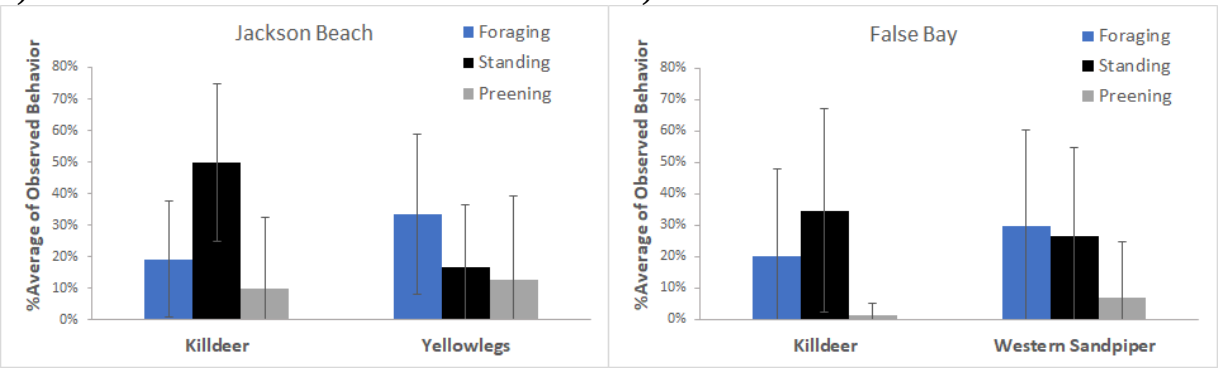

Figure 3: Bar charts showing the mean percentage of time focal species spent on each of the key behaviors at Jackson Beach (a) and False Bay (b). Greater yellowlegs at False Bay and western sandpipers at Jackson Beach are excluded due to limited sample size. Error bars represent standard deviation.

a) b)

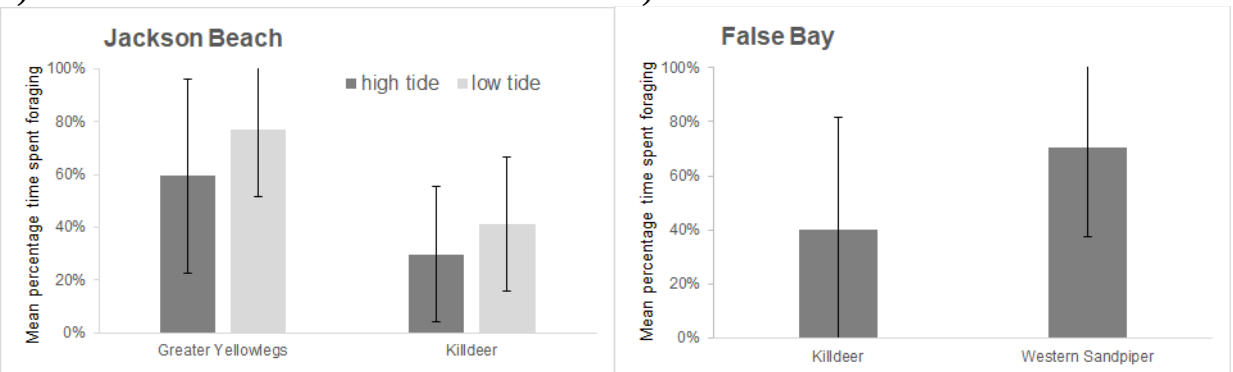

Figure 4: Bar charts showing the mean percentage of time focal species spent foraging at Jackson Beach (a) and False Bay (b). 3a is divided into high and low tides to exemplify differences

between the two. Greater yellowlegs at False Bay and western sandpipers at Jackson Beach are excluded due to limited sample size. Error bars represent standard deviation.