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Waterfowl pond preference and behavior during fall migration through southeastern Minnesota

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Abstract

Waterfowl and wetlands play important roles both ecologically and economically in Minnesota. Waterfowl like ducks and geese provide valuable ecosystem services like helping to manage populations of different plant and insect populations, as well as preventing the total takeover of invasive species like zebra mussels by eating them. Economically, waterfowl are important birds for birdwatching and hunting. As these migratory birds pass through Minnesota, it is valuable to understand what kind of habitat different species are likely to frequent, and for what reasons. Changes in temperature as a result of climate change have the potential to impact migration patterns and times for different species, so it is important to track presence of these waterfowl species as well as their behavior over the main migratory season. This study tracked species presence and behavior over the month of October at two ponds in the St. Olaf natural lands in Northfield, Minnesota. A greater number of species was observed on Big Pond than at Baseball Pond, and the number of individuals significantly differed between the two ponds. Geese preened more than mallards, but mallards ate more than geese. Additionally, Canada geese flew in and out of the ponds more frequently than mallards. There was no significant difference between behavior exhibition by species between ponds or the first and second halves of the data collection period. These results signal that multiple pond habitat options are utilized for the same purpose by waterfowl, even within a single day, so restoration efforts should continue to prioritize the creation of multiple wetland habitat options for waterfowl.

Introduction

Waterfowl and wetlands play important ecological and economic roles throughout the world. In Minnesota, hunting and birdwatching contribute to the state's economy and waterfowl are one of the most valuable animal groups in this context. In 2011, Minnesota ranked 11th in national birding participation rates with a rate of 25%, 5% above the national average. Waterfowl were the most-watched bird group, with seventy-five percent of birders who traveled more than a mile observing waterfowl (Carver 2013). This interest in waterfowl makes it valuable to understand where waterfowl will be likely to be observed throughout a migratory season. This is especially important to study over time in order to understand if climate change is having any effect on migration patterns of different species, and how that could impact where certain birds will be found at different times of year.

Climate change projections have anticipated fewer periods of extreme cold from September-February in the Great Lakes region, which has major implications for waterfowl species which have temperature as a trigger for migration (Schummer 2010). Increased

warming is expected to delay average migration date for several dabbling duck species, with the possibility that some, like the American Black Duck and Mallard could eventually overwinter in this region by the end of the 21st century (Notaro 2016). This can have major impacts on the ecosystems and communities which these species usually interact with, since waterfowl like mallards play an important role in the transport of propagules such as molluscs and plant seeds between freshwater ecosystems over potentially great distances (Bauer and Hoye 2014). Some dabbling ducks respond to photoperiod changes to trigger migration rather than to weather severity like Mallards (Schummer 2010). Because climate change might cause migration patterns to shift in different ways depending on the species, it is important to understand differences in habitat preference between species. Additionally, Canada geese have been shown to change their preferred habitat type in more metropolitan areas with decreases in temperature within a season (Dorak 2017). This change in habitat preference with temperature demonstrates the importance of considering how the habitat needs of a species in one location might shift over time.

Annual surveys of birds since the 1970s have shown that while most bird species in North America have been declining, ducks, geese, and other wetland bird populations have increased, likely as a result of habitat conservation and restoration efforts (Pennisi 2019). In order to maintain this positive trend in waterfowl populations, habitat needs of specific species need further study, and seasonal migration patterns should be monitored for changes from year to year. Understanding how birds' habitat use, including presence and behavior at different pond types, can help conservationists be holistic in their preservation and restoration efforts in order to be sure the habitat types they are restoring are able to fill the range of needs for waterfowl throughout the year. The objectives of this study were to

1. Compare species presence and frequency at two ponds in the St. Olaf Natural lands to investigate habitat preference of different waterfowl species over the course of a migratory season.

2. Compare waterfowl behavior at the two ponds, noting what behaviors different species are exhibiting and if those behaviors shift over the migratory season, which may illuminate for what purposes waterfowl might utilize different pond types.

Informed by the previously mentioned literature findings, as well as the results of Meagher (2019) and Mathison (2013), I hypothesize that I will find a difference in species diversity between the two ponds and that overall species diversity will decrease as the average daily temperature decreases. Additionally, I hypothesize that there will be behavioral differences within species between the two ponds.

Methods

Site Descriptions

Both ponds are located in the St. Olaf College Natural Lands in Northfield, Minnesota. Big Pond is a large pond with a forested edge along about half the pond, with the other side bordered by prairie. Big Pond sits about 100 meters from St. Olaf's Skoglund athletic center and parking lot. Baseball Pond is a smaller pond fully bordered by trees, about 100 meters from Cedar Avenue, a road. Both ponds are easily accessible by paths which run alongside the ponds on the forested edge, with the path located closer to the pond at Baseball Pond (Fig. 1).

Species Counts

During the month of October and the first week of November (10/1/21-11/5/21) I went to Big Pond or Baseball Pond on alternating days for one hour beginning at dawn every Monday, Wednesday, and Friday, meaning each pond was observed for one hour every four to five days. At the beginning of each hour I took air and water temperature using a digital thermometer. I then recorded which species were present on the pond and recorded an initial count of the number of individuals within each species. Over the course of the hour, I recorded the time and the number of birds when birds departed from or arrived at the pond. At the end of the hour I

recorded an end count for the number of individuals. This allowed me to calculate the peak number of birds which were present on the pond that day.

Behavior

During the hour, I also recorded four, three-minute "snapshots" of bird behavior. Following the methods of a previous St. Olaf student researcher who completed a similar project, I identified birds exhibiting the behaviors of eating, sleeping, preening, and swimming (Mathison 2013). Because of the potential for large numbers of birds, rather than attempting to count how many birds within a species were exhibiting a specific behavior at that time, I simply recorded a presence/absence measure of whether any birds of that species were that behavior during a three-minute period. For analysis, I then calculated an average, or proportion of snapshots when that species was exhibiting that behavior for a whole day and compared those.

Statistical Analysis

Shannon and Simpson diversity indices were calculated in Google Sheets for each pond. All graphing and analyses were completed using RStudio Server Pro 1.4.1103-4 in the library "tidyverse". All analyses were run including only the two most common species. For the species counts data, a chi-squared test of independence (contingency table) was run on the summed peak number of birds within a species by pond. Additionally, two-way ANOVAs were run on daily peak counts by species between the two ponds and also on daily peak counts by species comparing the first eight days of data collection to the last eight days of data collection. For behavior data, two-way ANOVAs were run comparing the daily percent exhibition of a behavior (in a proportion) by species between ponds and halves of the data collection period.

Results

Species counts

I observed a total of four species across the two ponds, which, in order of both number of individuals and frequency of sightings, were Canada goose (*Branta canadensis*), mallard (*Anas platyrhynchos*), wood duck (*Aix sponsa*), and hooded merganser (*Lophodytes cucullatus*). All four were observed at Big Pond while only the two most common, Canada goose and mallard, were seen at Baseball Pond. The Shannon and Simpson indices for Big Pond were 0.511 and 0.310, respectively, and for Baseball Pond were 0.369 and 0.069, respectively (Table 1). A chi-squared test revealed that pond and species were not independent, with a preference for Big Pond for both species and a greater proportion of geese overall (Table 1).

Although the ANOVA investigating the interaction between species and location in regards to daily peak number of birds was significant ($p = 0.00801$), a Tukey HSD test revealed that there was no difference in pond preference within a given species (Table 2, Fig. 2). The result was similar in the ANOVA investigating interaction between species and data collection period (first half vs second half) in regards to daily peak number of birds. The overall p-value was significant ($p = 0.0424$) but there were no significant comparisons of means between the first and second half peak numbers within a given species (Table 3, Fig. 3).

Behavior

Geese change their presence on the pond more frequently than mallards do, according to ANOVA comparing the number of times geese and mallards arrived at or departed from a pond ($p = 0.0018559$) (Fig. 4, Table 4). For the four categorized behaviors of eating, preening, sleeping, and swimming, ANOVA revealed that when comparing all geese and mallards across both ponds, Canada geese preen significantly more of the time than mallards ($p=3.07e-5$), but mallards eat significantly more of the time than geese ($p=0.0395529$) (Fig. 5). ANOVA and Tukey HSD comparisons revealed no significant difference in average exhibition of behavior within a species by pond or by data collection period (Figs. 6 & 7).

Discussion

Species Counts

The lack of significance in both the species count and behavior data suggest that the most common species of waterfowl observed are able to use both ponds in a similar way. While the total peak number of geese and mallards at the two ponds were significantly different from one another, the comparison of daily peak numbers in the ANOVA was insignificant (Tables 1 & 2). This could signal that the difference in total number of birds visible on the pond could be due to the larger size of the Big Pond allowing more birds to land there at the same time rather than a marked preference for Big Pond and avoidance of Baseball Pond. Meagher (2019) found a strong preference of waterfowl for Big Pond over Baseball Pond, but this was likely due to the fact that Big Pond was in drawdown that year, which is ideal habitat for dabbling ducks (Vanausdall and Dinsmore 2019). The gradual refilling of the pond after drawdown could also explain some of the differences in species richness between Meagher's observations and mine. He observed many shorebirds at Big Pond which would've been able to take advantage of the exposed mudflats for foraging, but which, by this year are no longer exposed and so do not provide idea habitat for these species (Meagher 2019; Vanausdall and Dinsmore 2019).

Behavior

Canada geese demonstrated a significantly greater number of changes in pond population in a day than mallards (Fig. 4, Table 4). The difference in overall behavior of the two most common species showed that Canada geese preened more than mallards while mallards ate more than Canada geese (Fig. 5). Rowe (1983) found that Canada geese and mallard preening frequency was similar, but the type and duration of preening differed between species. Because I only took four three-minute snapshot surveys of the behavior exhibited by the birds on the pond, and Canada geese were found to preen for longer periods of time–about a minute

longer, depending on the preening behavior,–these behaviors may not have overlapped with my "snapshot" observation window (Rowe 1983).

The lack of preference by species for one pond compared to another is also seen in the behavior results. There was no significant difference in behavior from one pond to the next for either Canada geese or mallards, showing that despite differences in size and surrounding vegetation, the birds are not using one pond preferentially to fulfill a certain need (Fig. 6). This lack of significant difference in behavior between ponds differs from past findings of Mathison (2013), who never observed Canada geese preening or eating at Baseball Pond. This study was performed largely during the month of November, which could have impacted the behavior of the geese since it was later in the migratory season, however the lack of temporal impact on behavior within a species, seen by lack of a significant difference in behavior from the first half of the data collection period to the second in this study, makes it seem unlikely that there would be a sudden dramatic change in behavior between ponds over time this year. My results are aligned with those of Meagher who found no significant differences in mallard behavior over time, however his behavioral categories differed from mine (Meagher 2019).

Significance

Overall, the lack of significant difference in species preference and behavior between the two ponds paired with the significant difference in movement in and out of pond locations between species is important in demonstrating the need for multiple habitat options available for waterfowl. Although I could not confirm the place of origin or destination of the geese moving around at the pond, I think it is likely that they could have been moving from one pond to the other during the hour I was watching. This means that even though there was not a significant behavioral difference between the two ponds, and the main difference between the two ponds was size, there could have been other factors contributing to the relatively frequent movement of the geese. Additionally, it is important to note that this lack of preference for one pond over

another is not reflected in past research, so factors like early versus late-stage migration, especially with the eventual freezing of ponds, as well as the drawdown and vegetation status of a pond, can have a big impact on preference from one year to the next (Mathison 2013; Meagher 2019; Vanausdall and Dinsmore 2019). Because of these factors, restoration efforts should provide a variety of habitat options in order to ensure that the restored wetlands area will be able to be used by a variety of waterfowl over many timescales, daily, seasonally, and yearly.

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Thanks to Professors Steve Freedberg and Kathy Shea for their assistance in brainstorming research ideas for this project. Thanks to the St. Olaf College Biology department for the use of binoculars, thermometer, and boots for data collection. Thanks to Professors Kathy Shea and Jennie Brentrup for their assistance with R analysis.

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Tables and Figures

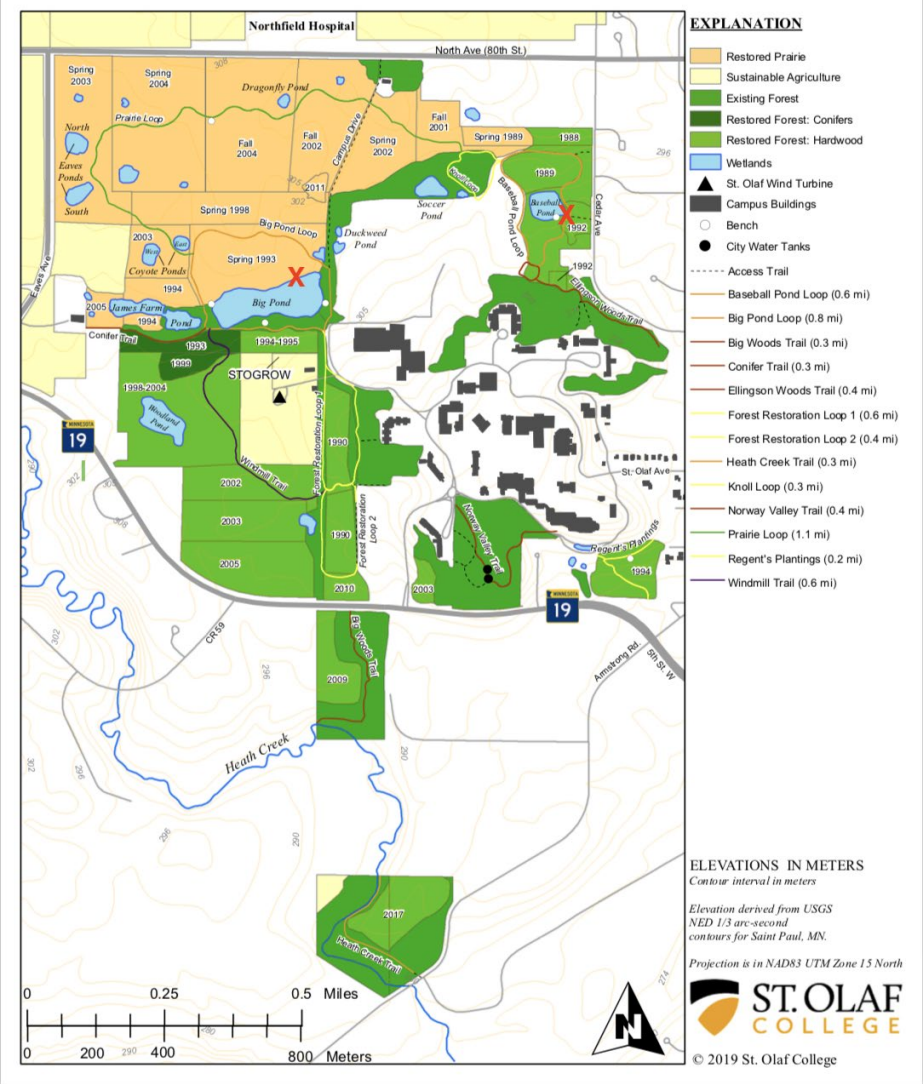

Figure 1. Map of St. Olaf College natural lands, with observation points marked in a red X at each of the two observed ponds.

Table 1. Sum of peak number of birds within each species at each pond. A chi-squared test of independence between the two most common species revealed a preference for Big Pond (p = 1.056565e-12, X^2 = 50.73613, df = 1).

Species	**Big Pond**	**Baseball Pond**
Canada goose	870	377
mallard	199	14
wood duck	3	0
hooded merganser	2	0
Total	1074	391
Species richness	4	2
Shannon Index	0.511	0.369
Evenness	0.154	0.223
Simpson Index	0.310	0.069

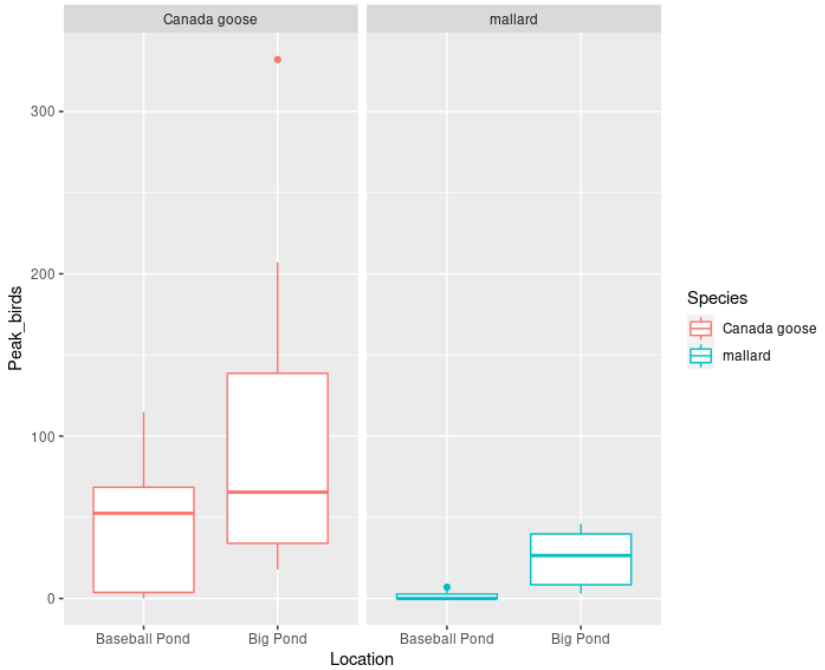

Figure 2. A boxplot comparing peak number of birds by species at each pond. "Peak_birds" refers to the peak number of birds within a species. An ANOVA found that there was no significant difference between average peak birds between ponds within either species (see Table 2).

Table 2. Mean peak values by species separated by pond. “Big” refers to Big Pond, “Baseball” refers to Baseball Pond. P-values listed in the table correspond to the Tukey HSD comparison of means p-values, the p-value for the overall ANOVA was p = 0.00801, F = 4.804. There were no significant differences between ponds in peak number of birds within a species. The only significant comparisons according to the Tukey HSD comparison of means was that there was a significantly greater average peak number of geese compared to mallards at Big Pond (p = 0.0403146), and that the peak number of geese at Big Pond was greater than the average peak number of mallards at Baseball Pond (p=0.0061884).

Species	Location	n	Mean Peak Birds	Standard Deviation	p-value
Canada goose	Big	8	108.750	109.040	0.185
Canada goose	Baseball	8	47.125	43.278	0.185
mallard	Big	8	24.875	17.683	0.863
mallard	Baseball	8	1.750	2.765	0.863

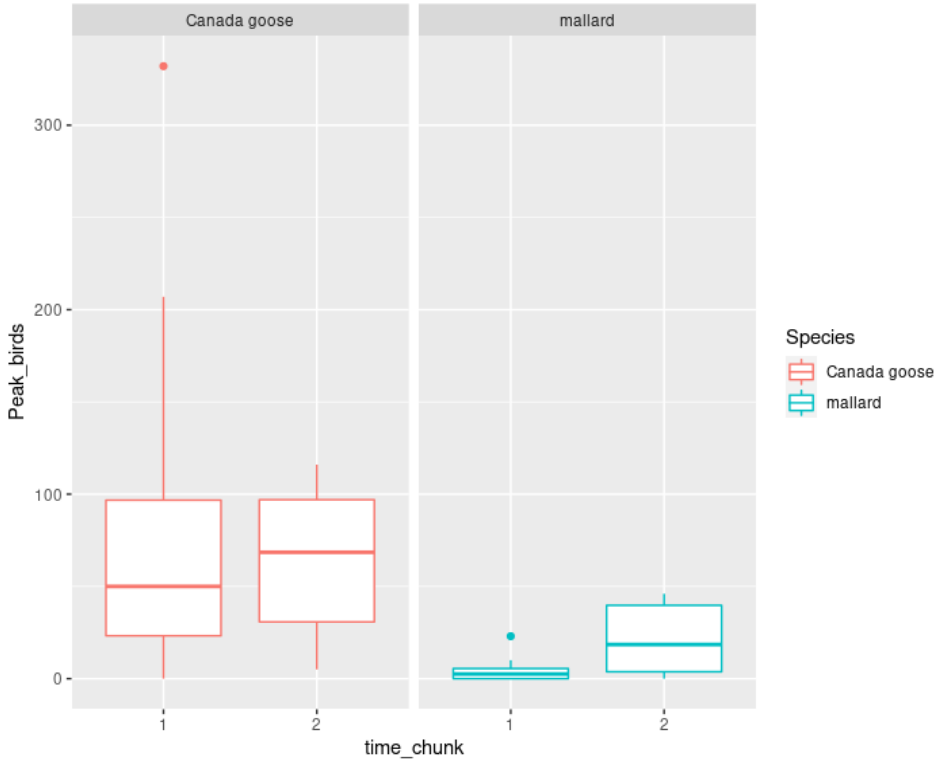

Figure 3. A boxplot comparing peak number of birds in the first half of data collection (10/1/21-10/18/21), to the second half (10/20/21-11/5/21). "Time_chunk" refers to the half of data collection, and "Peak_birds" refers to the peak number of birds within a species. An ANOVA found that there was no significant difference between average peak birds in the first half compared to the second half for either species (see Table 3).

Table 3. Mean peak values by species separated by time in the data collection period. Time chunk 1 corresponds to the first eight days of data collection (10/1/21-10/18/21), time chunk 2 corresponds to the second eight days of data collection (10/20/21-11/5/21). P-values listed in the table correspond to the Tukey HSD comparison of means p-values, the p-value for the overall ANOVA was p = 0.0424, F = 3.106. The average peak number of birds in the first vs second half of migration within species was not significant. The only significant comparison according to the Tukey HSD comparison of means was that there was a significantly greater average peak number of geese compared to mallards in the first half of the data collection period (p = 0.0512425).

Species	Time period	n	Mean Peak Birds	Standard Deviation	p-value
Canada goose	1	8	91.250	117.152	0.834

Canada goose	2	8	64.625	42.463	0.834
mallard	1	8	5.250	7.906	0.956
mallard	2	8	21.375	20.368	0.956

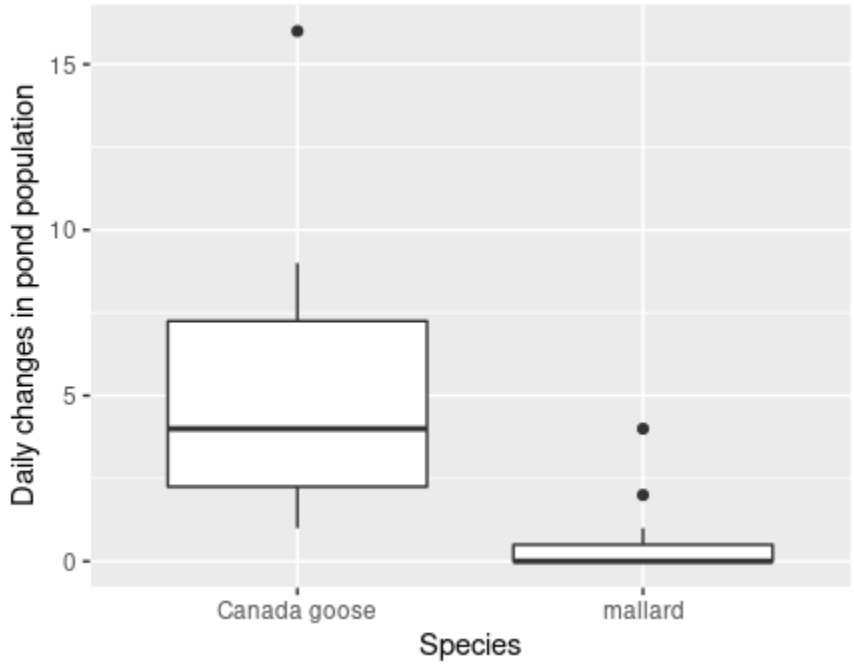

Figure 4. A boxplot of the number of changes in pond population (number of times birds flew in/out of the pond). Geese changed pond population significantly more than mallards (p = <2e-16, F = 25.15).

Table 4. Mean changes in pond population (birds flying in/out of the pond) by species. ANOVA showed that geese have more changes to daily pond population than mallards (p = 0.00186, F = 12.36).

Species	n	Mean changes in daily population	Standard Deviation	p-value
Canada goose	14	5.0714286	4.008919	1.86e-3
mallard	11	0.6363636	1.286291	1.86e-3

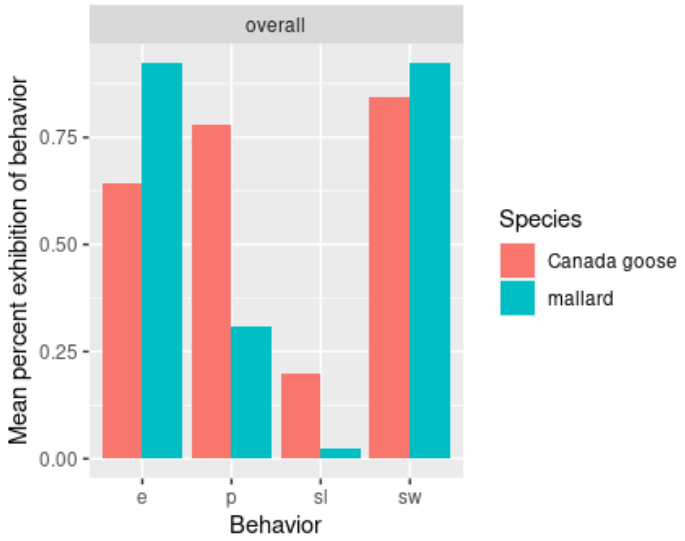

Figure 5. A barplot of the general behavior of all geese and mallards across both ponds during the whole data collection period. An ANOVA revealed some significant differences in behavior between species (p = <2e-16, F = 25.15). Based on TukeyHSD, the pairwise comparisons tell us: mallards eat significantly more of the time (p=0.0395529), but Canada geese preen significantly more of the time (p=0.0000307).

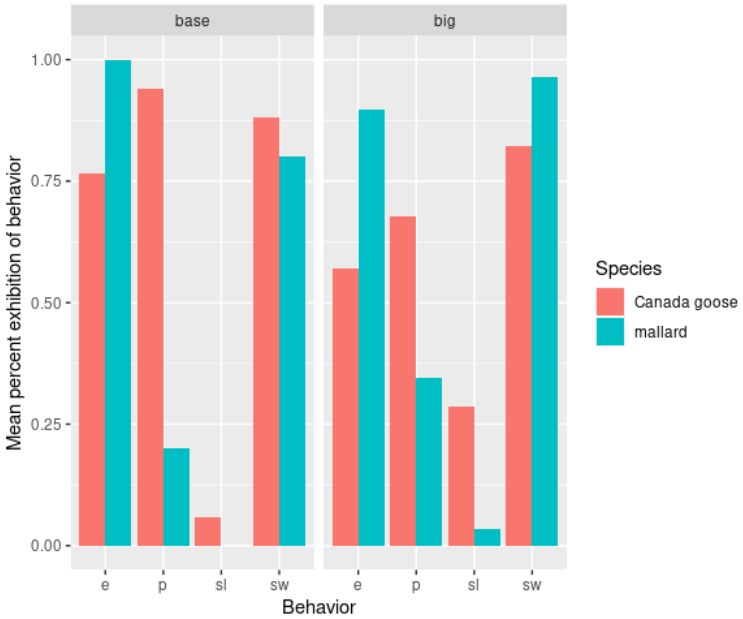

Figure 6. A barplot comparing the average proportion of snapshots each species was exhibiting the given behavior over the whole data collection period, separated by pond. Behavior “e” = eat, “p” = preen, “sl” = sleep, “sw” = swim. There was no significant difference in behavior from one pond to the other within a species.

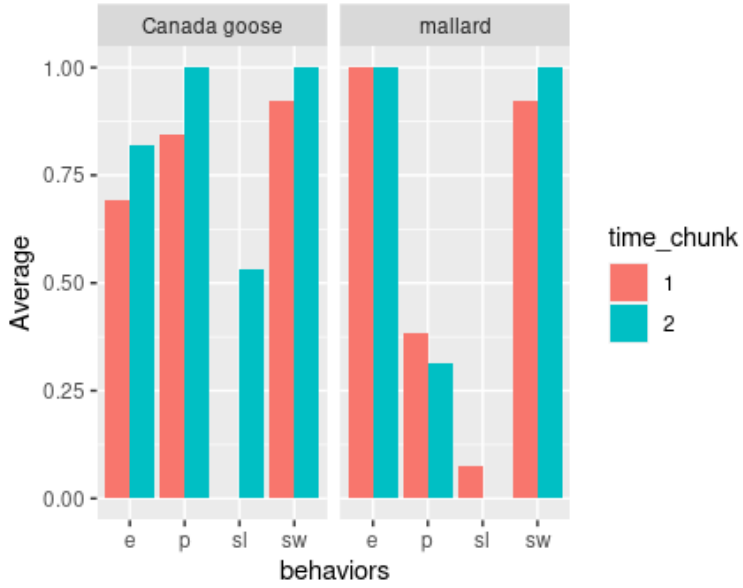

Figure 7. A barplot comparing the average proportion of snapshots each species was exhibiting the given behavior over the both ponds, separated by collection period. Behaviors “e” = eat, “p” = preen, “sl” = sleep, “sw” = swim. There was no significant difference in behavior from half of the data collection period to the next within a species.