

Seasonality and Water Level on the Usage of Grassy Lake, a Basin Marsh, by Seven of Florida’s Threatened Bird Species

West Pasco Audubon Society

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Summary

This study reports the frequency of sightings¹ and behaviors of seven threatened Florida bird species, in comparison to changes in season and water level. It was conducted at the Grassy Lake basin marsh in the Jay B. Starkey Wilderness Park in Odessa, Florida. A total of 302 surveys were completed during the 12-month study period, which commenced on August 1st, 2020. The focal species were the Florida sandhill crane, little blue heron, tricolored heron, wood stork, southeastern American kestrel, least tern, and roseate spoonbill.

There were variations in species composition and behavior throughout the different seasons, but there was less of an obvious trend for the different water levels. Sandhill cranes were present in approximately 99% of surveys and were the most consistent in their use of Grassy Lake. Their presence appeared to be influenced by seasonality rather than water level. One crane pair nested in the wetland and reared a colt in the spring of 2021. Little blue herons were present in approximately 59% of surveys, while tricolored herons were present in approximately 38% of surveys. There were differences in wetland use by water level for both species, however, further review showed that seasonality was the most probable cause of those differences. Wood storks were present in approximately 19% of surveys. There was no trend for seasonality, but the storks were sighted more frequently at lower water levels. Due to the limited amount of data collected, the trend may not have significance. Roseate spoonbills were present in approximately 9% of surveys. Due to the lack of consistent sightings, trends for both seasonality and water level could not be determined. Kestrels were present in approximately 15% of surveys and appeared to be influenced by seasonality but not water level. The kestrel sightings were only recorded from October 8th, 2020 to February 26th, 2021 (with one exception of a kestrel observed flying over the study site on May 17th, 2021), which could indicate that they were the Northern subspecies instead of the Southeastern. Least terns were not observed during the study.

The scope of the study was limited, but it could serve as a blueprint for further studies to help inform land management policy. One suggestion is to limit pumping in the early spring months when the sandhill cranes are nesting, which may prevent nest flooding. However, further observations may be required to substantiate this suggestion.

Methodology

¹ The term “sighting” refers to an instance where a bird or group of birds was recorded.

The study team (Caitlin Westerfield, Cody Coates, Richard Valdez, Peter Day, Catherine Day, Mitchell Dormont, Olivia Sciandra, and Christine Rowland) conducted point-count surveys from the bird blind located at Grassy Lake. If weather permitted, different team members visited the blind a minimum of five days per week. Each survey was conducted within two hours of sunrise and lasted at least 30 minutes. From the study period of August 1st, 2020, to July 31st, 2021, a total of 302 point-count surveys were conducted (about 83% coverage for the year). The average length of a survey was approximately 56 minutes, with a total survey time of approximately 280 hours. Because the study commenced during the final month of the three-month summer season, the split 2021 and 2022 summer seasons were combined for analysis.

The study team used binoculars to record bird sightings, as well as spotting scopes and high-resolution cameras when available. Each team member entered data into the shared study database. Recorded variables were temperature, wind speed and direction, rain, cloud cover, water level in feet NAVD (North American Vertical Datum of 1988), start time, and length of the visit. Volunteers also noted the species sighted, number of birds sighted per group, location of the sighting, bird behavior, and additional comments and observations. Each sighting was counted once per survey even if the bird or group changed position. The total count of each species represented overall visitations to the site, and did not indicate that a unique bird was observed with each individual sighting.

The location of each sighting and the primary behavior exhibited by the bird or group was recorded. The options for bird behavior were perched, preening/sunning, vocalizing, foraging, and flying (with and without wetland occupation). Preference was given to wetland-occupying behaviors, which were perching, preening/sunning, and foraging. If a bird or group was first sighted flying into the wetland and landing to forage, the primary behavior was recorded as foraging. If a bird or group was sighted flying into or out of the wetland but not seen utilizing it (due to visual obstructions), it was still counted as wetland occupation and recorded as “flying with use”. If a bird or group was sighted flying over the site without stopping, the behavior was classified as “flying without use”, which was considered a non-occupying behavior. A unique “vocalization only” behavior was created for sandhill cranes that were heard in the wetland without visual confirmation. Conservative estimates of the number of sandhill cranes were used with this specific behavior, because their exact location could not be determined.

Location

Based on measurements performed in the Geographic Information System (GIS) program ArcMap, Grassy Lake is approximately 91 acres and the established study site was approximately 83 acres. An estimated 32 acres were visible from the bird blind (approximately 39%), and the rest of the study site was obscured by trees and emergent/aquatic vegetation. The GIS program was used to create a grid which was superimposed over an aerial photograph of the wetland (Fig. 2). The grid was divided into 15 sections which were not equal in size due to the irregular shape of the wetland. All sightings were recorded within the GIS grid, except for the “flying without use” and “vocalization only” behaviors. Physical markers were not constructed for the study due to the managed status of the wetland. Unique landmarks, vegetation, and pre-existing structures, such as dead trees, duck boxes, and staff gauge poles were used to differentiate the sections when applicable.

The wetland was classified in the U.S. Fish and Wildlife Service’s Natural Wetlands Inventory (NWI, 2022) as a palustrine, semi-permanently flooded, persistent wetland with hydric soils. A variety of wetland plant communities were present at the site, as recorded in the Starkey Park Land Assessment by the Southwest Florida Water Management District (SWFWMD, 2005). Emergent and aquatic plants included bulltongue arrowhead (*Sagittaria lancifolia*), pickerelweed (*Pontederia cordata*), frog’s bit (*Limnobiium spongia*), big floating heart (*Nymphoides aquatica*), American white water-lily (*Nymphaea odorata*), and yellow pond-lily (*Nuphar advena*). Shallow-water plants included assorted grasses such as maidencane (*Panicum hemitomon*) and sawgrass (*Cladium jamaicense*), various rushes including nutrushes (*Scleria spp.*) and spikerushes (*Eleocharis spp.*), and sedges (*Carex spp.*). Trees were primarily pond cypress (*Taxodium ascendens*), with cabbage palm (*Sabal palmetto*), oaks (*Quercus spp.*), and slash pine (*Pinus elliottii*) along the perimeter.

The wetland system is augmented by surface water pumped from the Pithlachascotee River to prevent flooding of nearby residences in Pasco County in periods of heavy inundation. The augmentation also enhances the wetland’s hydroperiod, which has been altered from its historic Normal Pool Elevation of 30.3 feet NAVD due to groundwater withdrawals from the Starkey Wellfield (SWFWMD, 2005). For augmentation to commence, the Pithlachascotee River must meet its Minimum Flow Level of 19.0 feet NAVD, and the wetland’s water level must be below the Normal Pool Elevation. Augmentation ceases when these criteria are no longer met.



Figure 1: Drone photograph of Grassy Lake with the bird blind visible (Credit: Casey Cumley, SWFWMD)

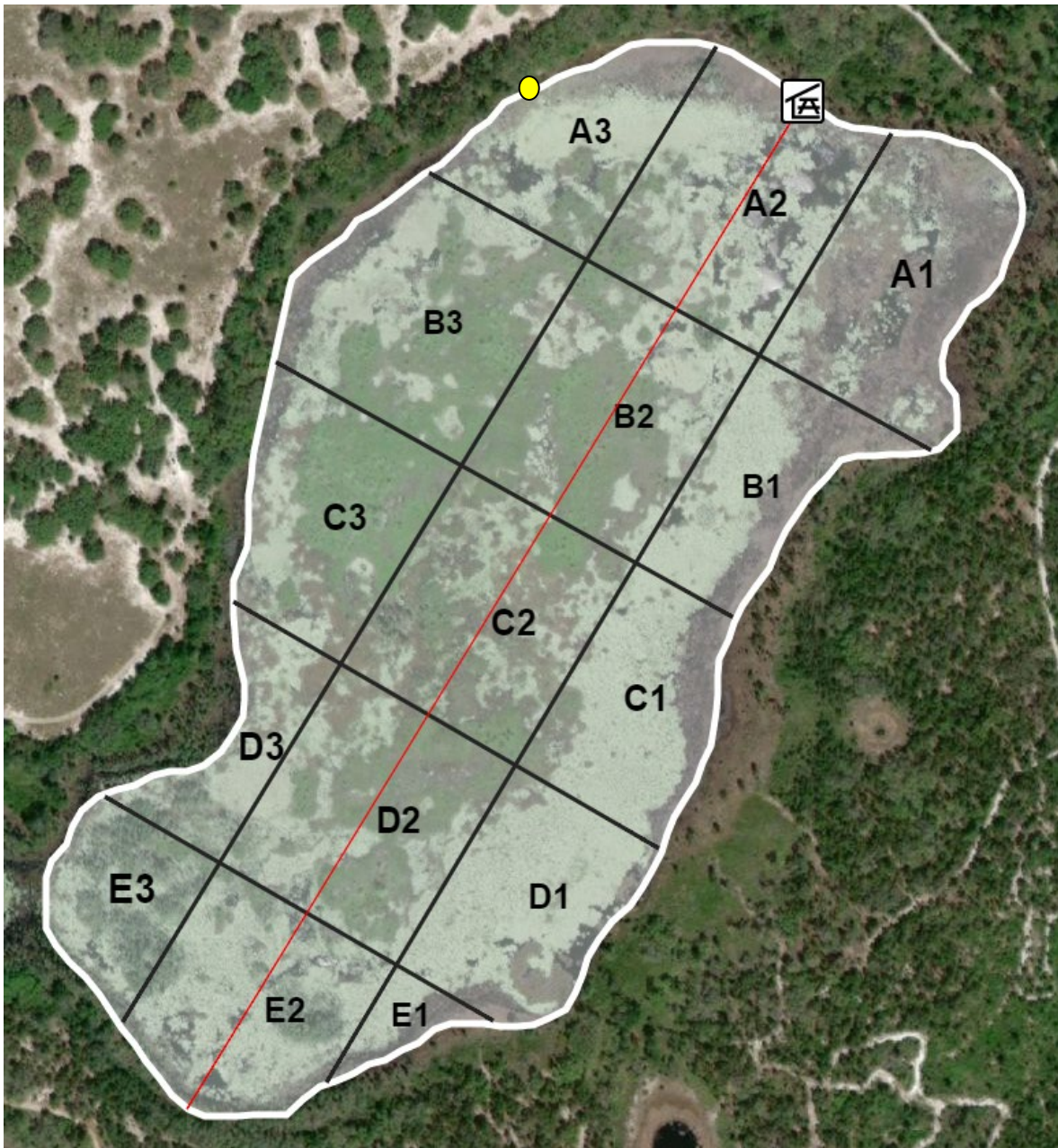


Figure 2: The GIS grid of Grassy Lake, with the bird blind marked by the recreational icon in section A2 and the central line highlighted in red. The location of the staff gauge is marked by the yellow point in section A3.

Focal Species

Sandhill Crane

Two subspecies of sandhill cranes are present in Florida, but the target species of this study was the threatened Florida sandhill crane (*Grus canadensis pratensis*). The Florida sandhill crane measures up to 47 inches long, and it is difficult to distinguish from the migratory greater sandhill crane (*Grus canadensis tabida*) without a direct comparison (Florida Fish and Wildlife Conservation Commission [FWC], n.d.). The *pratensis* subspecies is year-round resident in Florida, while the *tabida* subspecies winters in Florida but does not breed there. The current population estimates for Florida sandhill cranes are between 4,000 to 5,000 individuals based on suitable habitat availability. Nesting occurs primarily in January and egg-laying occurs primarily in late February to early March, but the breeding season can range from December to August each year depending on environmental conditions (Stys, 1997). Cranes use both upland and herbaceous wetland habitats to forage for food and exclusively use wetland habitats to nest. They are opportunistic omnivores with a highly variable diet, which includes seeds and roots, crop plants such as corn and peanuts, insects, snakes, frogs, and occasionally young birds and small mammals (FWC, n.d.).

Little Blue Heron

The little blue heron (*Egretta caerulea*) is a small wading bird (up to 29 inches long) found in Florida year-round (Cornell Lab of Ornithology [CLO], n.d.). They forage in shallow freshwater, brackish water, and saltwater, although densely vegetated freshwater lakes, marshes, swamps, and streams are preferred. Little blue herons are sight-hunters with a diet of small fish, insects, amphibians, crustaceans, and other invertebrates. They are mostly solitary but will occasionally forage among other wading bird species (FWC, 2003). Nesting occurs in mixed-species wading bird colonies from April to September, and nests are built in protected below-canopy areas such as low shrubs, small trees, and emergent vegetation (CLO, n.d.).

Tricolored Heron

The tricolored heron (*Egretta tricolor*) is a small wading bird (up to 26 inches long) found in Florida year-round (CLO, n.d.). They forage in wetlands, mangrove swamps, tidal creeks, ditches, and the edges of ponds and lakes (Florida Natural Areas Inventory [FNAI], 2001). They are sight-hunters with a diet of mostly of small fish. Tricolored herons either forage alone or among other wading bird species, and they nest in mixed-species wading bird colonies from February to August (FWC, 2003). Preferred nesting habitats are coastal environments, which include mangrove islands and woody thickets over standing water, although nesting is less common inland and during winter (FNAI, 2001).

Wood Stork

The wood stork (*Mycteria americana*) is a large wading bird (up to 45 inches long) found in Florida year-round (CLO, n.d.). They forage in freshwater wetlands and estuarine marshes, and are attracted to falling water levels that concentrate prey (FNAI, 2003). Wood storks are tactile feeders and forage by probing their bills underneath the water while kicking the substrate and flicking their wings to disturb small to medium-sized fish, crayfish, amphibians, and reptiles (FWC, n.d.). They feed alone or in groups, and nest colonially in mixed hardwood swamps,

sloughs, mangroves, and cypress domes. In Florida, their nesting season can range from October to June, although most breeding colonies are established from February to March.

Roseate Spoonbill

The roseate spoonbill (*Platalea ajaja*) is a medium wading bird (up to 40 inches long) found in Florida year-round (CLO, n.d.). They forage in freshwater, brackish water, and saltwater with high concentrations of aquatic invertebrates, although they are found mostly along the coast. Spoonbills are tactile filter-feeders and capture prey by moving their bill from side to side in shallow water less than five inches deep. In the Tampa Bay region, breeding and nesting occurs from February to June in mixed wading bird colonies on small mangrove keys or artificial dredged-material islands along the coast (FWC, 2003).

Southeastern American Kestrel

The southeastern American kestrel (*Falco sparverius paulus*) is a small falcon (up to 12 inches long) found in Florida year-round, while the similar northern American kestrel subspecies (*Falco sparverius*) winters in Florida (FWC, n.d.). Southeastern American kestrels prefer open habitats, like pine flatwoods and longleaf pine sandhills that have enough ground cover to house prey such as insects, rodents, and lizards. (FWC, 2003) They nest between March and June, and use old woodpecker cavities, power poles, kestrel boxes, and buildings to raise their young.

Least Tern

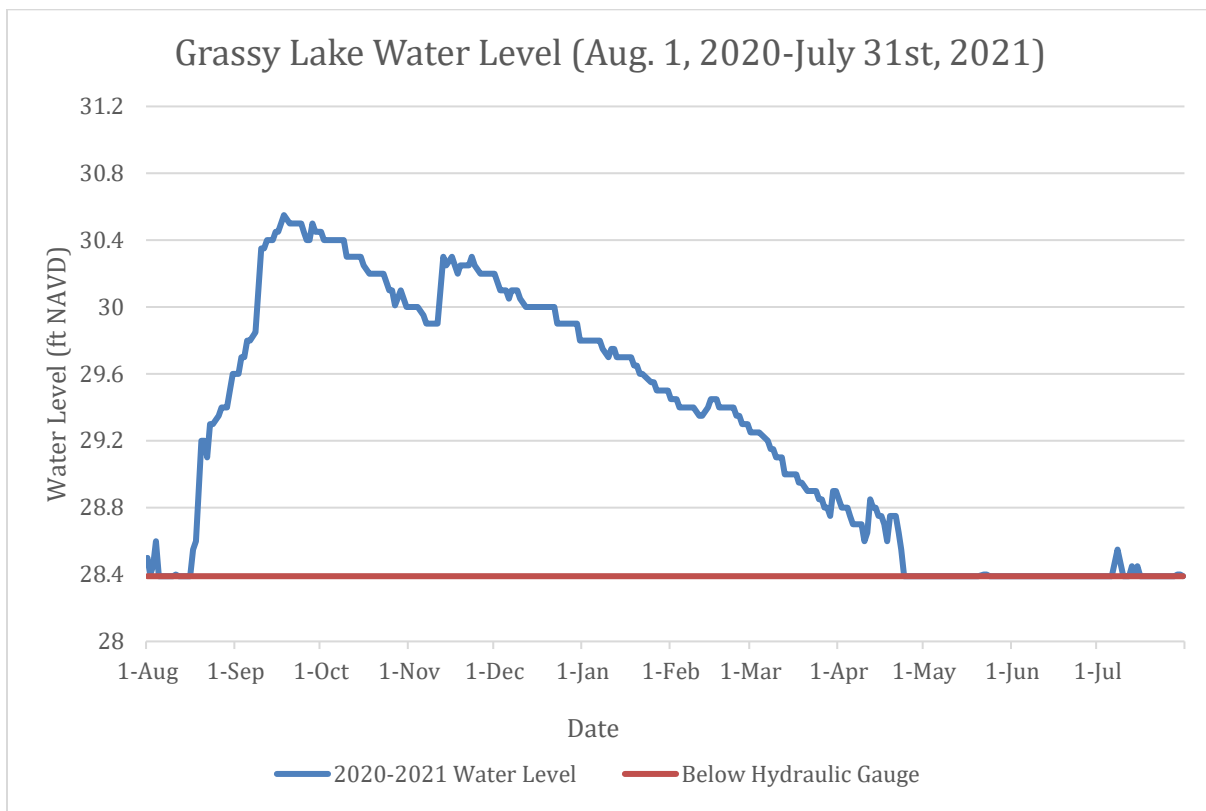
Least terns are the smallest species of tern in North America (up to 9 inches long), and they are a migratory species found in Florida from March to October (FNAI, 2001). They are seabirds which are found in coastal habitats, although there have been inland sightings of least terns at parking lots, agricultural fields, and airports (CLO, n.d.). They will hunt for small fish in almost any aquatic environment, where they catch prey by diving into the water from above. Least terns nest in colonies on beaches or areas with sandy/shelly soil and limited vegetation, such as islands along coastlines and rivers from mid-April until August (FWC, 2003). Due to human disturbance and increased predation, least terns have been using gravel roof tops to nest (FNAI, 2001).

Data Analysis

Water Level

Water levels (in feet NAVD) were taken from the Pasco County hydraulic staff gauge, which was read daily by Pasco County data technicians. The hydraulic gauge was located in the northwest corner of the wetland, where water was pumped in for augmentation. Periods when the water levels were below the bottom measurement of the gauge (28.4 feet NAVD) were classified as “below hydraulic gauge” and combined into one weighted interval. Other gauges installed in Grassy Lake were only recorded biweekly, so they were not used for comparison. The exact bathymetry of the wetland was unknown, and measurements from the water surface to the bottom were not taken due to study constraints. The wetland was inferred as shallow with intermittent deeper pools, due to the mix of shallow-water grasses among clusters of emergent and aquatic plants.

Grassy Lake had standing water year-round, even as water levels fluctuated with the seasons and rainfall. The highest water levels were recorded in the fall and winter, and declined in the spring and summer (Graph 1). The peak water level was 30.55 feet NAVD on September 18, 2020 and the lowest level was below 28.4 feet NAVD from the months of May 2021 to July 2021. The 2021 dry season was significantly dryer than previous years with total recorded rainfall at 15.56 inches, as compared to about 23.24 inches in 2020, about 23.53 inches in 2019, and about 23.81 inches in 2018 (SWFWMD, n.d.).



Graph 1: Fluctuations in water level from the beginning of August 2020 to the end of July 2021

Water Level and Seasonality Comparisons

Water level was measured in 0.05-foot increments from 28.4 feet NAVD to 30.55 feet NAVD. At each increment, the water level was compared to the weighted average of recorded sightings. The weighted average was calculated by dividing the number of sightings by the number of days at each 0.05-foot increment.

Each season was compared to the recorded focal species behaviors. The seasons were three months long, and included summer (August 2020, and June 2021 to July 2021), fall (September 2021 to November 2021) winter (December 2021, and January 2022 to February 2022), and spring (March 2021 to May 2021). The two split summers were combined for analysis, because the study started in August 2020 and ended in July 2021.

Sandhill Crane²:

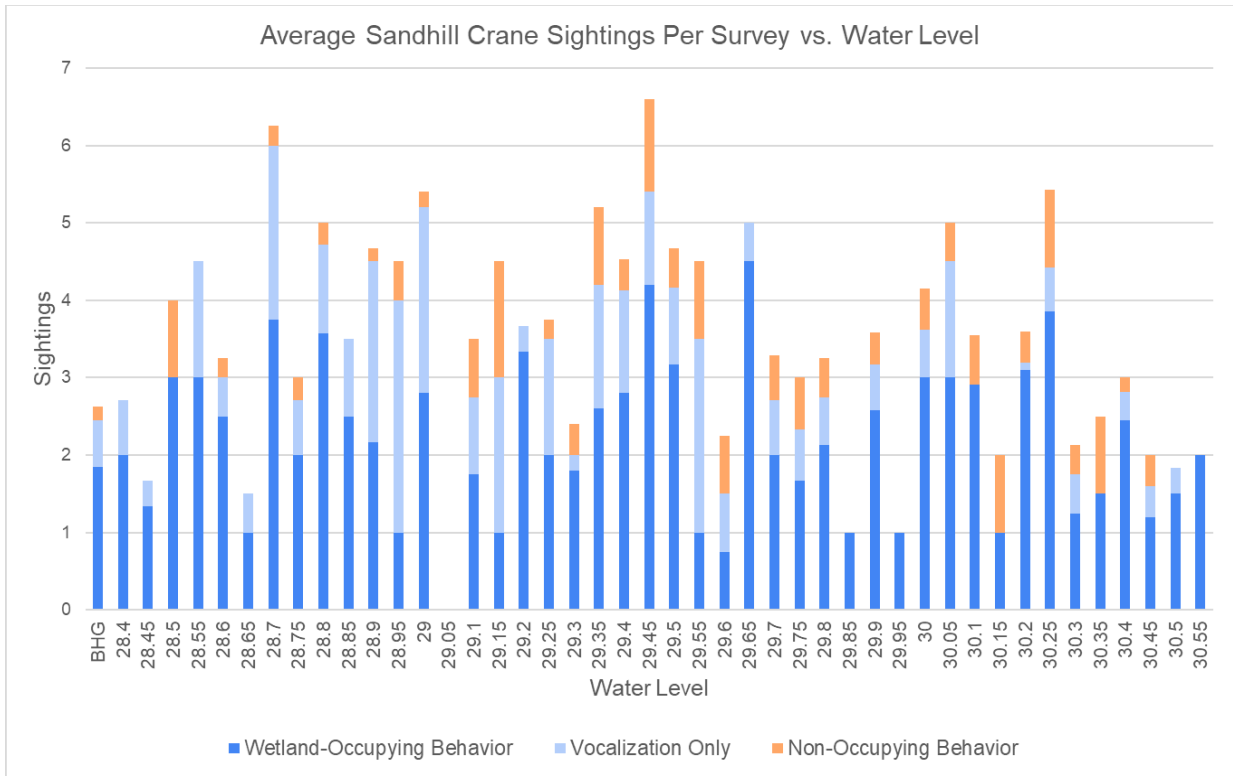
Sandhill cranes were observed in Grassy Lake in 300 out of 302 surveys (about 99%), and the average number of sightings per survey was about 3.44. A total of 2,050 cranes were seen across 1,043 total sightings, with the average size of a group at about 1.97 cranes. The average wetland occupation was about 56% of the total sightings, not including “vocalization only” entries. About 33% of instances³ were identified by “vocalization only”, and about 11% of sightings were classified as “non-occupying”.

There was no measurable trend for sandhill crane sightings when compared to water levels (Graph 3). “Vocalization only” behavior increased at lower water levels, but no other behavioral trends correlated to water level fluctuations. The average crane sightings increased from fall to winter, then decreased from winter to summer (Graph 4).

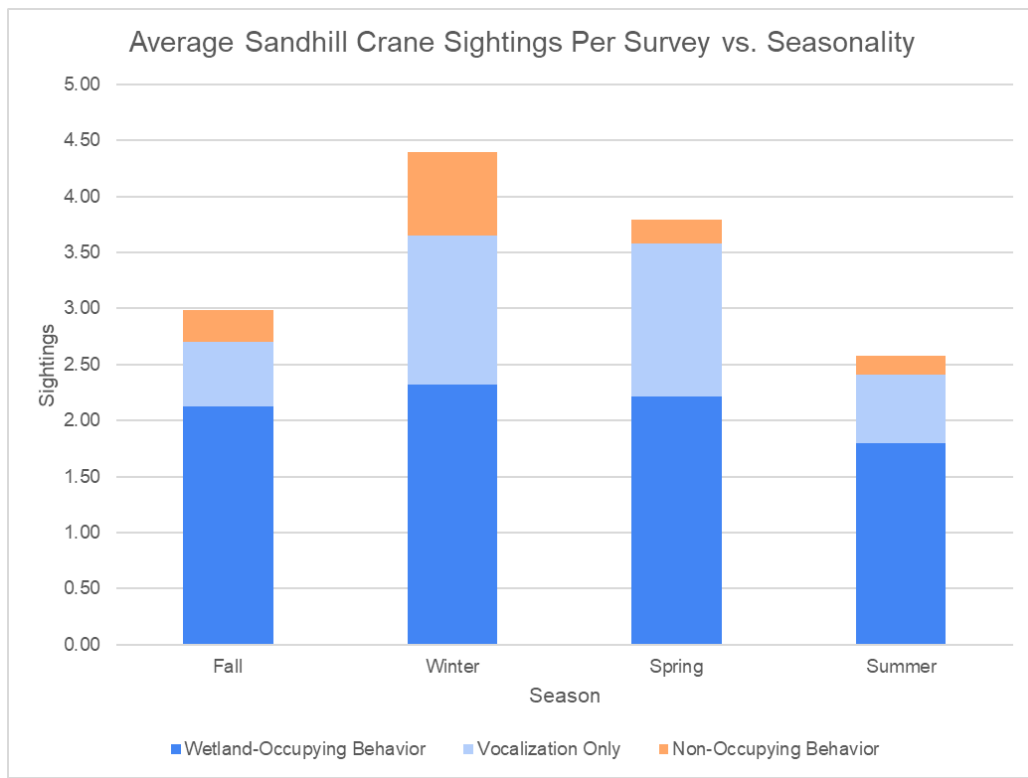
Wetland occupation by sandhill cranes was lowest in winter at about 53% and spring at about 58%, while occupation was about 71% in the fall and about 70% in the summer. Vocalizations increased in the winter at about 30% and spring at about 36%, then decreased in summer at about 23% and fall at about 19%. When vocalizations were included with wetland-occupying behavior, the data showed about 83% occupation in the winter, compared to about 94% in spring, about 93% in the summer, and about 90% in the fall.

² The designation “Sandhill Crane” was given to both the threatened *Grus canadensis pratensis* subspecies and the *Grus canadensis tabida* subspecies, because the subspecies could not be accurately determined without a direct comparison.

³ When the birds were not visually observed but still recorded in a database entry



Graph 3: Average weighted relationship between water level and sandhill crane sightings per survey, separated by behavior

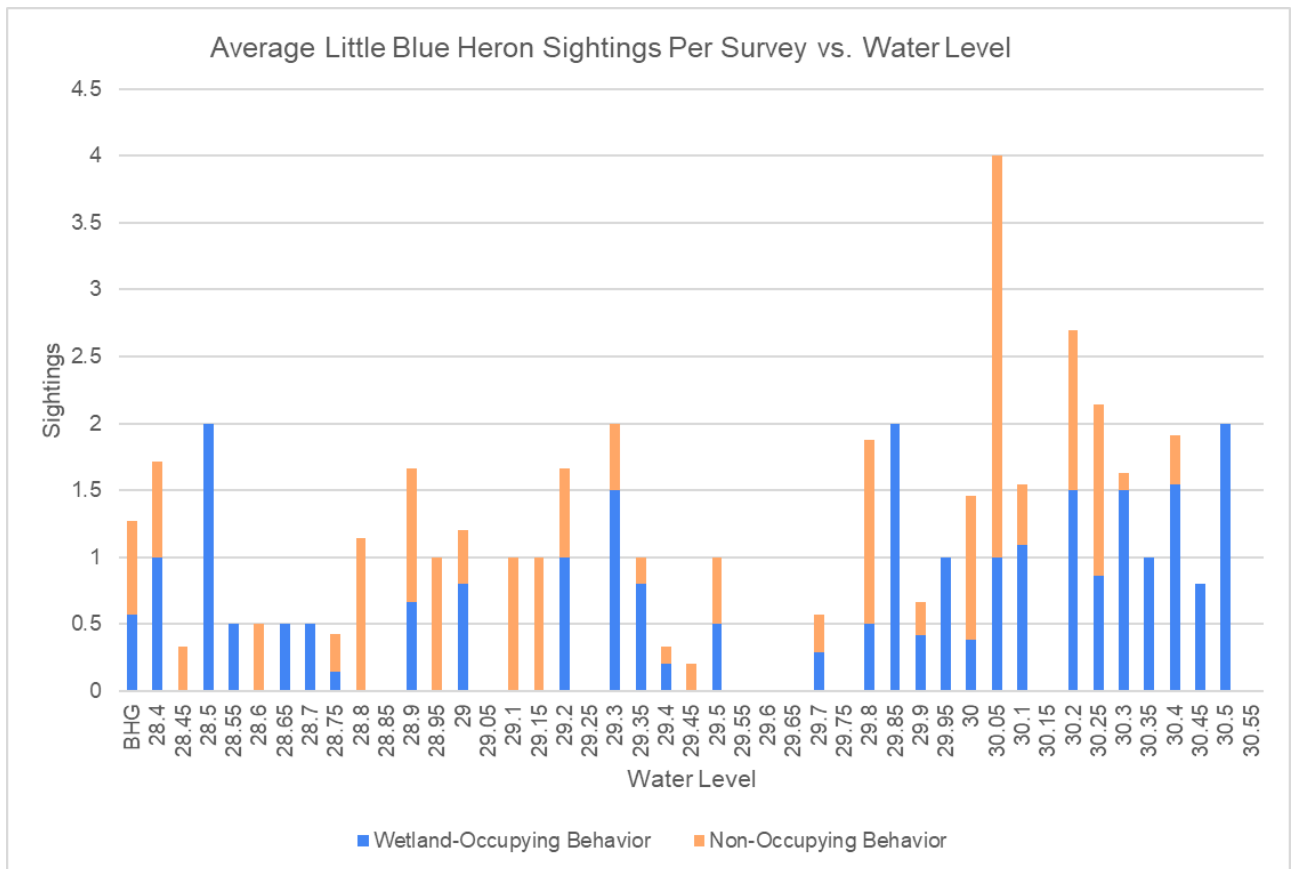


Graph 4: Average number of sandhill crane sightings per survey during each season, separated by behavior

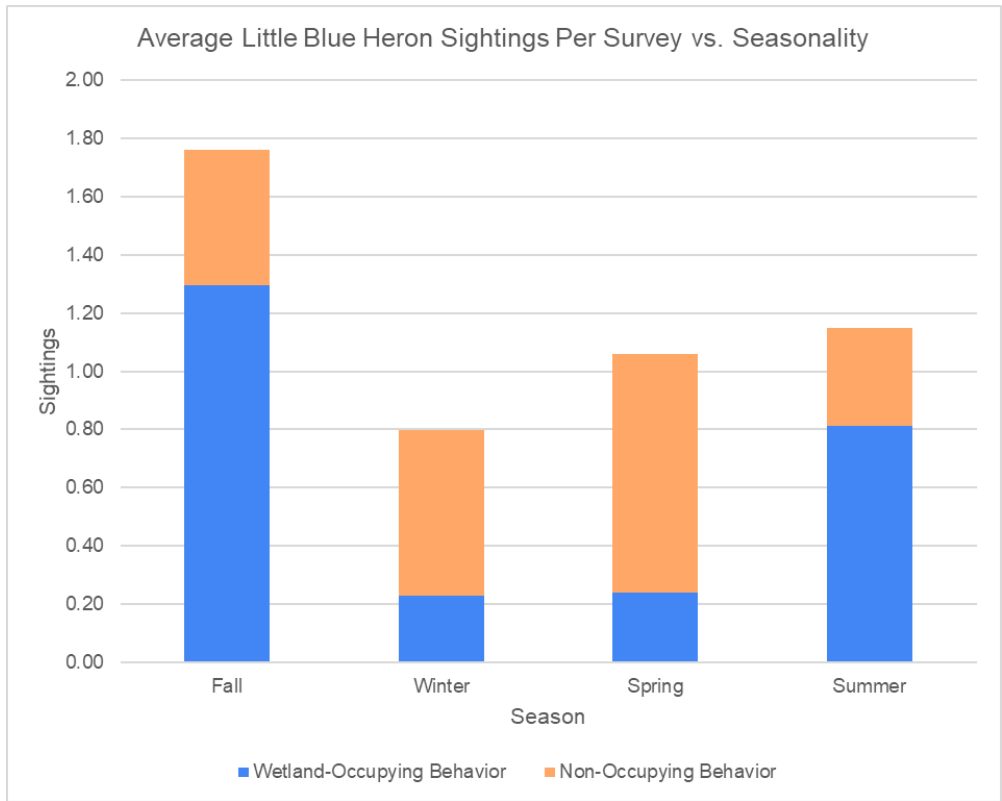
Little Blue Heron

Little blue herons were observed in Grassy Lake in 179 out of 302 surveys (about 59%), and the average number of sightings per visit was about 1.19. A total of 599 herons were seen across 357 sightings, with the average size of a group at about 1.68 herons. The average wetland occupation was about 53% of the total sightings.

Little blue heron sightings were highest when the water level was above 29.80 feet NAVD. Wetland-occupying behavior also increased beyond that interval (Graph 5). Seasonally, the highest number of little blue heron sightings occurred in the fall, then decreased in winter, and increased in the spring and summer (Graph 6). Winter and spring had the lowest wetland occupation, with winter at about 29% and spring at about 23%, compared to about 74% in the fall and about 71% in the summer.



Graph 5: Average weighted relationship between water level and little blue heron sightings per survey, separated by behavior

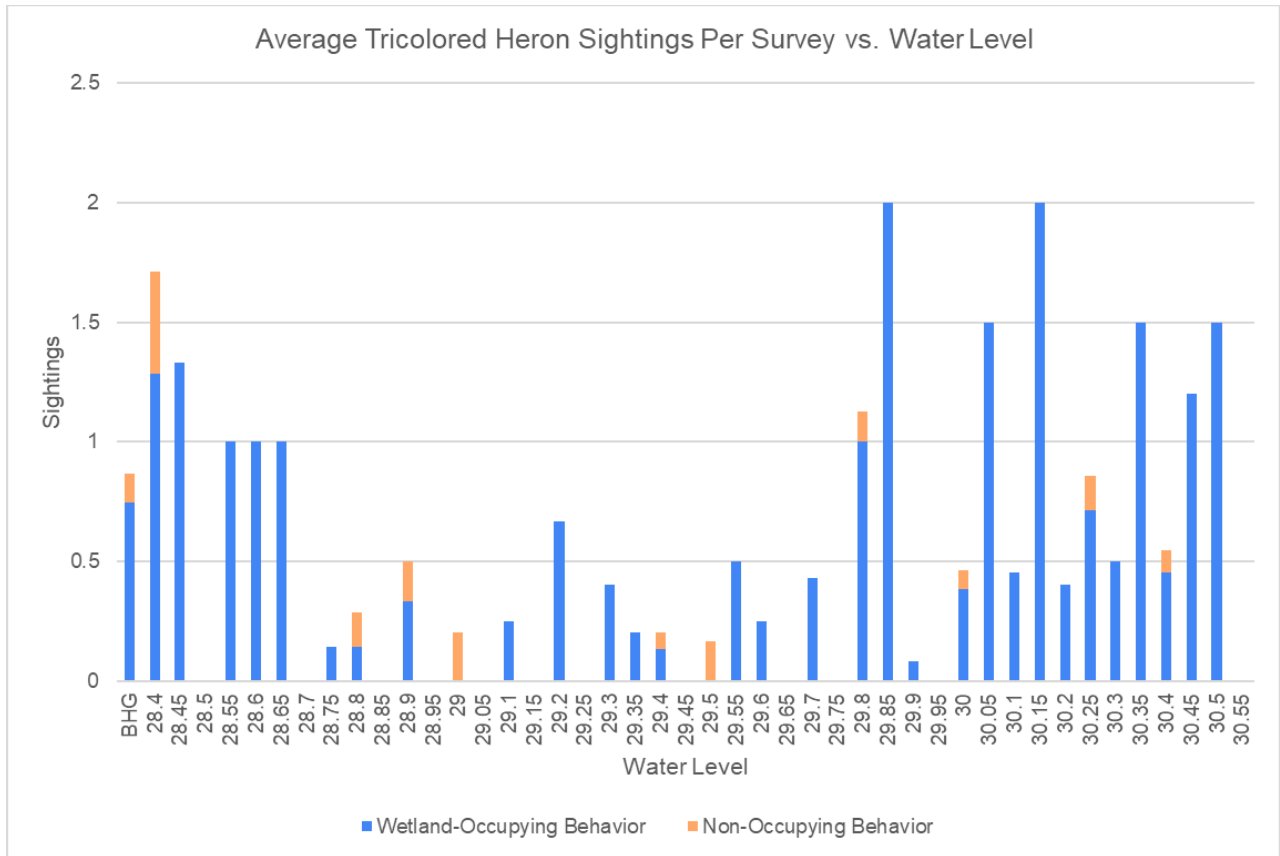


Graph 6: Average number of little blue heron sightings per survey during each season, separated by behavior

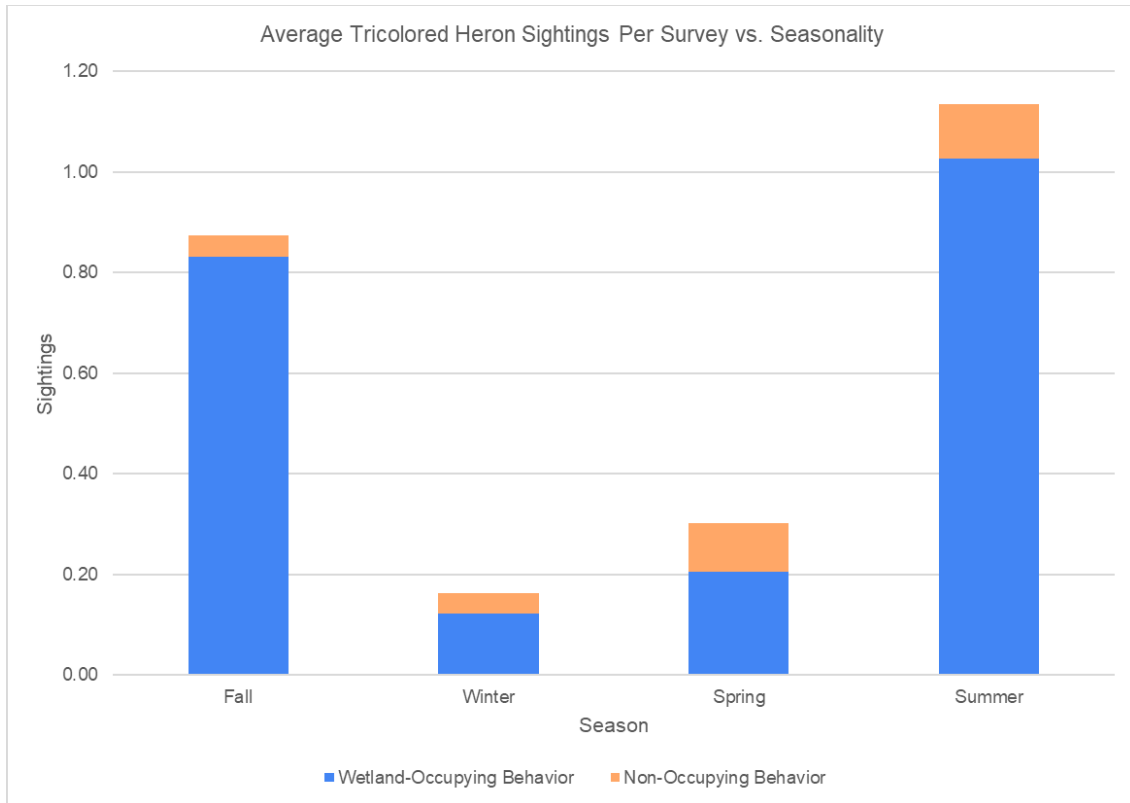
Tricolored Heron

Tricolored herons were observed in Grassy Lake in 116 out of 302 surveys (about 38%), and the average number of sightings per visit was about 0.61. A total of 208 herons were seen across 183 sightings, with the average size of a group at about 1.14 herons. The average wetland occupation was about 88% of the total sightings.

Tricolored heron sightings were recorded most frequently at the lowest water levels (28.65 feet NAVD and below) and highest water levels (29.85 feet NAVD and above), as shown on Graph 7. There was no observable trend when behavior was compared to water levels. Seasonally, there were more sightings in fall and summer, and the percentages of wetland-occupying behavior decreased in winter and spring (Graph 8). In the winter, wetland-occupying behavior was at about 75%, and in the spring it was about 68%, compared to the fall which was about 95% and the summer which was about 90%.



Graph 7: Average weighted relationship between water level and tricolored heron sightings per survey, separated by behavior

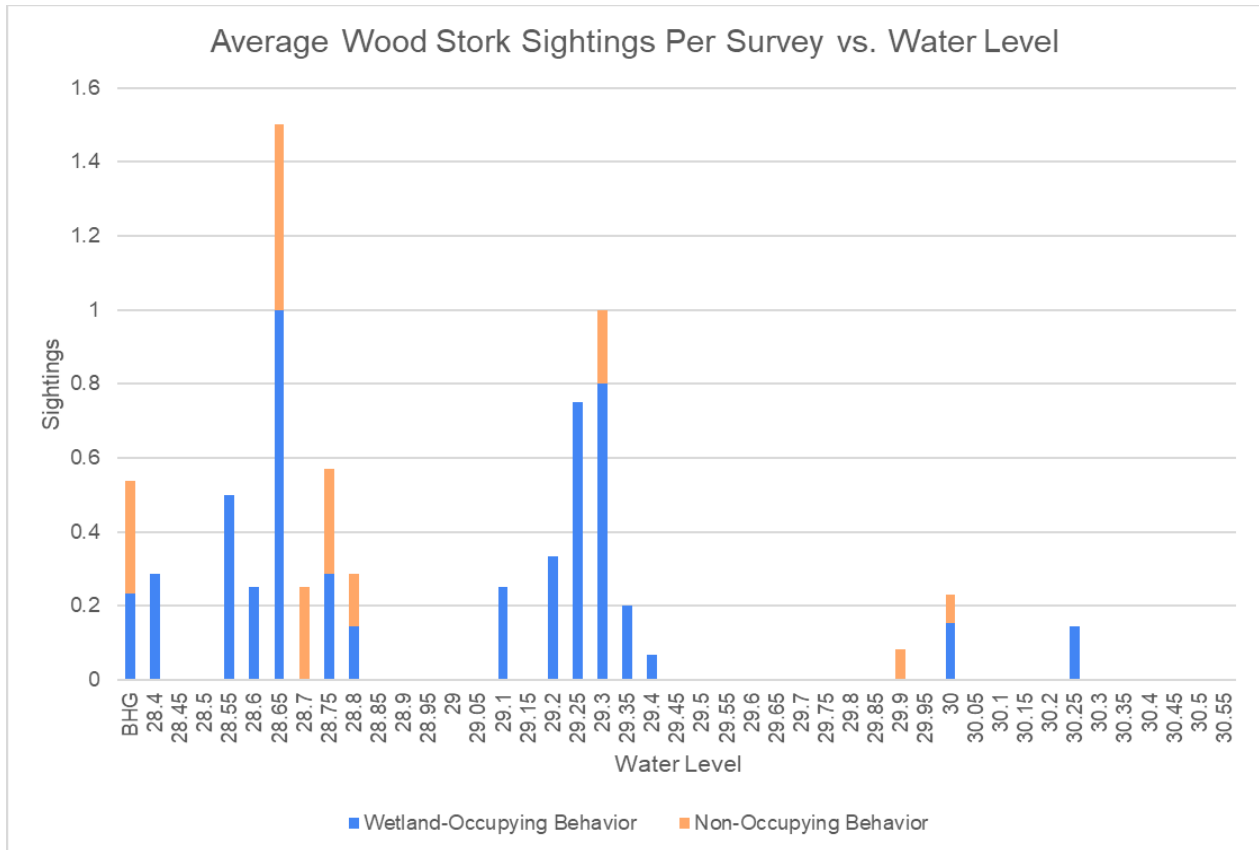


Graph 8: Average number of tricolored heron sightings per survey during each season, separated by behavior

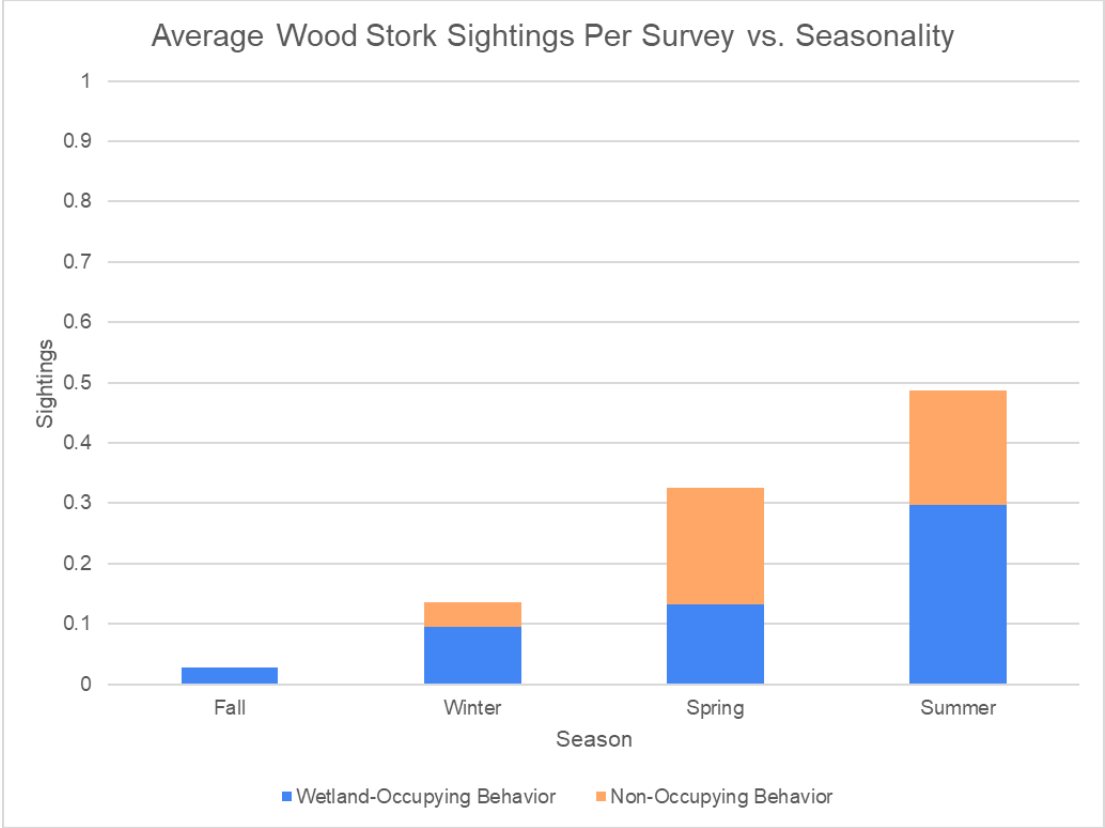
Wood Stork

Wood storks were observed in Grassy Lake in 59 out of 302 surveys (about 20%), and the average number of sightings per visit was about 0.25. A total of 84 storks were seen across 75 sightings, with the average size of a group at about 1.12 storks. The average wetland occupation was about 56% of the total sightings.

Based on the limited data, wood storks were present more frequently when the water levels were lower, from the intervals 29.1–29.35 feet NAVD and 28.8 feet NAVD and below (Graph 9). There was no observable trend for behavior when compared to water depth. Seasonally, wood stork sightings were lowest in the fall, then increased with each subsequent season until they peaked in summer (Graph 10). Wetland-occupying behavior was 100% in fall (with a total of two sightings), about 70% in the winter, about 41% in the spring, and about 61% in the summer.



Graph 9: Average weighted relationship between water level and wood stork sightings per survey, separated by behavior

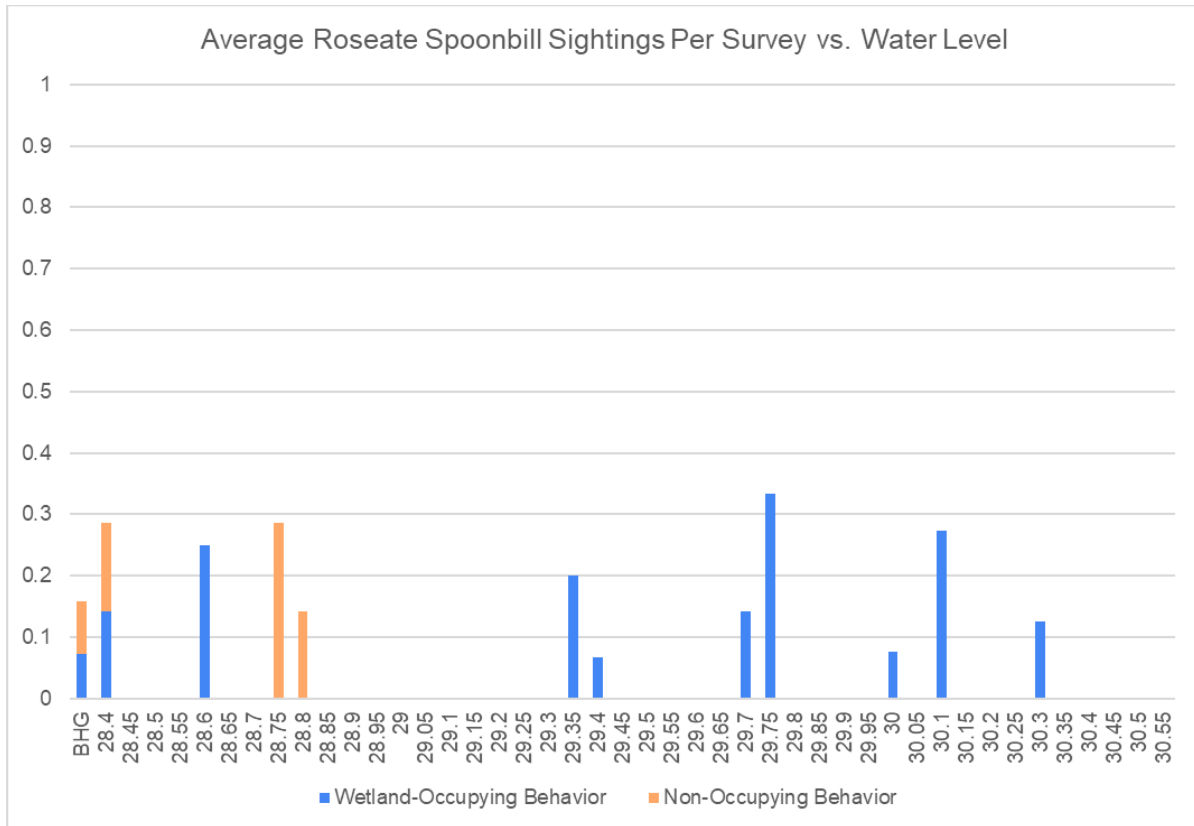


Graph 10: Average number of wood stork sightings per survey during each season, separated by behavior

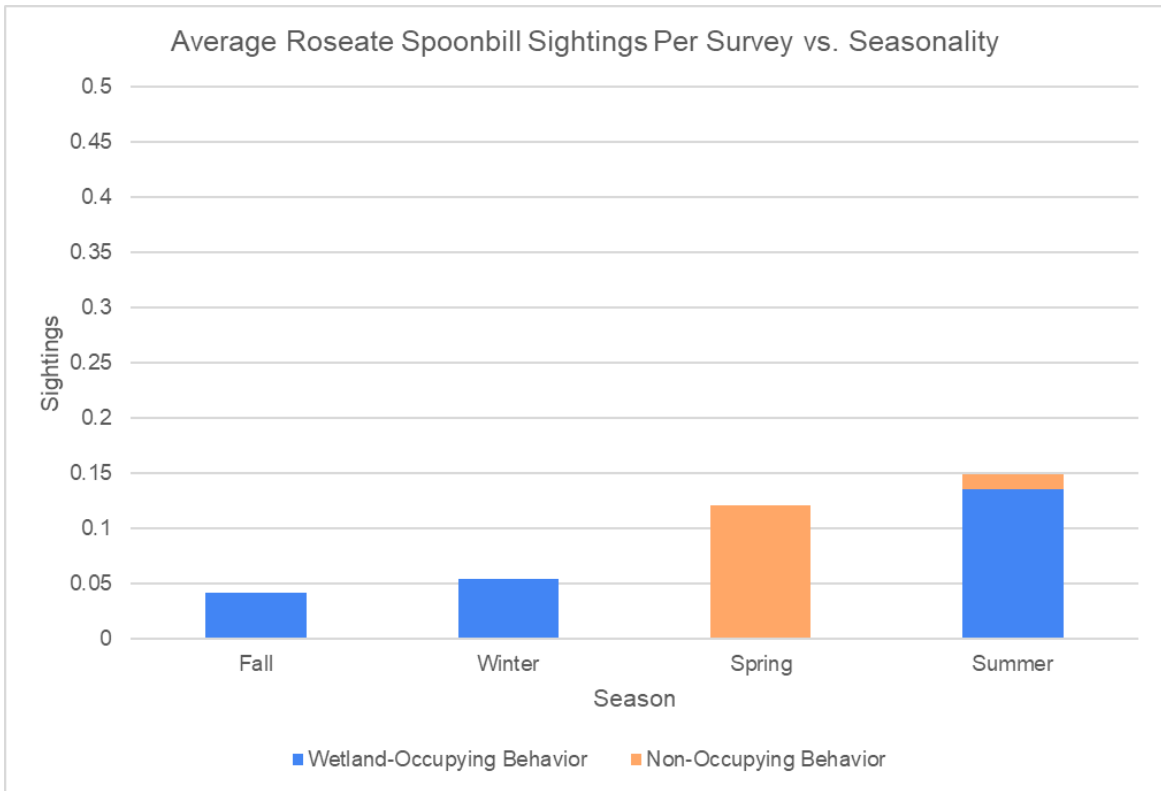
Roseate Spoonbill

Roseate spoonbills were observed in 27 out of 302 surveys (about 9%), and the average number of spoonbills seen per visit was about 0.13. A total of 40 spoonbills were seen across 28 sightings, with the average size of a group at about 1.43. The average wetland occupation was about 61% of the total sightings.

Based on the limited data, there was no significant trend for water level and roseate spoonbill sightings (Graph 11). Non-occupying behavior was only observed at water levels 28.80 feet NAVD and below. Seasonally, sightings were lowest in the fall and winter, then increased in the spring and peaked in the summer (Graph 12). Wetland-occupying behavior was 100% in fall and winter (each with a total of three sightings), and about 91% in the summer. Spring was the only season where spoonbills were not seen using the wetland.



Graph 11: Average weighted relationship between water level and roseate spoonbill sightings per survey, separated by behavior

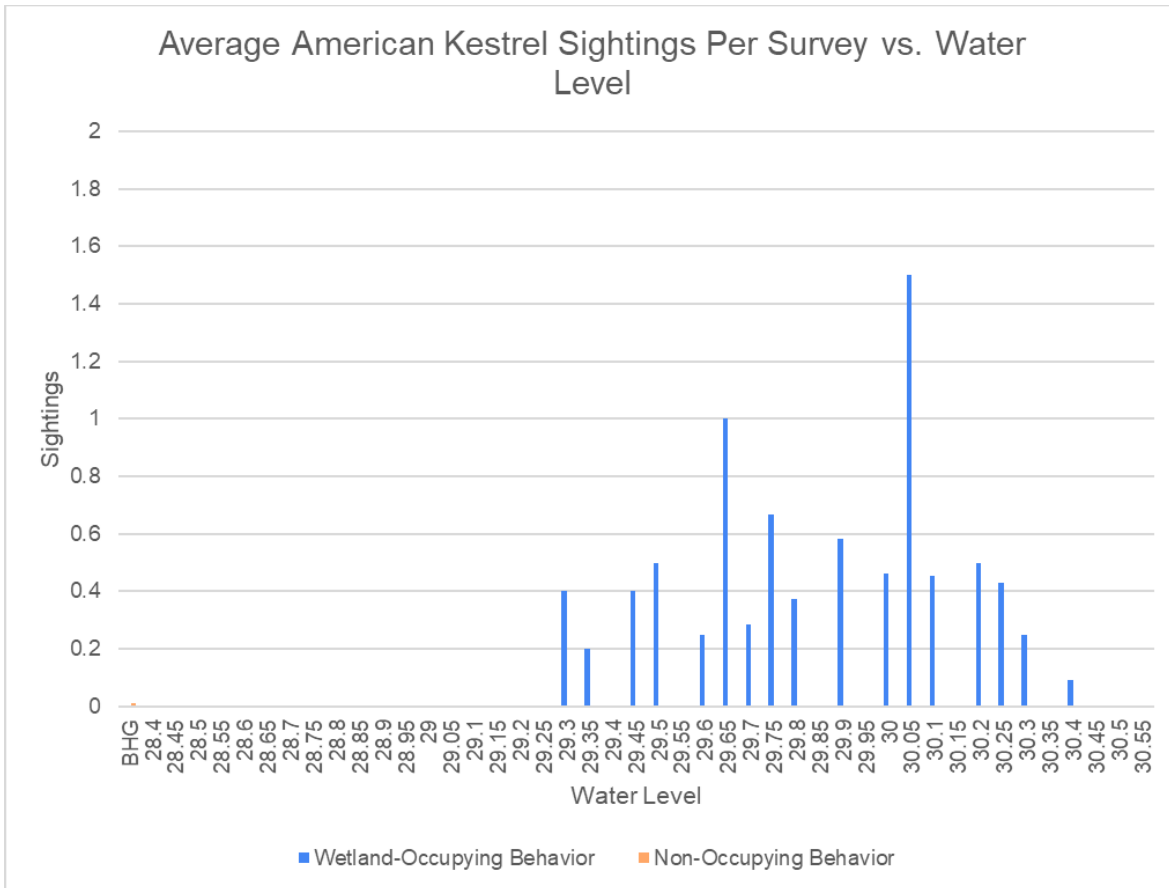


Graph 12: Average number of roseate spoonbill sightings per survey during each season, separated by behavior

American Kestrel⁴

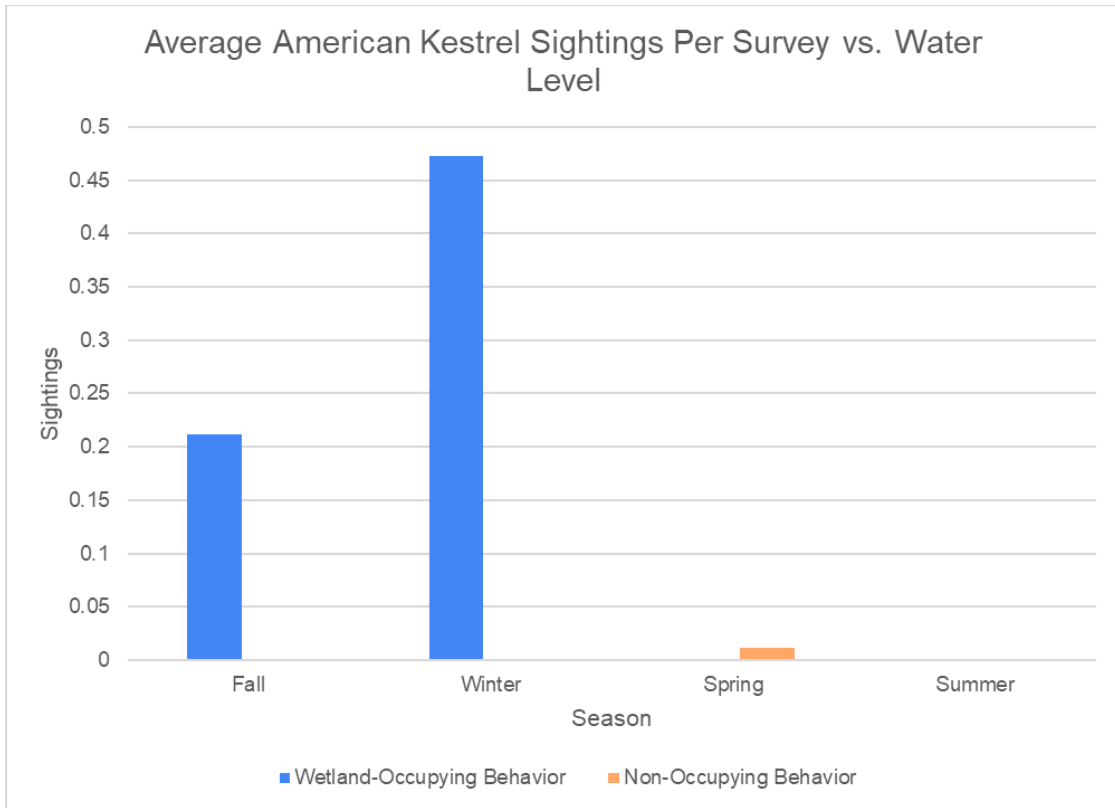
American kestrels were observed in Grassy Lake in 46 out of 302 surveys (about 15%), and the average number of kestrels seen per visit was about 0.17. A total of 51 kestrels were seen across 50 sightings, with the average size of a group at 1.02. Only one of the sightings was classified as “non-occupying”, or about 0.02%.

Based on the limited data, American kestrels were almost always sighted between the water levels of 29.3 feet NAVD to 30.4 feet NAVD, although one sighting occurred when the water level was below the hydraulic gauge (Graph 13). Wetland-occupying behavior was the only behavior observed in fall and winter, and all sightings were of kestrels perched in trees. A single occurrence of non-occupying behavior occurred in the spring. Seasonally, sightings increased from fall to winter, then significantly decreased in spring (Graph 14). Summer had no recorded sightings.



Graph 13: Average weighted relationship between water level and American kestrel sightings per survey, separated by behavior

⁴ The designation “American kestrel” was used due to potential sightings of both the southeastern (*Falco sparverius paulus*) and northern (*Falco sparverius*) subspecies



Graph 14: Average number of American kestrel sightings per survey during each season, separated by behavior

Least Tern

No least terns were seen or recorded during the duration of the study.

Results and Discussion

Focal Species

Sandhill Crane

Overall water level did not appear to have a significant effect on the wetland-occupying behavior of sandhill cranes at Grassy Lake. The presence of sandhill cranes was relatively consistent across the range of water levels recorded. Vocalizations were more frequent at the low and mid-range water levels; however, overall use of the wetland did not markedly decrease at those levels. It is possible that the vocalizations came from parts of the wetland that were out of sight, which may have become accessible due to lower water levels, although this cannot be confirmed.

It appeared that seasonality affected sandhill crane behavior and wetland occupation. It can be inferred that the migratory greater sandhill crane species (*Grus canadensis tabida*) utilized Grassy Lake as a wintering ground, as demonstrated by the increase in sightings in the winter and spring. Additionally, the increase in non-occupying behavior in the winter may be attributed to sightings of migratory cranes flying over the study site.

The findings suggest that Grassy Lake was used by the threatened Florida sandhill crane subspecies (*Grus canadensis pratensis*) for nesting and breeding. Sightings that included breeding behavior were outside of the *tabida* subspecies' migratory window. Two separate family groups, each with a flighted juvenile, were observed throughout August 2020. On April 4, 2021, it was confirmed that a sandhill crane colt was reared by a pair of cranes that had nested in Grassy Lake (Figure 2). Although the nest was not directly visible, the crane pair was observed sitting in flattened grasses in section B2 on multiple occasions.

As noted in the supplementary database comments, the sandhill cranes appeared to establish small grazing territories within the wetland. Distinct pairs and family groups were recorded foraging in the same general locations over the course of the study. Established pairs displayed territorial behavior such as vocalizing and defensive posturing toward other groups of cranes that approached.



Figure 2: Sandhill crane pair foraging with colt in April 2021 (Credit: Christine Rowland)

Little Blue Heron

Little blue herons were sighted most frequently during periods of raised water levels. The highest water levels were recorded in the fall, which was the season that had distinctly more little blue heron sightings overall. Water levels were also high in the winter, but overall heron sightings greatly decreased. Based on this observation, wetland occupation may be more reliant on seasonality.

It is possible that the wetland was mostly vacated for the breeding season due to the large percentage of non-occupying behavior in the winter and spring combined with a low number of sightings. Most sightings during the winter and spring seasons were of herons that flew a south-north path over the wetland. Because little blue herons travel to forage, it is possible that a rookery had been established to the south of Grassy Lake. Juveniles were observed in Grassy Lake (Figure 3), but there was no reported nesting. One important note is that the presence of juveniles may have contributed to misidentification and under-reporting of little blue herons sighted, because they have white plumage and appear similar to snowy egrets and cattle egrets from a distance.



Figure 3: Juvenile little blue heron perched on a young cypress tree in Grassy Lake (Credit: Christine Rowland)

Tricolored Heron

Tricolored heron sightings occurred most frequently at lowest and highest recorded water level ranges. Fall had the highest water levels with distinctly more tricolored heron sightings, but sightings markedly decreased in the winter while water levels were still elevated. The lowest water levels were recorded in the late spring and summer; however, the number of spring sightings was low while summer sightings greatly increased. Decreases in wetland-occupying behavior in the winter and spring were also noted, so it is possible that seasonality is a bigger factor for wetland occupation than water level. However, the data is limited so it is unclear if this is a true trend. It is possible that the wetland was mostly vacated for the breeding season due to the tricolored heron's preference for nesting in coastal habitats.

Wood Stork

Wood storks were sighted more frequently when water levels were low. Fall had the highest water levels and the lowest number of sightings, and sightings increased sequentially with each season. Summer had the highest number of sightings, which is when the water levels were lowest. Due to the limited amount of data collected, the trend may not be significant and further observations would help supplement the findings of this study. It is unclear if the storks were influenced by seasonality because there was no observable trend when wetland-occupying behavior was compared to the seasons.

Roseate Spoonbill

There was no observable trend when roseate spoonbill sightings and behaviors were compared to water levels. Sightings increased slightly with each season from fall to summer, and spring was the only month where no wetland-occupying behavior was recorded. However, seasonal trends could not be established due to the extremely limited dataset. With the lack of consistent sightings throughout the course of the year, it is possible that Grassy Lake is too far inland for roseate spoonbills due to their preference for coastal habitats. Based on this, it is likely that they use Grassy Lake infrequently, regardless of water level or seasonality.

American Kestrel

The appearance of American kestrels in the late fall and early winter indicated that they may have been the Northern subspecies, rather than the threatened Southeastern subspecies. No kestrel sightings were recorded before October 8th, 2020, or after February 26th, 2021 (with one exception on May 17th, 2021, where the bird was observed flying over the study site). They did not display any foraging or food-seeking behaviors and were only recorded perching in trees. Therefore, it is likely that water level did not affect the kestrel's use of Grassy Lake and that sightings were based solely on seasonality.

Least Tern

Least terns were not observed during the duration of the study. It is likely that Grassy Lake's wetland habitat was not suitable for their needs due to their coastal habitat preference.

Considerations

Limited conclusions can be drawn from this study regarding the effects of seasonality and water level on wading bird behavior, because the study's duration was only a year and each season was observed once. The trends established from the data may vary on a yearly basis, so a multiple-year study would be able to capture any notable trends. Additionally, different environmental factors (such as hurricanes, wildfires, and rainfall variations) may impact bird behavior and wetland occupation. However, the data gathered can serve as a useful blueprint for more in-depth studies in the future, as well as guide management suggestions based on the observed behaviors.

Overall, Grassy Lake is a productive ecosystem that supports a variety of wildlife, including the threatened bird species highlighted in this study. It is evident that the Florida sandhill crane consistently uses Grassy Lake for multiple purposes, including roosting, foraging, and nesting. Limiting pumping in the early spring months when the cranes are nesting may be a useful consideration. Sandhill crane nests are vulnerable to destruction by flooding, and the cranes will seek out different territories after a failed nesting (Stys, 1997).

For future studies, a deeper-water staff gauge would depict water levels more accurately, because the water levels recorded in this study were constrained due to gauge length. Also, imagery that depicts the bathymetry of Grassy Lake would help identify shallower and deeper portions of the wetland. Such information would provide a clearer insight on the relationship between the water levels and wetland use by waders. Additionally, an in-depth assessment of the vegetative structure of Grassy Lake may provide insight into wetland use, as this variable was unaccounted for during this study.

Acknowledgements:

Special recognition is given to the Duke Energy Corporation for sponsoring the Grassy Lake bird blind on behalf of the Audubon Society. Recognition is also given to the Pasco County Public Works department for providing access to the staff gauge reading data and providing copies of the Water Use and Environmental Resource Permits associated with the augmentation of Grassy Lake. Thanks are given to Casey Cumley of the Southwest Florida Water Management District for providing aerial photography and drone footage of Grassy Lake.

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