Anthropogenic disturbances do not affect the abundance of shorebirds on Long Island Sound beaches

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Abstract

The increase of the human population on beaches changes the behavior of the avian populations. This study tests if human disturbance will have a negative effect on the abundance of the shorebird populations. Surveys conducted at four beach sites. Each site was surveyed 5-8 times for a total of one hour by walking from the end of the beach to the other counting individual birds and humans. The data do not suggest anthropogenic disturbances affected how the birds used the beach, where they chose to congregate, and overall behavior.

Introduction:

Coastal zones are diverse habitats that house humans, flora, and fauna alike. These zones are ideal habitats for their ecological importance, aesthetically pleasing views, and recreational activities. Coastal beaches are rich in biodiversity and house resident and migratory shorebirds that are vital species to the coastal ecosystem (Epstein 2016). Sandy beaches are crucial for shorebird populations for foraging, nesting, and roosting (Meager et al. 2012). The shorebird populations rely on coastal biodiversity for a selection of food sources and plant diversity for nesting and roosting comfortably.

More than half of the world's population resides within 60 kilometers of ocean shorelines (Schlacher et al. 2008). With the population of humans increasing near the shore, there are increased demands for development and recreational activities that can escalate the degradation of sandy beach ecosystems (Schlacher et al. 2008). Outdoor recreation and ecotourism are becoming more popular, this has led to the importance of management and planning for development projects to accommodate the human populations residing near coastal zones (Navedo and Herrera 2012). The increase of the human population to the shores has led to the development of drainage systems, dykes, and land conversion for residential and agricultural purposes (Navedo and Herrera 2012).

In the Anthropocene era, humans have drastically changed Earth's ecosystems and landscapes (Monastersky 2015). Coastal zones are being shaped by the actions of humans and the effects of climate change (Schlacher et al. 2008). All these human disturbances to the land have adverse effects to the fauna that inhabit these shore ecosystems. Human disturbances can

be described as any activity that can change the behavior and physiology of fauna (Nisbet 2000). In beach ecosystems, human disturbances can be broken down into three categories: scientific investigators, ecotourists, and recreators (Burger at al 1995). Mayo et al. (2015) found that human disturbances to fauna populations increased in the summer months when the weather is warmer.

Human activities have shown to have a negative influence on shorebird choice and use of habitat (Meager et al. 2012, Mayo et al. 2015). Human recreational activities can disturb shorebirds by limiting the birds' access to profitable foraging areas, which reduce their foraging rates, increasing energetic costs and decreasing their feeding rates (Navedo and Herrera 2012, Mayo et al. 2015, and Schlacher et al. 2013). The avian response to the human disturbance has led to the birds led birds to either risk predation to forage or sacrifice foraging for safety. Stillman and Goss-Custard 2002). Meager et al. (2012) have found that avians are likely to avoid habitats with recreational activities in the intertidal zone where the bird forage. Navedo et al. (2012) suggest that human disturbance influencing these energetic costs can be more detrimental than the gradual loss of habitat. With human presence hindering the energetic demands of birds, starvation and reduced fitness become more apparent in shorebird populations. Human recreational activities also affect avian food sources directly. Humans clean the beaches with large off-road vehicles leading to the destruction of nests and beach invertebrates which are a staple in the shorebird diet (Schlacher et al. 2008). Foraging for food is essential to survival but often becomes more challenging with the presence of humans (Goumas et al. 2020).

Along with altering foraging behavior, human disturbance impacts the nesting behavior of shorebirds. Avian species that use the shorelines as nesting habitats are hindered by human disturbance and increased development and are vulnerable to human intrusion (Burger 1991, Carney and Sydeman 1999). Shorebirds see humans as a threat or predator, when humans occupy the beaches and nesting sites this causes either temporary or permanent abandonment of their nests which reduces their time feeding or incubating chicks (Mallord et al. 2007, Carney and Sydeman 1999). Kury and Gochfield (1975) found that the impact of human recreation leads to nest abandonment of avians, exposing the nest contents to predation. Wilson et al. (1990) have found that human air crafts had devastating effects on breeding avian populations, they found that the birds had a panic response to the initial disturbance and there was a delay in returning to nesting sites which can be detrimental to the brood. Burger et al. (1995) have found that Least Tern (*Sternula antillarum*) colonies that were exposed to the disturbance by ecotourists had smaller colonies and lower reproductive output than other colonies with no disturbance. Since shorebirds live and adapt to so much change in their environments, it is proposed that shorebirds be used as sentinels to monitor the ever-changing coastal habitats (Piersma and Lindstrom 2004).

To perceive if human disturbance has a negative effect on Long Island shorebirds, an observational study was performed to get a general understanding of the effects the human recreational disturbances have on the abundance avifauna populations.

Methods:

Study Sites:

The four study sites, Sunken Meadow, Short Beach, Long Beach, and West Meadow are located on the north shore of Long Island. The sites are a mixture of woodland, marsh wetland, rock/sand beach, and estuary habitat. The width of each beach is roughly 0.1 km. Beach width was measured to consider the density of both avian and human populations that could be observed on the beach during the survey.

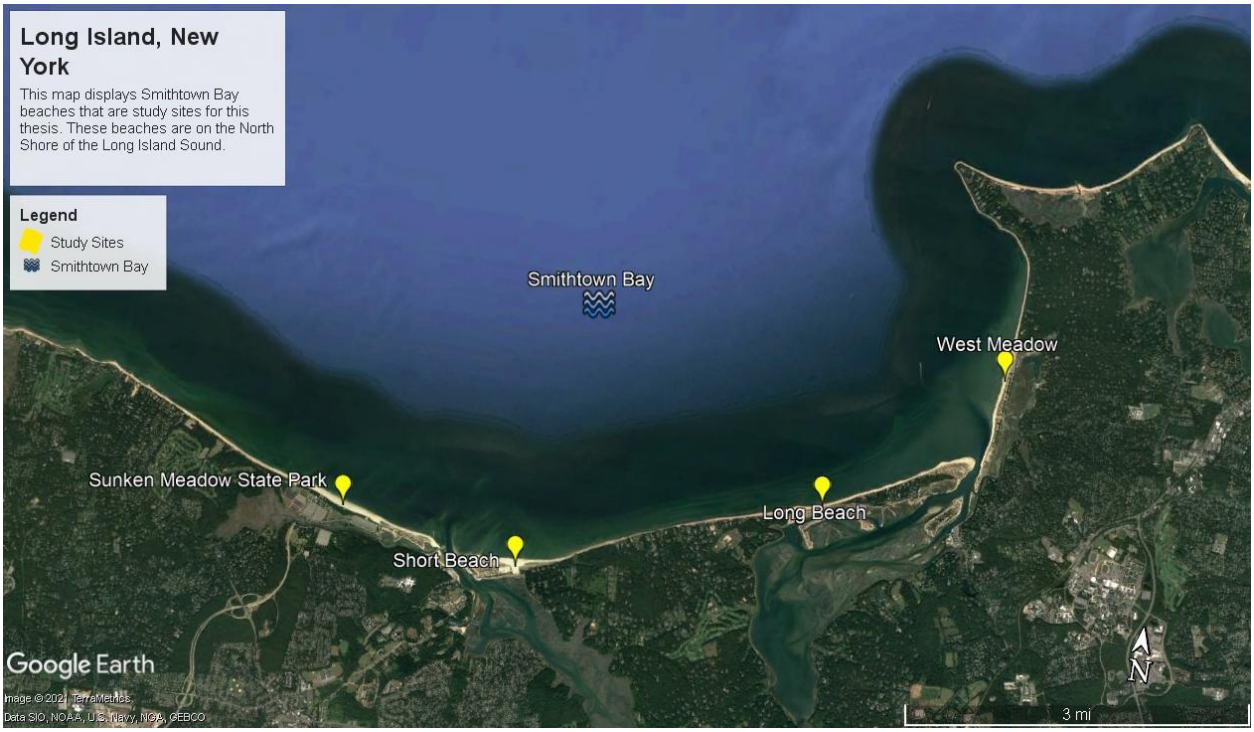

Fig 1. Map of the study area; Site 1: Sunken Meadow, Site 2: Short Beach, Site 3: Long Beach, Site 4: West Meadow.

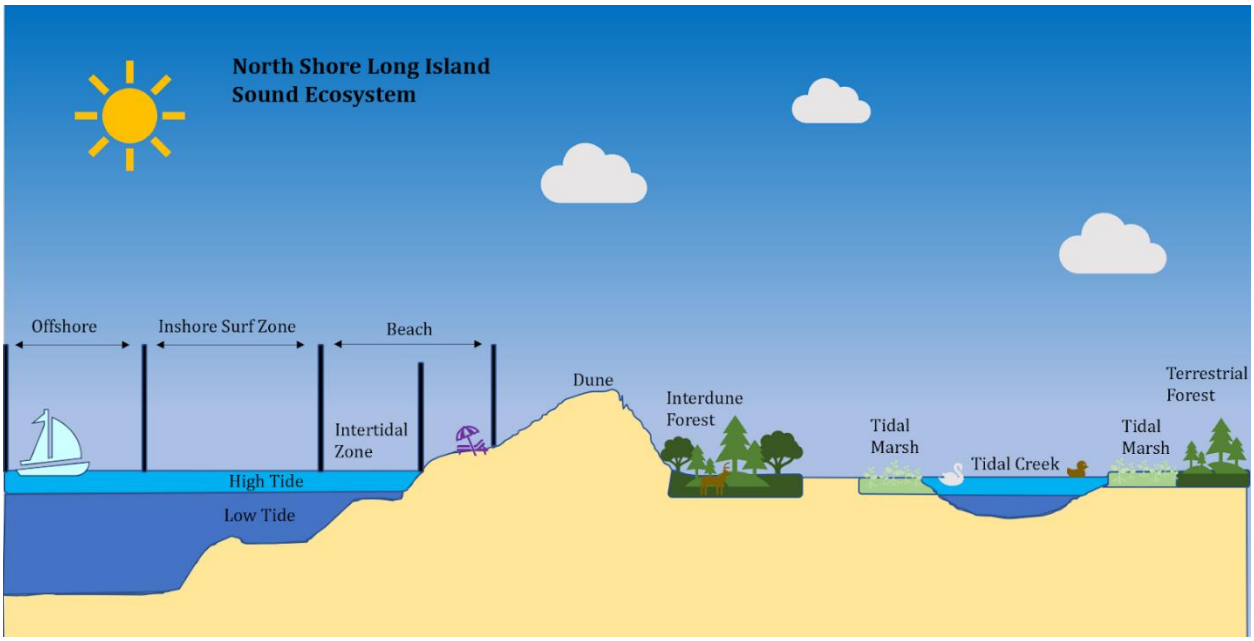

Fig 2. This figure shows the habitat structure of all 4 study sites; the main setting for the avian and human surveys were conducted on the beach.

Sunken Meadow:

Sunken Meadow State Park, also known as Governor Alfred E. Smith State Park, is a New York State Park in Kings Park, NY (40.9116° N, -73.2579° W). This state park is approximately 5.21 km^2 and 2.24 km in length. Annually Sunken Meadow is visited by more than three and a half million people. People utilize this park for beach going, hiking, and picnicking mostly. The ¾ mile long boardwalk along the beach makes this park particularly popular. The woodland habitat has an extensive trail system for hikers, many fields for picnicking and sports, and playgrounds for families. The beach habitat offers great fishing spots and views of the Long Island Sound sunsets. The wetland habitat provides more fishing spots and access to hiking trails from bridges over the Sunken Meadow Creek that flows into the Nissequogue River. This park also has a golf course that many people frequent.

Short Beach:

Short Beach is a town park located in Smithtown, NY (40.9068° N, -73.2271° W). Short Beach is approximately 0.25 km^2 and 0.9 km in length. Short Beach is only accessible by town permit only so access to this park is limited if you are not a resident, the approximate population of Smithtown is 120,000. In the woodland habitat, there is a small loop trail that provides beautiful views of the flora and fauna different from the beach habitat. Town residents utilize this space mostly for beach going, swimming, the playground. This park is also popular for fishing, kayaking, jet skiing, and camping during the summer months.

Long Beach:

Long Beach is a town park also located in Smithtown, NY (40.9206° N, -73.1711° W). Long Beach is approximately 2.73 km in length and 0.53 km^2. The wetland habitat allows access into the Long Island Sound for boaters from the Porpoise channel in Stony Brook Harbor. Both wetland and beach habitats have a great variety of flora and fauna and offer great views of Long Island sunsets. Like Short Beach, this beach is accessible only with a town permit. Long Beach has more to offer than Short Beach and West Meadow with boat ramps, marinas, town concerts, windsurfing and swimming lessons in addition to three different beach access points. There are picnic tables and grills for park goers to have picnics, multiple kayak, canoe, and boat launch spots, and refreshment stands to serve park goers.

West Meadow:

West Meadow Beach, also referred to as the West Meadow Historic District is a town park located in Stony Brook, NY (40.9321° N, 73.1453° W). West Meadow is approximately 1.73 km in length and 0.71 km^2. West Meadow has a protected wildlife wetland reserve to protect the multitude of flora and fauna that can be found here. This park is particularly popular with wildlife photographers for the variety of songbirds, shorebirds, and birds of prey that can be spotted. Another main reason why people visit this park so often is the paved walking trail that is 1 mile long. This path offers views of the wetland ecosystem and glimpses of the beach habitat through the woodland habitat. West Meadow is on the United States National Register of Historic Places.

Field Observations:

Surveys were conducted at each of the sites. Each site was surveyed for a total of one hour by walking from the end of the beach to the other. The walk was roughly two hours, the one hour conducting the survey along the shoreline and the one hour walking back not conducting the survey. Using Eagle Optics 8x42 binoculars, individual birds and humans on the beach were located and counted. Individual birds and humans on the beach were located and counted. All individuals, human and avian, were accounted for at each site on the shoreline on the survey sheet along with the type of human disturbance. To prevent double counting, the battlement method (Fig 3) that is used for counting objects under a microscope to count birds was applied in the field. The beach was scanned with binoculars in a zig zag method to account

for all the stationary humans and birds on the beaches. The different avian species observed in this study can be found in Figure 4.

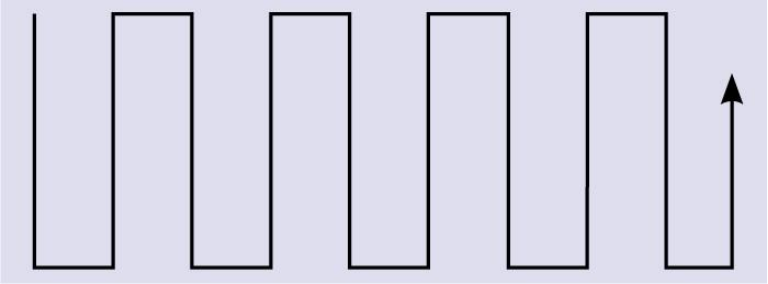

Fig 3. The battlement method is used for counting objects observed under a microscope. This method made it easy to keep track and count efficiently.

Fig 4. These are the most common and abundant bird observed during beach surveys.

Results:

A significant statistical difference between the human populations across all four sites (ANOVA, F=10.56, p-value<0.01). Because of the significance, a Tukey's HSD post-hoc test was conducted. There was a significant difference of human abundance, with Sunken Meadow different than Long Beach (A) (p-value=0.001), Short beach (A) (p-value=0.0000897), and West Meadow (B) (p-value=0.0069).

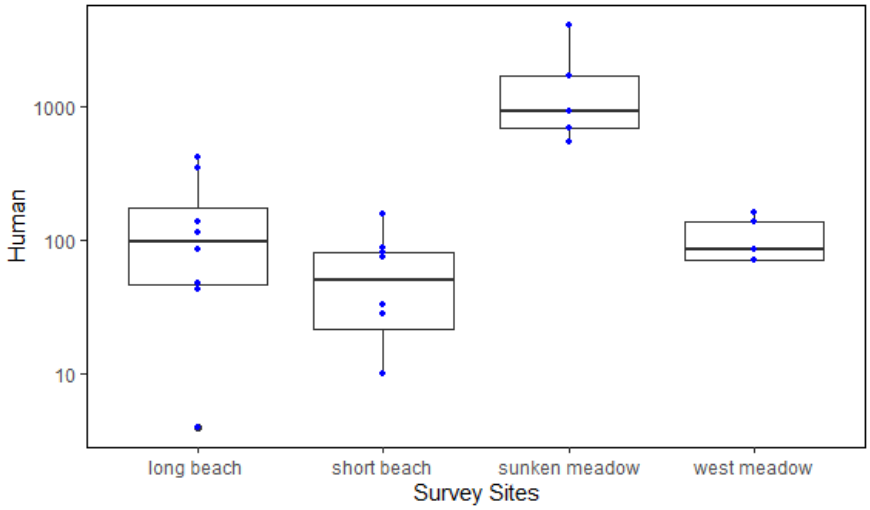

Fig 5. Comparing human populations across all sites. This figure shows that there is a significant difference in the human population observed at Sunken Meadow compared to the other study sites, survey one (n= 4122), survey two (n=695), survey three (n=1737), survey four (n=943), survey five (n=553), F value=10.65. P-value of Long Beach, Short Beach, West Meadow are all < 0.01 in all cases. The low p-value demonstrates the significant difference in the observed human population with Sunken Meadow compared to the other three study sites.

There was no statistically significant difference found among the bird populations across all four sites (ANOVA, F=1.095, p>0.01).

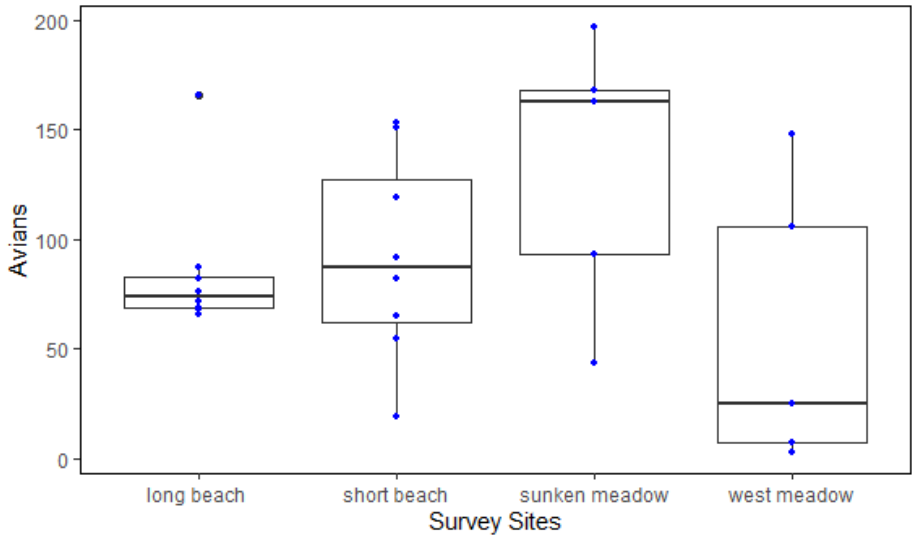

Fig.6 Comparing avian population across all sites. This figure shows that there is no significant difference in the avian populations across all four sites. F value= 1.095.

The relationship between the total number of avians compared to the total number of humans was sought out across all four sites. Even though a slight positive trend seemed visible in the data, a simple linear regression revealed no relationship between the number of humans and avians present on the beaches.

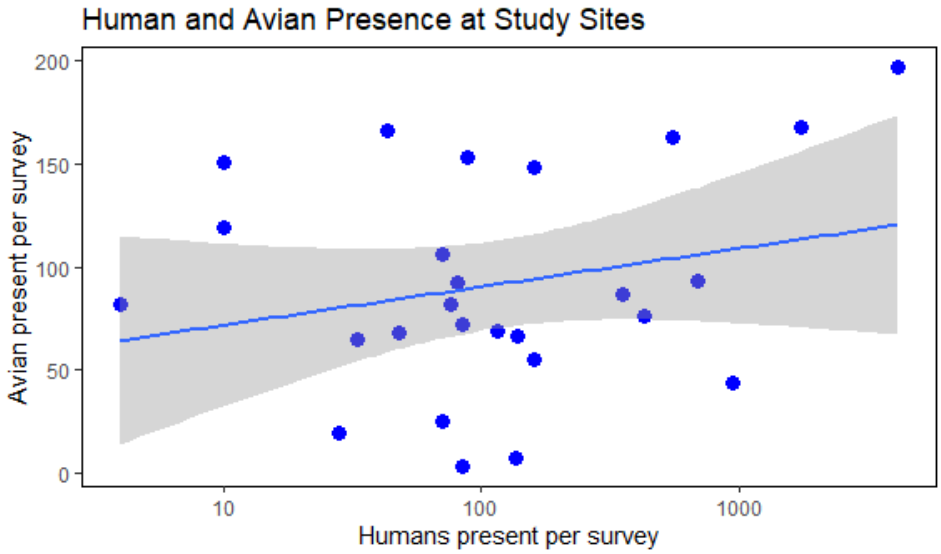

Fig 7. This figure shows that human presence on the beaches has no influence the total avians observed during surveys. Slope=0.75, Adjusted R-squared: 0.019, F-statistic: 1.486, p-value: 0.23.

The information in figure 7 was separated for each individual site to get a closer look at the relationship they share on the beaches. Data found at site 1 and site 4 suggest a possible relationship between the number of avian and humans, figures 8 and 11 display this data. There is a negative relationship found between the number of avians and humans at site 2 and site 3, figures 9 and 10 display this data.

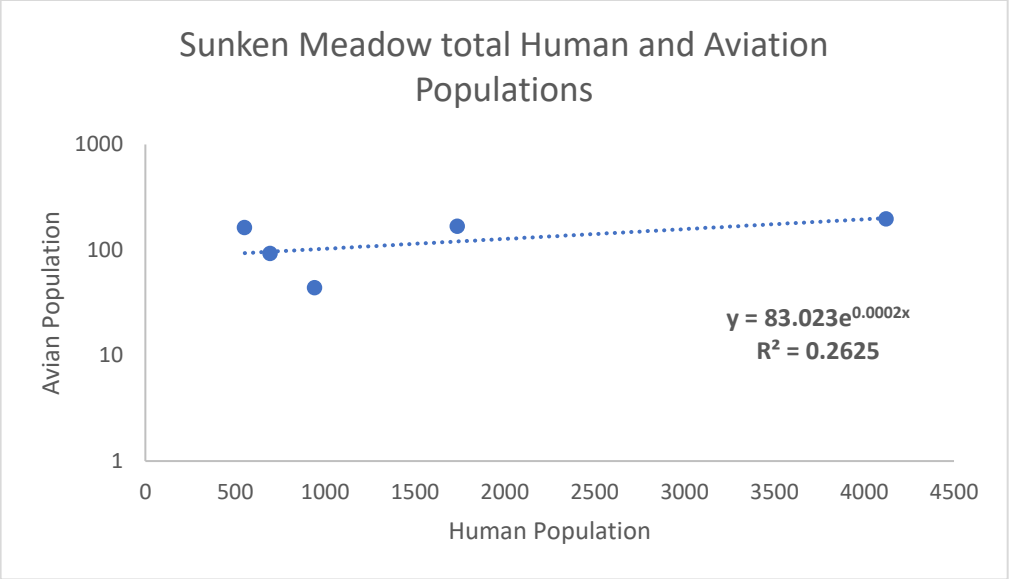

Fig. 8 This graph shows the relationship between the amount of avians present at Sunken Meadow compared to the human population. Data suggest a no relationship between the human and avian populations (F=1.86, p=0.2).

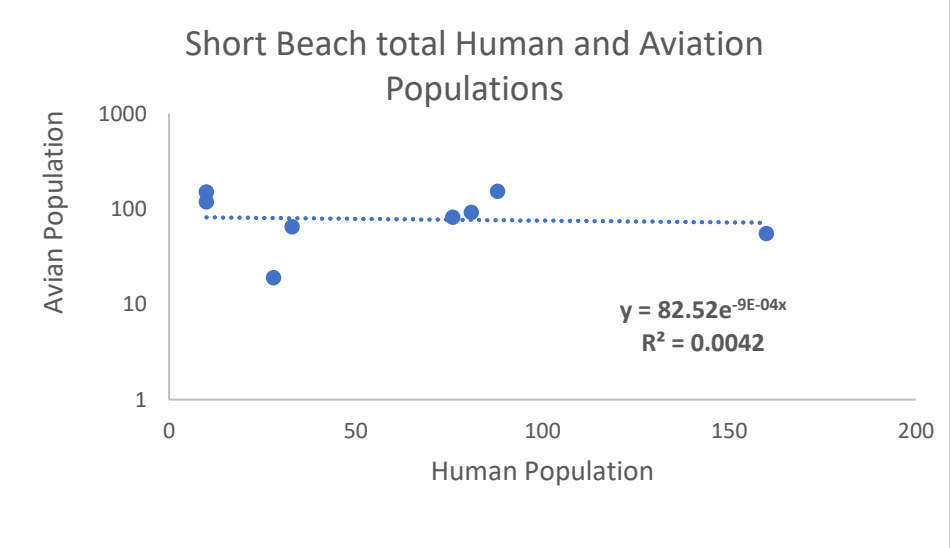

Fig. 9. This graph shows the relationship between the amount of avians present at Short Beach compared to the human population. There is no significant relationship between the human and avian populations (F=0.25, p=0.6).

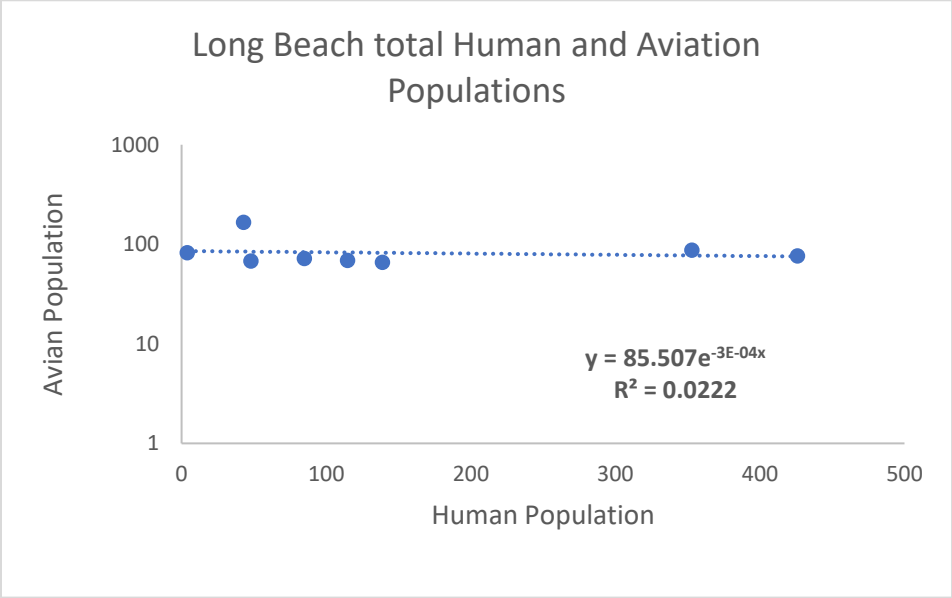

Fig. 10 This graph shows the relationship between the amount of avians present at Long Beach compared to the human population. There is no significant relationship between the human and avian populations (F=0.23, p=0.64).

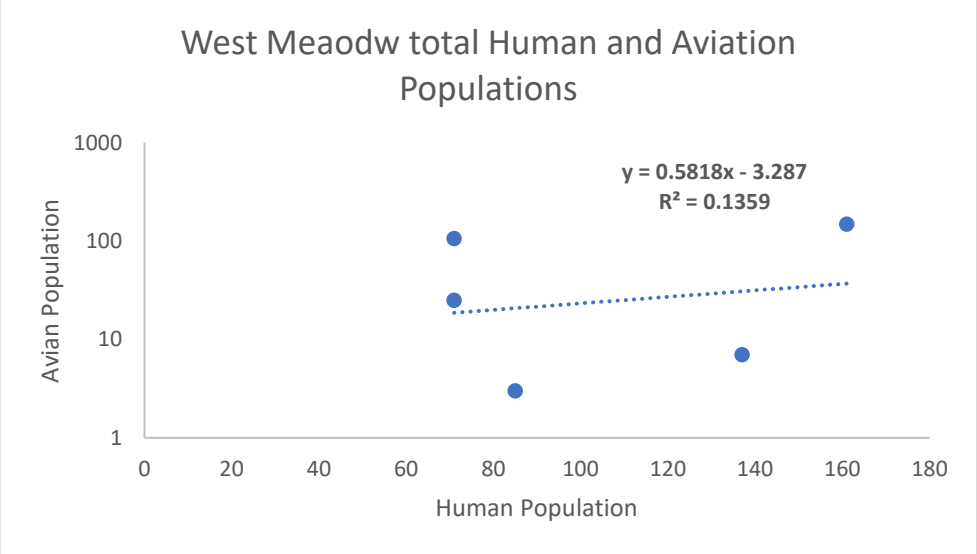

Fig. 11 This graph shows the relationship between the amount of avians present at West Meadow compared to the human population. Data suggests no relationship between the human and avian populations (F=0.47, p=0.5)

In addition to total abundance of birds, patterns in individual species distribution were noted Certain species frequented all sites, and some were rare at all sites. Across all 4 sites,

American Herring Gull (*Larus smithsonianus*), Ring Billed Gull (*Larus delawarensis*), Least Tern (*Sternula antillarum),* and Barn Swallow (*Hirundo rustica*) were present at all sites during the surveys. Bonaparte's Gull (*Chroicocephalus philadelphia*), Piping Plover (*Charadrius melodus*), and Osprey (*Pandion haliaetus*) were present three out of four sites. Killdeer (*Charadrius vociferus*), Song Sparrow (*Melospiza melodia*), and American Crow (*Corvus brachyrhynchos*) were present at two out of four sites. House Sparrow (*Passer domesticus*), Common Loon (*Gavia immer*), Gray Catbird (*Dumetella carolinensis*), Northern Mockingbird (*Mimus polyglottos*), and Rock Pigeon (*Columba livia*) were only present at one of four sites. Table 1 shows which bird species frequented which sites and the percentage of their visitations per site. Table 2 shows the disturbances that were observed during surveys and avian proximity to the disturbance.

Table 1. Percent of avian visitations per site.

Species	Sunken Meadow	Short Beach	Long Beach	West Meadow
American Herring Gull (*Larus smithsonianus*)	**100%**	**100%**	**87%**	**60%**
Ring Billed Gull (*Larus delawarensis*)	**100%**	**100%**	**87%**	**100%**
Bonaparte's Gull (*Chroicocephalus philadelphia*)	**83%**	**100%**	**87%**	**0%**
House Sparrow (*Passer domesticus*)	**17%**	**0%**	**0%**	**0%**
Least Tern (*Sternula antillarum*)	**60%**	**62%**	**12%**	**20%**
Killdeer (*Charadrius vociferus*)	**20%**	**50%**	**0%**	**0**
Piping Plover (*Charadrius melodus*)	**20%**	**12%**	**0%**	**60%**
Song Sparrow (*Melospiza melodia*)	**20%**	**12%**	**0%**	**0%**

Common Loon (*Gavia immer*)	**20%**	**0%**	**0%**	**0%**
Barn Swallow (*Hirundo rustica*)	**60%**	**50%**	**50%**	**20%**
Osprey (*Pandion haliaetus*)	**0%**	**62%**	**25%**	**40%**
American Crow (*Corvus brachyrhynchos*)	**0%**	**0%**	**50%**	**20%**
Gray Catbird (*Dumetella carolinensis*)	**0%**	**0%**	**0%**	**20%**
Northern Mockingbird (*Mimus polyglottos*)	**0%**	**0%**	**0%**	**20%**
Rock Pigeon (*Columba livia*)	**0%**	**12%**	**0%**	**0%**

Table 1. This table shows the percentage of how often certain avian species were observed at each site.

Table 2. Human disturbances witnessed and avian proximity to disturbances.

Site	Disturbance	Avian Proximity
Sunken Meadow	**Walking on the board walk**	**Far from humans**
	Fishing	**Close when few humans far when 4+ humans present**
	Sitting on the beach	**Far from humans**
	Walking in fenced off nesting site	**Far from humans**
	Golf carting on the beach	**Far from humans**
Short Beach	**Sitting on beach**	**Far from humans**
	Truck driving on beach	**Far from humans**
	Jet skiing	**Far from humans**
	Fishing	**Close to humans**
	Dog walking on the beach	**Far from humans**
	Biking on beach	**Far from humans**
Long Beach	**Fishing**	**Close to humans**
	Picnicking	**Close to humans**
	Sitting on the beach	**Far from humans**
	Loud groups on the beach	**Far from humans**
	Town concert	**Very far from humans**
	Photoshoot on beach	**Far from humans**
West Meadow	**Picnicking**	**Close to humans**
	Sitting on the beach	**Close to humans**
	Fishing	**Close to humans**

Table 2. This table shows the different types of human disturbances that were observed during the surveys across all the sites. All disturbances were on the beach and had an impact on the number of birds in the vicinity during the survey. Close to humans:1.5-4.5 m, Far from humans: 6.0-9.0 m, Very far:12.0+ m

Discussion

The hypothesis for this study was that the disturbances from the human population will negatively affect the distribution and abundance of the Long Island shorebird population. The purpose of this experiment was to determine if human disturbance affected the avifauna populations. Table 1 displays the species of bird observed in this study and their percent visitation to the sites. Table 2 displays the types of disturbances of shorebirds observed in this study, Mayo et al. (2015) have found similar disturbances in their study such as walking on the beach, water motor sports, fishing, and general beach going This observational experiment yielded that there is no correlation between both populations across Sunken Meadow, Short Beach, Long Beach, and West Meadow.

The results show that the human population varies across all sites ($F=10.56$, $p<0.01$; Fig 5). Sunken Meadow has the highest amount of human traffic because it is a state park, Short beach, Long Beach, and West Meadow are all town parks, therefore access is limited to town residents and human traffic was lower than Sunken Meadow. Overall, across the four sites, the avian abundance was all very similar (F value=1.91, $p>0.01$) and there were no major differences in the number of individuals observed (Fig. 6).

Unfortunately, populations of avians and humans across all sites showed no correlation ($p=0.23$; Fig. 7). At each individual site, there were no relationship between the avian and human populations.

Even though there was no positive correlation in the data, there were some observable patterns with the avian population. At Sunken Meadow and West Meadow birds were observed close to human presence on the beaches. The human activities consisted of fishing and picnicking. In theory, the relationship between humans and avians at Sunken Meadow and West Meadow could be traced back to birds using humans as a readily available food source. Table 2 shows birds at Sunken meadow were near the fishermen and at West Meadow the birds were close to humans that were picnicking and fishing.

Since shorebirds are adapting to extensively changing environments, one way they adapt is by becoming opportunistic feeders (Gochfield and Burger 1980, Goumas et al. 2020). The shore bird diet consists of aquatic and terrestrial invertebrates such as earthworms and cutworms, crustaceans, small fish such as minnows, herring, and smelt (Gochfield and Burger 1980, United States Department of Agriculture 2000). During observations, the gull species and terns were observed being opportunistic feeders by eating the fishermen's bait and unwanted fish carcasses. Gochfield and Burger (1980) had similar observations, they reported observing herring gulls approaching the fishing spots to feed on the scraps of commercial fishermen. Gulls forage and tear open fish to eat and then leave, shorebirds come to scavenge on the maggots and flies in the fish carcasses. The exploitation of these discarded anthropogenic resources is acquired through social learning (Goumas et al. 2020). Avifauna use social learning to communicate food and other resources, gulls in this case are the beacons for food sources (Goumas et al. 2020). The form of social learning that contributes to finding food is called local enhancement, which helps the birds find food sources after observing humans interacting with food or objects in a certain location (Goumas et al. 2020).

The lack of relationship between humans and avians at Short Beach and Long Beach can be traced back where the birds decided to roost and habituation. Habituation can be described as the waning of a response to human presence based on repealed stimulation (Nisbet 2000). Table 2 shows birds at Short Beach and Long Beach were far from human disturbance with an exception fishing and picnicking. From observations, it was noted that the birds at Short Beach and Long Beach often roosted on areas of the beach where humans were not present. Humans stayed mainly near the beach entrances and didn't venture the length of the beaches. Human disturbance over time could have had an influence on roosting selections on the beach. Meager et al. (2012) suggest that disturbance can affect this selection on both landscape and local spatial scales. Pfister et al. (1991) has found that human disturbance over time has caused a change in resting site location of avian species. A study conducted by Peters and Otis (2007) found that human disturbance had little to no effect on sanderlings, sandpipers, and oyster catchers roosting. These species are very similar to the Piping Plovers, Killdeer, and Least Terns observed in this study. Previous studies suggest that disturbance over time can determine the location of selected roosting sites.

Some things that can be improved from this study would be to get a larger sample size across all sites to see if there is a stronger correlation between avians and humans. If one were to use this study in the future, getting a larger and more uniform data set to determine the relationship would be needed. Comparing the disturbance by measuring with flight initiation distance (FID) to get a better understanding to which bird species are more affected by human disturbances is also suggested. Some constraints with data collection were being denied access

to West Meadow because of COVID restrictions and not being a town resident, this made it difficult to get to the site to gather data.

Human disturbances have been found to change coastal zone habitats and negatively affect shorebird populations by hindering their foraging and nesting success and can affect roosting behavior. The data presented in this study do not suggest anthropogenic disturbances affected general roosting, nesting, or foraging. This study found no significant effect of human disturbance on the shorebird population sampled. This study suggests humans and birds cohabitate on beaches.

Conclusion

Human disturbance was not found affect the shorebird populations on Long Island Sound beaches. Human disturbance did not affect birds in this study but has affected birds in previous studies. The actions and attitudes of humans can be the key factor in conserving usable habitats for avifauna, plants, and food sources to support healthy populations.

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Works Cited

Burger, J. 1991. Forage Behavior and the Effect of Human Disturbance on the Piping Plover (*Charadrius melodus*). Journal of Coastal Research 7:39-52

Burger, J., M. Gochfeld and L.J. Niles. 1995. Ecotourism and birds in coastal New Jersey: contrasting responses of birds, tourists, and managers. Environmental Conservation 22: 56-65.

Carney, K.M and Sydeman, W.J. 1999. A review of Human Disturbance Effects on Nesting Colonial Waterbirds. Waterbirds: The International Journal of Waterbird Biology 22:1:68-79

Epstein, M. 2016. Waterbird use of coastal beach at Merritt Island National Wildlife Refuge, Florida. Florida Scientist. 79:28-38

Gochfield, M. and J. Burger. 1980. Opportunistic Scavenging by Shorebirds: Feeding Behavior and Aggression. Journal of Ornithology. 54:4:373-375

Goumas, M., N.J. Boogert, and L.A. Kelley. 2020. Urban herring gulls use human behavioral cues to locate food. Royal Society Open Science. 7:1-9

Kury, C. R. and M. Gochfield. 1975. Human interference and gull predation in cormorant colonies. Biological Conservation 8: 23-34

Mallord, J.W., P.M. Dolman, A.F. Brown, and W.J. Sutherland. 2007. Linking recreational disturbance to population size in a ground-nesting passerine. Journal of applied Ecology. 44:185-195

Mayo, T. W., Paton, P. W. C., & August, P. V. (2015). Responses of birds to humans at a coastal barrier beach: Napatree Point, Rhode Island. Northeastern Naturalist.22:501-512.

Meager, J.J., T.A. Schlacher, and T. Nielsen. 2012. Humans alter habitat selection of birds on ocean-exposed sandy beaches. Diversity and Distributions 18: 294-306

Monastersky, R. (2015). Anthropocene: The human age. Nature News, 519(7542), 144.

Navedo, J. G., & Herrera, A. G. 2012. Effects of recreational disturbances on tidal wetlands: Supporting the importance of undisturbed roosting sites for waterbird conservation. Journal of Coastal Conservation. 16:373-381

Nisbet, I. C. T. 2000. Disturbance, habituation, and management of waterbird colonies. Waterbirds: The international journal of waterbird biology. 23: 312-332.

Peters, A., and D.L. Otis. 2007. Shorebird Roost Site Selection at Two Temporal Scales: Is Human Disturbance a Factor? British Ecological Society. 44:196-209

Pfister, C., B.A. Harrington, M. Lavine. 1991. The impact of human disturbance on shorebirds at a migration staging area. Biological Conservation 60:115-126

Piersma, T. and A. Lindstrom. 2004. Migrating shorebirds as integrative sentinels of global environmental change. British Ornithologists Union. 146:61-69

Schlacher, T. A., Nielsen, T., & Weston, M. A. 2013. Human recreation alters behavior profiles of non-breeding birds on open-coast sandy shores. Estuarine, Coastal, and Shelf Science. 118:31-42.

Schlacher, T.A., D.S. Schoeman, J. Dugan, M. Lastra, A. Jones, F. Scapini, A. McLachan. 2008. Sandy Beach ecosystems: key features, sampling issues, management challenges, and climate change impacts. Marine Ecology. 29:70-90.

Stillman, R.A. and J.D. Goss-Custard. 2002. Seasonal Changes in the response of oyster catchers *Haematopus ostralegus* to human disturbance. Journal of Avian Biology. 33: 358-365

United States Department of Agriculture. 2000. *Shorebirds*. Fish and Wildlife Habitat Management Leaflet. 17:1-14

Wilson, KCJ., R. H. Taylor and KCJ. Barton. 1990. The impact of man on Adelie Penguins at Cape Hallett, Antarctica. Antarctic ecosystems: ecological change and conservation. 12:183-190