How do different tidal patterns (high and low tides) influence the hunting methods utilized by Great Egrets (Ardea alba) in urban estuarine ecosystems?

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Abstract

We aim to identify the specific hunting behaviors (mainly distinguishing between a passive or active approach) of Great Egrets and associating them with the varying tidal conditions in a different environment that has not been researched extensively before in an urban estuary ecosystem. Understanding how they adapt their hunting strategies to the changing tide can help provide us with helpful information on how many avian species function in the everso changing ecosystem nowadays. Additionally nowadays, urbanization and climate change pose significant threats to estuarine ecosystems, altering tidal levels and even affecting the wildlife of these habitats. After researching for 3 weeks, we found that tidal patterns do affect the hunting patterns of birds like the Great Egret. Great Egrets often employ more active hunting methods during low tide, as conditions like predation are influenced by tidal levels.

Introduction

Great Egrets (Ardea alba) are large wading birds that are often found in a number of different wetland habitats that include marshes, estuaries, and even along the shores of ponds and lakes. Their foraging behavior is very flexible, allowing their food source to be plentiful ranging from fish and amphibians to insects and small mammals (Kushlan, 1978). Estuarine ecosystems, where many great egrets live, are often characterized by their tidal fluctuations. Tidal cycles, which include high tides and low tides do play a big role in shaping the availability and accessibility of prey for wading birds.

Great Egrets have various different hunting techniques from active methods like stalking or striking to more passive methods such as perching or waiting for prey. There have been previous studies done on foraging behaviors of wading birds and the influence that their environmental factors have on their hunting success (Kushlan, 1978; Bildstein, 1993). These experiments were done in the Southern United States, around Florida, allowing our research to tackle a specific gap -- Great Egrets in urban estuarine ecosystems, specifically those in Jersey City. The main objective of our experiment is to see how the different tidal patterns affect the hunting methods that are used by Great Egrets in these urban estuarine ecosystems (like that of those seen at Lincoln Park West and Caven Point).

We choose Great Egrets for a number of reasons. Great egrets are on the larger side when looking at wading birds and also has a unique look to them, which allows us to conduct closer observation and reduces observational errors that may happen if we were identifying another type of bird. Next, Great Egrets have unique foraging behaviors. They tend to shrink their S shape necks when they are stalking their prey and this is easily noticeable to the human eye. Most importantly, they are considered indicator species for the health of wetland and estuarine ecosystems, meaning that changes in their behavior or numbers can greatly cause alterations in the environment ranging from water quality to even prey availability.

Our hypothesis is: If tidal levels are low, then Great Egrets will use more active hunting methods like stalking, due to an increased accessibility of prey. Conversely, if tidal levels are high, then Great Egrets will favor passive hunting techniques like waiting or even not hunting, as prey becomes harder to get.

Methodology

Materials: Binoculars, Universal All-Weather Notebooks, noaa tides website
Methods: Every day we will be collecting data on tidal patterns using an online website, linked here: https://tidesandcurrents.noaa.gov/. This will allow us to tell whether the tide is high tide or low tide and even potentially data on whether it is rising or waning. Additionally we will also record the number of egrets during each session in TOTAL, and their respective activity. The activities being the types of active hunting (striking, stalking) versus passive hunting (sitting in a tree, waiting around). After recording this data for each day we observe and all the Egrets we observe that day, we will use a chi-square test for independence to see if there is a relationship between the tidal levels and the hunting activities of Great Egrets. Based on the results of this test, we will decide if the null hypothesis of there being no association between tidal levels and the hunting methods used by Great Egrets is true or not.

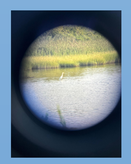
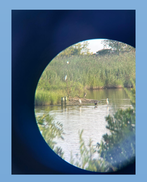
Variables:
Independent variable: Level of the tide, whether it's high tide or low tide
Dependent Variable: Hunting methods Great Egrets use
4 main methods of Hunting: Active approach: walking slowly (stalking), striking
Passive approach: Standing still waiting in the water, and perching (which in our case would be in a tree)
Controlled variables: Same time intervals (9 - 11 am on Saturdays and 5- 7 pm on Wednesdays) and at the same locations (Lincoln Park West and Caven Point); experimenters

Results

Low Tide 1: 4 Active, 0 Passive
Low Tide 2: 1 Active, 0 Passive
Low Tide 3: 1 Active, 1 Passive
Low Tide 4: 2 Active, 2 Passive
Low Tide 5: 2 Active, 1 Passive

High Tide 1: 2 Active, 4 Passive
High Tide 2: 1 Active, 2 Passive
High Tide 3: 2 Active, 3 Passive
High Tide 4: 1 Active, 6 Passive
High Tide 5: 2 Active, 6 Passive

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Tables & Figures

Tide level/Location	Date	Time	Tide height	Egrets spotted	Respective activity
WANING Low tide @Caven Point	7/24/24	5:43	2.05 ft	4	Active: 4 Hunting (swooping down)
RISING Low tide @Caven Point	7/27/24	9:00	2.31 ft	1	Active: 1 hunting
RISING Low tide @ Caven Point	7/29/24	9:15	2.44 ft	2	Active: 1 hunting (jabbing its beak, head bopping) Passive: 1 flying, (unfocused on hunting)
WANING High tide @Lincoln Park West	7/31/24	5:25	4.36 ft	6	Active: 2 flying, neither hunting Passive: 4 perching in a tree
WANING High tide @Lincoln Park West	8/3/24	9:00	4.21 ft	3	Active: 1 perching in a tree Passive: 2 swimming in the water
WANING Low tide @Caven Point	8/10/24	5:25	2.12 ft	4	Active: 2 hunting, moving, jabbing in water Passive: 2 not hunting
RISING High tide @Caven Point	8/14/24	5:11 pm	4.69 ft	5	Active: 1 hunting, 1 ready to hunt Passive: 3 standing
RISING High tide @ Lincoln Park West	8/15/24	5:15 pm	4.52 ft	7	Active: 1 hunting Passive: 6 perching
WANING Low tide @Lincoln Park West	8/17/24	9:28 am	1.9 ft	3	Active: 2 hunting Passive: 1 perching
RISING High tide @Lincoln Park West	8/7/24	5:43 pm	4.61 ft	8	Active: 2 Passive: 6

Table 2

Tide Level	Active Hunting	Passive Hunting	Total
Low Tide	10	4	14
High Tide	8	21	29
Total	18	25	43

Use A Chi-Square Test for Independence:

Expected Frequency: (Row Total * Column Total) / Grand Total

Expected Frequency Table:

Tide Level	Active Hunting	Passive Hunting
Low Tide	5.86	8.14
High Tide	12.14	16.86

Using Chi Square Formula:
$\chi^2 = \Sigma(O_i - E_i)^2/E_i$
Where Oi is the observed value and Ei is the expected value
Low Tide -- Active Hunting: Approximately 2.93
Low TIde -- Passive Hunting: Approximately 2.11
High Tide -- Active Hunting: Approximately 1.41
High Tide -- Passive Hunting: Approximately 1.01

$\chi^2 = 2.93 + 2.11 + 1.41 + 1.01 =$
7.46 ← our critical value

Null Hypothesis (H_0): There is no association between tidal levels and the hunting methods used by Great Egrets. (The hunting method is independent of the tidal level.)

Alternative Hypothesis (H_1): There is an association between tidal levels and the hunting methods used by Great Egrets. (The hunting method is dependent on the tidal level.)

Our degrees of freedom would be 1

Critical value when DOF= 1: 3.84

Since 7.46 is greater than the critical value when the degree of freedom is 1 (3.84), the p-value will be less than 0.05 and thus we reject the null hypothesis, saying that there is an association between hunting methods of Great Egrets and tidal levels.

Discussion

The objective of this experiment was to determine whether there is a significant association between tidal conditions and the hunting methods employed by Great Egrets in an urban estuarine ecosystem. We used a chi-square test of independence to analyze the data collected from observations during different tidal conditions. The significant chi-square result ($p < 0.05$) indicates a strong association between tidal conditions and the hunting methods of Great Egrets. Specifically, the data suggests that Great Egrets are more likely to engage in active hunting behaviors, such as stalking and striking, during low tides. In contrast, during high tides, they tend to adopt passive strategies, such as waiting or perching. Conducting further research, we've learned potentially reasons why this may have been:

1. Prey accessibility: During low tide, water levels recede, exposing mudflats, shallow pools, and intertidal zones where small fish, crustaceans, and other prey species tend to congregate. These areas become hunting hotspots for Great Egrets because prey are concentrated in smaller, shallower areas, making them easier to spot and capture.

2. Energy conservation: Active hunting methods, such as stalking and striking, require significant energy expenditure. Stalking involves slow, deliberate movements that demand focus and precision, while striking requires rapid bursts of energy to capture prey. During low tide, when prey is more concentrated and accessible, the energy expended in these active hunting strategies is more likely to result in successful captures. In contrast, high tide conditions may not justify the energy costs associated with active hunting.

3. Habitat structure: Lastly, low tides often expose a variety of microhabitats rich in foraging opportunities. During high tides, these are submerged, significantly altering the landscape. The restricted habitat forces them to adopt a more conservative approach, such as waiting in areas where they anticipate prey will appear or perching until the tide recedes.

Conclusion:

This study provides evidence that tidal conditions significantly influence the hunting strategies of Great Egrets in urban estuarine environments. The results support the hypothesis that Great Egrets adjust their foraging behavior based on prey accessibility, which varies with tidal levels. These findings contribute to a better understanding of how environmental factors like tidal patterns affect the behavior of wading birds and underscore the importance of tidal dynamics in shaping the foraging strategies of Great Egrets. Further research could explore the effects of additional environmental variables, such as prey density or water temperature, to provide a more comprehensive understanding of the ecological interactions in estuarine habitats.

References

Florida Field Naturalist. "Digital Commons @ University of South Florida." *White-Ibis Wetland Wanderer*, Searchable Ornithological Research Archive at Digital Commons @ University of South Florida, Jan. 1994, digitalcommons.usf.edu/.