Impact of invasive fire ants (*Solenopsis invicta*) on brown pelican (*Pelecanus occidentalis*) nesting success

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Abstract

Brown pelicans and their habitats have long been subjected to anthropogenic disturbances, such as increasing frequencies of natural disasters, erosion, and sea level rise. More locally, on several barrier islands in the northern Gulf of Mexico, pelicans are also under stress due to a high prevalence of invasive species, including fire ants. It is imperative that the negative effects of fire ants are understood more completely in order to gain a better foundation of knowledge about brown pelican chick survival and nest success. Fire ants were collected from plots of nesting pelicans on Raccoon Island, Louisiana, and counted to determine the average number of ants present at each plot. Linear regressions were used to define elements contributing to ant count and nest success in the plots on the island. Ant count was found to be a significant predictor of nest success, proving that fire ants have a marked negative effect on pelican chick survival rates. Nevertheless, it would be beneficial to gain a better sense of additional aspects leading to nest failure, as well as a more detailed understanding of the implications that fire ants have for pelican survival. Numerous avenues exist for conducting future research that would help to more clearly elucidate the consequences of invasive species, increasing the potential for expanding conservation efforts for brown pelicans and all seabird species inhabiting the Gulf coast region.

Introduction

Species of all taxa face a growing number of challenges that threaten their ability to maintain viable natural populations (Pimm et al., 2014). Birds are one group that has been especially affected by recent changes in the environment (Huntley et al., 2008). In particular, seabird populations worldwide have been adversely influenced by humans' destructive habits of intrusion and resource consumption (Mallory et al., 2009). Barrier islands are critical habitats to many seabirds, serving as refuges where they can escape predators and remain in close proximity to their food sources (O'Connell et al., 2005). It is important to monitor barrier islands, many of which are disappearing from erosion, as they can provide key information about the diverse species that inhabit them (Miller 2015).

The barrier islands in the northern Gulf of Mexico are under an inordinate amount of stress both from direct anthropogenic influences and damaging natural processes. Hurricanes, rising sea levels, erosion, and invasive species are among the issues that degrade the quality of barrier island habitat (Zinnert et al., 2016). Brown pelicans (*Pelecanus occidentalis*) that nest in the area must overcome these challenges to ensure that their chicks will survive and sustain regional populations. As a variety of stressors impact the availability of high-quality nesting substrates for brown pelicans, it is critical for researchers to gain a complete understanding of the factors that contribute to nest failure.

Raccoon Island, a barrier island located in Terrebonne Bay, Louisiana, is home to the largest breeding colony of brown pelicans in the region (Selman et al., 2016). The species was only recently removed from the Endangered Species List, and it is still a priority for monitoring as it faces pressures from invasive species that inhabit the island (Shields 2014). The introduction of fire ants (*Solenopsis invicta*) to seabird breeding colonies has had disadvantageous effects on brown pelicans, as this invasive species has contributed to both nest substrate destruction and direct chick mortality (B. Geary, unpubl. data). It is critical to better

understand how the presence of fire ants affects the habitat and survival rate of brown pelicans in order to continue protecting this ecologically important species.

Methods

Fieldwork was conducted on Raccoon Island from late April through June, which spans the typical nesting season for brown pelicans. Fire ants were collected in test tubes from five different 50 x 20 m plots on the island. Each test tube was baited with a piece of Vienna sausage to attract nearby ants (Seymour 2007), and the test tubes were then equally spaced throughout the plots. After a period of one hour, the test tubes were retrieved, capped, and stored. Ethanol was then added to each test tube for preservation. Later, the ants were emptied from each test tube and counted by hand. Data collected from observational studies of vegetation present on plots on Raccoon Island from 2013 to 2017 (B. Geary, unpubl. data) was also analyzed to determine if there is any existing relationship between mangrove cover and fire ants. Statistical analyses were run that incorporated all of the fire ant data collected from 2013 to 2017. A simple linear regression was calculated to predict ant count based on longitudinal coordinate points from the island. Longitude was selected as the independent variable to determine if there was a higher or lower quantity of fire ants present on certain areas of the island. Another simple linear regression was calculated to predict nest success based on ant count. A third simple linear regression was calculated to predict ant count based on percent mangrove cover.

Results

The results of the first regression indicated that longitude explained 4.9% of the variance in ant count ($R^2 = 0.049$, $F_{1,28} = 1.45$). It was found that longitude did not significantly predict the presence of ants ($\beta = 0.22$, $p = 0.24$). The results of the next regression showed that ant count explained 18% of the variance in nest success ($R^2 = 0.18$, $F_{1,28} = 6.26$). There is a moderate linear relationship between the two variables ($R = 0.427$). Ant count significantly predicted nest success ($\beta = -0.43$, $p < .05$). Thus, higher numbers of ants resulted in lower nest success. The third regression indicated that percent mangrove cover explained 4.4% of the variance in ant count ($R^2 = .044$, $F_{1,28} = 1.28$). Percent mangrove cover did not significantly predict ant count ($\beta = -.67$, $p = .27$).

Discussion

The presence of invasive fire ants was shown to have a negative effect on brown pelican nest success, preventing chicks from maturing to their fledging age. This may result from the physical harm that fire ants inflict by stinging adult pelicans, leaving them vulnerable, stressed, and more poorly equipped at tending to their young. However, fire ants only explained 18% of the variance in nest success, suggesting that there are additional contributing elements, which may include invasive nutria (*Myocastor coypus*), antagonistic interactions with other birds, and basic challenges associated with parenting, such as adult birds' sometimes limited ability to provision chicks. Although longitude and percent mangrove cover were not found to significantly predict ant count, they each still explain a small percentage of the variance. However, there are likely other existing factors that have a stronger effect on influencing the quantity of ants present in designated areas on the island.

Future research should be conducted to further examine the diverse, and often detrimental, effects that the presence of fire ants has on brown pelicans. It would be beneficial to continue performing annual fire ant counts on Raccoon Island in order to develop a long-term collection of data. Such an expansive assemblage of data could provide insights that cannot be garnered from only a few years of fieldwork, potentially shedding light on how factors such as severe natural disasters and changing environmental conditions affect the relationship between and survival of brown pelicans and fire ants. The data collection process could be enhanced in future studies by including more intensive monitoring to visually examine nests and chicks for fire ants, thereby allowing mortalities to be more directly attributed to the presence of ants. The methodology could also be expanded by applying it to other barrier islands in the Gulf of Mexico, and perhaps additional types of seabirds, to analyze if the same patterns are replicated across different locations and species. Many species of birds living on Raccoon Island, including sandwich terns and laughing gulls, nest directly on the ground, and they are potentially at even greater risk of fire ant invasion. In addition, it is known that nutria also contribute to brown pelican nest destruction and chick mortality, and supplementary studies that further assess the effects that this invasive species has on brown pelicans could prove to be invaluable for better understanding the dynamic interrelationships of Gulf coast species (B. Geary, unpubl. data).

These findings help to provide a more comprehensive understanding of the factors impacting brown pelicans, and they could have critical implications for the entire northern Gulf region. This is valuable data that can be used to inform conservation decisions, ensuring that brown pelican populations, as well as the Gulf coast ecosystem as a whole, remain healthy and productive.

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