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Responses of Shorebirds to Human Disturbance at Exposed Sandy Beaches of North-Eastern Algeria

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ABSTRACT

Throughout this study we present the results of an expert opinion survey on flight initiation distance (FID) estimates for the three beachiest shorebirds species (Lesser Black-backed Gull Larus fuscus, Black-headed Gull Chroicocephalus ridibundus, Audouin's Gull Ichthyaetus audouinii) when overwintering at exposed sandy beaches Annaba Bay, north-eastern Algeria. Our final data set contained 336 flushing events of the three shorebird species, FIDs for both species ranged from 11m up to 151m. The univariate analysis of variance indicates that the studied Gulls behave similarly against human disturbance, since that mean FIDs were not varied significantly between species (F2= 0.24, P = 0.78). In contrast, change in escape behavior of our sampled species was found to be significant (F2=20.54, P<0.05) across the three coastal sites that were under varying human pressures (High, moderate, and low). In fact, individuals reduced their FIDs when anthropogenic levels increased. Additionally, using a regression analysis, the relationship between starting distance (SD), flock size and FIDs was confirmed (SD: r=0.9, F=176.52, P<0.005; Flock size: r=0.68, df=1, F=30.9, P<0.005), the obtained positive correlations (indicate that escape behavior of our birds increases with the starting approaching humans distance, and with flock size. Producing information of the extent and circumstances under which birds may habituate to stresses are an evidence-base which can be used by regulatory authorities to start appropriate site-specific assessments for anthropogenic marine activities with regard to the sensitivity or habituation of seabirds to such activities.

Keywords: *Annaba Bay, FID, Gulls, marine activities*

MathematicsSubject Classification: 62J12, 62G99

Journal of EconomicLiterature (JEL) Classification : Q12, D24

1. INTRODUCTION

Like almost all coastal countries around the world, the Algerian Seaboard faces high population growth. More than half of the industrial units, development programs, and arbitrary constructions located at this part of the country. The removal of sand from beaches and variety of environmental pollution are also increased. This fact, constantly affects many existing valuable coastal marine areas such as salt marshes, estuaries, wetlands, and bays. These areas are inhabited by a vast number of organisms; the most sensitive among them are Water-related bird species (Elafri et al. 2017). Therefore, environmental legislation and any management plans aimed at protecting

these coast areas, must take into account responses of this class of animals (waterbirds) to human disturbance.

Disturbance in wild animals refers to any activity undertaken by humans that causes a deviation response from the normal behaviour or activities of the animal affected (Frid and Dill 2002). The measurement of the distance at which an approaching predator disturbs an animal enough to make it move away from the threat is known as the flight initiation distance (FID) (Blumstein 2003) or flush distance (Runyan and Blumstein 2004; Jenni et al. 2007). Quantifying responses of birds to human disturbance can also be a tangible tool to determine levels of habituation and behavioral plasticity of avian species (Livezey et al. 2016).

Many shorebirds species use exposed shores for roosting or loafing around the world (Colwell and Sundeen 2000; Hubbard and Dugan 2003). Despite their importance as a major component of the coast ecosystems, shorebird distributions in the Algerian Coast (exposed sandy and rocky intertidal shores), unfortunately have not been actually categorized. However, our personal surveys of avifauna during the over-wintering period (from November 2019 to February 2020) showed that shorebird can attain an abundance of more than 2500 individuals and a diversity up to 10 species at approximately 30 km shoreline on northern Algeria beaches (Annaba Bay). Here, we present the results of an expert opinion survey on FID estimates for the three beachiest shorebirds species (Lesser Black-backed Gull *Larus fuscus*, Black-headed Gull *Chroicocephalus ridibundus*, Audouin's Gull *Ichthyaetus audouinii*) when overwintering at exposed sandy beaches of north-eastern Algeria. Knowledge obtained from this study is expected to be useful in the design and discussion of such a study or management initiative aimed at protecting this part of the Algerian Coast and the whole coastline areas.

2. Method

2.1. Flight distance

We adopted the following protocol for recording flight initiation distances. When an individual bird has been located, the observer, while looking at the bird, should move to a normal walking speed towards the individual, while recording the number of steps (which approximately equals the number of meters) (Møller, 2010).The person approaching the animals was the same each time, and approached at a similar pace (normal walking pace) each time. The distance at which the bird takes flight is defined as flight initiation distance, while the starting distance is the distance from where the observer started approaching up to the position of the bird (Blumstein 2006). We sampled only species and individuals which we are able to reach their initial location

2.2. Study area

The Bay of Annaba is located in the eastern part of Algeria, between cape Rosa (36°38′N, 8°15′E) and Cape de Garde (36°38 N, 7°16′E) (Hadjadji et al. 2014). Our gulls survey was located at three localities Sidi Salem, Boukhmira, and El-Battah which are an exposed sandy beach about 30 km long

and 200 m wide (Figure 1). The coastal site named Sidi Salem is subject to periods of high human visitation compared to El-Battah and Boukhmira region supposed a more wilderness areas.

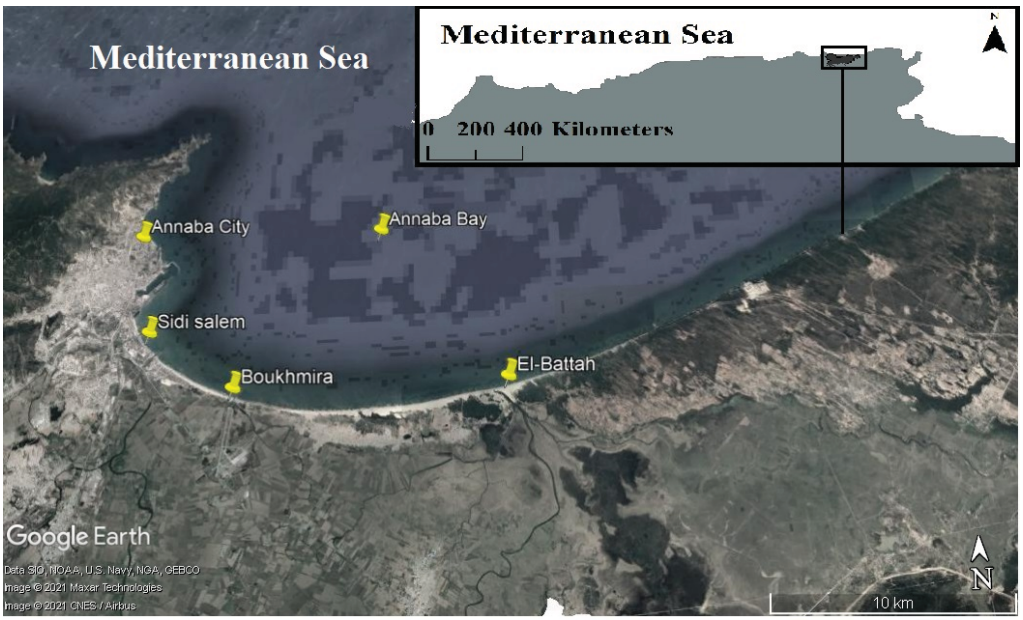

Figure 1: Annaba bay and the three studied sites

2.3. Statistical analysis

Statistical analyses were performed using PASW Statistics for Windows version 25 (IBM Corp. Released 2017). To fit the regression modeling assumptions (normality of variables and homogeneity of variance) we proceeded to transform the variables when appropriate (FIDs were square root transformed and starting distances were Log transformed). Univariate analyses of variance and linear regression models were used, using $P < 0.05$ as significant. In the modelling process FIDs were included as the dependent variable, starting distance as a covariate variable, and (1) the area where gulls were studied (two levels) (2) flock size (3) species (three levels) were included as independent factors

3. RESULTS

Our final data set contained 336 flushing events of three shorebird species, resulting in 132 records for Lesser Black-backed Gull, 112 records for Black-headed Gull, and 92 records for Audouin's Gull (Table 1). All were approached at right angles to shore, at varying starting distances. FIDs for both species that were the most common at exposed sandy beaches of north-eastern Algeria ranged from 11m up to 151m. The univariate analysis of variance indicate that the studied Gulls behave similarly against human disturbance, since that mean FIDs were not varied significantly between the three species ($F2= 0.24$, $P = 0.78$). In contrast, change in escape behavior of our sampled species was

found to be significant (F2=20.54, P<0.05) across the three coastal sites that were under varying human pressures (High, moderate, and low). In fact, individuals reduced their FIDs when anthropogenic levels increased (Figure 2). Accurately, we note that the shortest FID (11 m) was at Sidi Salem (High anthropogenic levels), while the greatest FID (up to 151 m) was at El-bettah region (Low anthropogenic levels) (Figure 2). Additionally, it was found that starting distance effect significantly FIDs of the three shorebirds. Using a regression analysis, the relationship between starting distance and FIDs was confirmed (F=176.52, P<0.005), and the obtained positive correlation

Table 1: Mean flight initiation distance (m) with standard deviation and the distribution of observations (records) for the most common shorebirds found at exposed sandy beaches of north-eastern Algeria.

Common names of sampled species	Scientific names	Number of records	Mean FID (m)	Min FID (m)	Max FID (m)	Starting distance
Lesser Black-backed Gull	*Larus fuscus*	132	56.84 (±41.61)	11	151	95 (±55.90)
Black-headed Gull	*Chroicocephalus ridibundus*	112	64.31 (±41.45)	22	151	96.06 (±51.89)
Audouin's Gull	*Ichthyaetus audouinii*	92	55.5 (± 20.17)	42	85	88 (± 14.76)

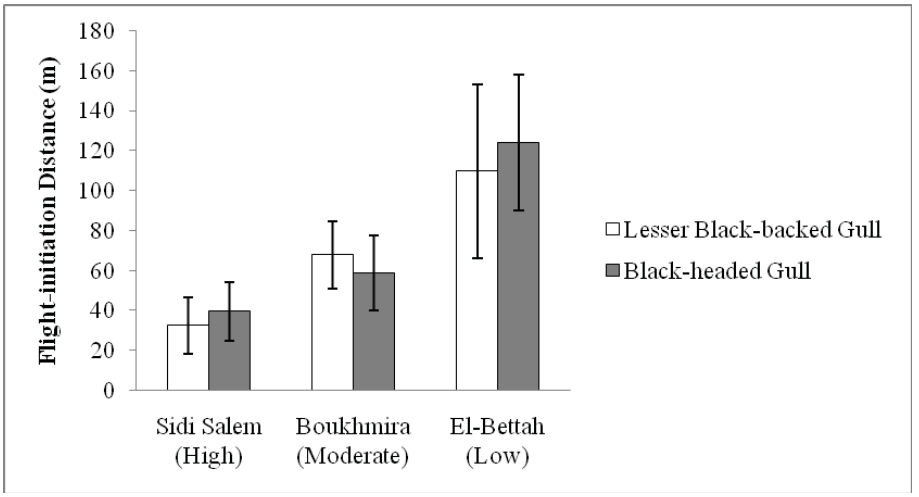

Figure 2: Flight initiation distance of Gulls at zones with varying anthropogenic levels (High, moderate, and low). (Audouin's Gull excluded, because it have not been found at the three zones)

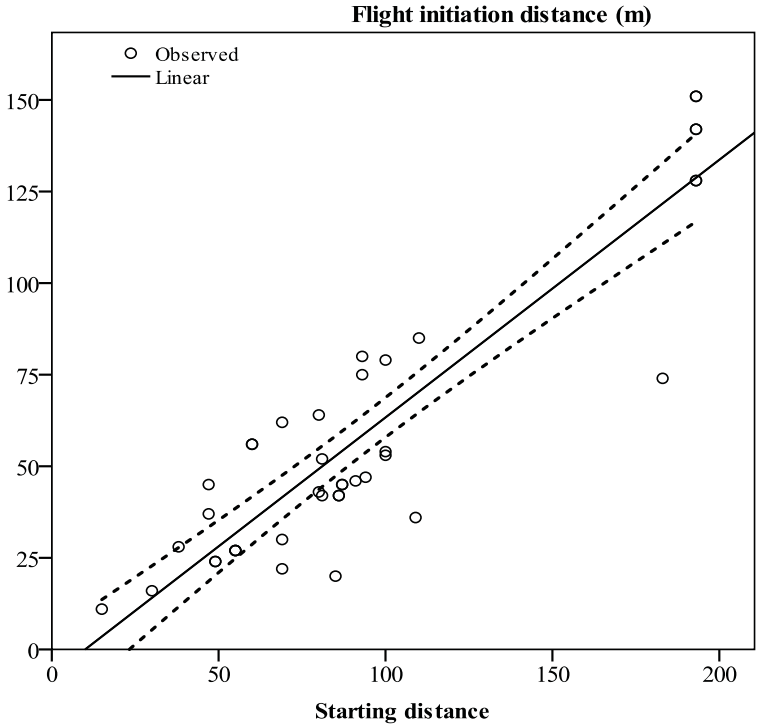

Figure 3: The relationship between FID and starting distance (all data). Envelopes around dashed lines are 95% confidence intervals.

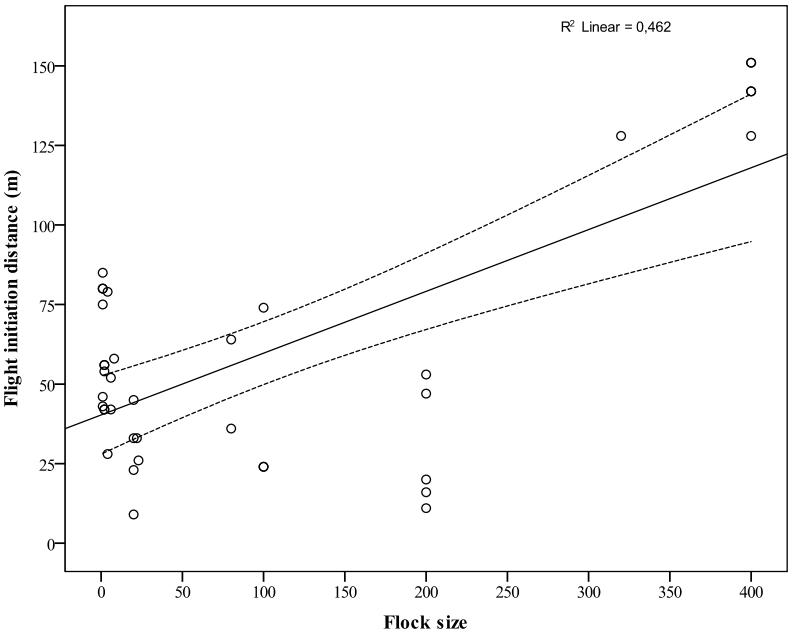

Figure 4: Linear regression lines between flight initiation distance (FID, m) and flock size. Envelopes around dashed lines are 95% confidence intervals.

4. DISCUSSION AND CONCLUSION

This study has shown how shorebirds react with human disturbance at exposed sandy beaches of north-eastern Algeria (Annaba Bay), using flight initiation distances approach in the three beachiest shorebirds species (Lesser Black-backed Gull, Black-headed Gull, and Audouin's Gull) when over wintering. For the relatively small area sampled (30 Km), we think that Annaba Bay is a singular coastal area southwestern Mediterranean Sea, which has been consistently subjected to severe human problems induced by direct domestic or industrial activities (Ounissi et al. 2016). It needs thereby, particular efforts in conserving biodiversity and safeguarding ecosystem services. It is well known that the implementation of management plans or environmental legislation must be carefully considered with the aid of contemporary research. Therefore, we believe that our brief expert opinion survey on FID estimates that are a tangible tool to measure impacts of human activities can be of help in the design and discussion of such a study or management initiative aimed at protecting this part of the Algerian coast and the whole coastline areas.

There is no attempt seeks to quantify responses of birds to human disturbance neither in Algeria nor in the other North African countries. Thus, we will discuss our finding with similar studies elsewhere as match as we can. When compared to a study by (Livezey et al. 2016), flight initiation distances found in the three Gulls at Annaba Bay were shorter than other conspecific birds reported in Australia, Europe and America. Accurately, our FIDs (58.88m means of the three species) were reduced by a large margin (84 m) if compared with FIDs of Charadriiformes (143 m) obtained in the aforementioned studies. Also, in another study at Barberspan Bird Sanctuary, South Africa by (Coetzer and Bouwman 2017), our Gulls seemed to be more habituated to humans (i.e. short FIDs) than other birds of similar body size. From the literature review, the substantial variations in the distances at which birds of the same species react to human disturbance may be accounted for by several interacting reasons such as flock size (Morelli et al. 2019), the disturbance sources (Rodgers and Smith1997; Stalmaster and Kaiser 1998), the availability of alternative habitat (Gill et al. 2001; West et al. 2002), and the time of year (Richardson and Miller 1997). This fact corroborates that any management plans attempting to promote co-existence between wildlife should be designated on the basis of contemporary and locally disturbance distance estimates, instead of being extrapolated from existing measures of disturbance responses elsewhere.

In this study FIDs were found to be much smaller at the coastal site named Sidi Salem that is subject to periods of high human visitation compared to El-Battah region supposed a more wilderness areas. This finding confirm that birds could be habituated to repeat human exposure, leading thereby to a significant reduction in their escape distances, when approached by a human, compared to rural or more wilder populations (Runyan and Blumstein 2004; Blumstein, D.T. 2006; Samia et al. 2017; Morelli et al. 2019). This behavioural plasticity allows birds to coexist with humans in specific areas such as urban and recreational areas (Møller et al. 2013). This fact may explain the increased trend of Gulls number that colonise the study areas and the overall Algerian coast (Franck and Moulaï 2013).

We found that starting distance was positively related to escape distances consistent with many studies (Blumstein 2003; Geist et al. 2005; Hingee and Magrath 2009) and it explains a large part of

the variation in FID, confirming thereby that starting distances should be considered as an important covariable to include in FID studies. The next variable also affected when individuals respond to a disturbance was flock size. Our linear regression confirmed the positive association between FIDs variation and number of individuals. This fact is already shown in other studies (Morelli et al. 2019). Because a flight response by one individual (generally the most sensitive one in the flock) will often cause the entire group to take flight (the contagious fear hypothesis) (Morelli et al. 2019), and since larger flocks have more individuals scanning the surrounding environment which increased their capacity to detect any approaching intruder (the many eyes effect hypothesis) (Hingee and Magrath 2009).

Through this study, we provide insights into some aspects of how shorebirds react to human disturbance in a North African context. The main findings of this study were that the three gull species (Lesser Black-backed Gull, Black-headed Gull, and Audouin's Gull) are extremely tolerant to human disturbance. They decrease their escape distances (up to 11m) when human presence increase. We revealed also in this study that starting distance and flock size are among the most important driver of FIDs in birds. Producing high-level information of the extent and circumstances under which birds may habituate to stresses are an evidence-base which can be used by regulatory authorities to start appropriate site-specific assessments for anthropogenic marine activities with regard to the sensitivity or habituation of seabirds to such activities.

Whilst we provide good data for the degree of habituation to human disturbance in the three beachiest shorebirds at Annaba Bay, several aspect of bird’s escape distances remain poorly explored. For example FIDs in this study was stimulated by a single person thus data on other stimulus as, larger parties of people (mainly fishermen) and tourists needed to be accomplished. Also number of observations for each level of factors (species and habitats) is unequal in the present study we assert therefore that future FIDs investigations should respect as much as possible an even sampling effort among all factors.

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