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# Mudflat Use and Predation on Male Southwestern Atlantic Fiddler Crabs (*Uca uruguayensis*) by Gull-billed Terns (*Gelochelidon nilotica*)

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**Abstract.—**Gull-billed Terns (*Gelochelidon nilotica*) comprise a group of cosmopolitan subspecies that make use of a wide range of aquatic ecosystems and have a broad dietary spectrum. This study documents the use of a southwestern Atlantic mudflat in Argentina and depredation of the southwestern Atlantic fiddler crab (*Uca uruguayensis*) by Gull-billed Terns. Gull-billed Terns preyed exclusively on male fiddler crabs. This may have been due to the observed presence of Gull-billed Terns mainly between 2 and 3 hr after low tide, when more than 80% of fiddler crabs active on the surface were males. Gull-billed Terns spent 66.9% of the time flying over and feeding on fiddler crabs. Gull-billed Terns landed without feeding 9.3% of the time. Gull-billed Terns succeeded in capturing prey in 29.8% of cases. Food capture rate of Gull-billed Terns was 68.9 items/hr, which is higher than rates reported for the species feeding on fiddler crabs in Mauritania and Guinea Bissau. *Received 30 March 2017, accepted 9 September 2017.*

**Key words.—***Gelochelidon nilotica*, Gull-billed Terns, sex-biased predation, southwestern Atlantic fiddler crabs, time budgets, *Uca uruguayensis*.

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Gull-billed Terns (*Gelochelidon nilotica*) comprise a group of cosmopolitan subspecies (Molina *et al.* 2010; Miller *et al.* 2013) that make use of a wide range of terrestrial and continental aquatic ecosystems (Blendinger and Alvarez 2002; Yorio 2005; Molina *et al.* 2014). They have a broad diet that includes crustaceans, bivalves, insects, small fishes, frogs, and lizards (Dies *et al.* 2005; Molina *et al.* 2014) and will prey on small mammals such as shrews, murids, and voles (Goutner 1991) and on chicks of the Common Tern (*Sterna hirundo*) (Bogliani *et al.* 1990) and Least Tern (*S. antillarum*) (Densmore 1990). Gull-billed Terns have a striking prey-capture technique that consists of flying slowly into the wind searching an area for potential prey. If a prey is of interest, the bird swoops down and picks it up from the surface (Land 1999). Depending on the prey size, Gull-billed Terns may capture it in flight or may stop and land to handle it (Molina *et al.* 2010).

Gull-billed Terns have been globally designated as a taxon of "Least Concern" on the International Union for Conservation of Nature Red List (BirdLife International 2016) and as "Birds of Conservation Concern" in the United States (U.S. Fish and Wildlife Service 2008). Despite the worldwide distribution of the species, the general population trend appears to be decreasing, mainly in association with the loss of natural nesting and feeding sites (Molina *et al.* 2010). However, in contrast to populations in the northern hemisphere (Bogliani *et al.* 1990; Goutner 1991; Dies *et al.* 2005; Molina *et al.* 2014), there is limited information for the southern hemisphere, especially for populations in South America. In Argentina, Gull-billed Terns appear to nest mainly in continental wetlands and occasionally along the marine littoral zone (Blendinger and Alvarez 2002; Yorio 2005; Suárez *et al.* 2014); they also make use of intertidal areas to prey on various crab species (Wetmore 1926; Iribarne and Martínez 1999).

Here, we document the use of a southwestern Atlantic intertidal mudflat and predation on the southwestern Atlantic fiddler crab (*Uca uruguayensis*; hereafter, fiddler crab) by Gull-billed Terns.

## Methods

### Study Area

We conducted the study during five 3-day periods during the austral summer 1999. The five sampling periods were 11 to 13 January, 26 to 28 January, 8 to 10

February, 22 to 24 February, and 9 to 11 March. The study was conducted in eastern Bahía Samborombón, Argentina, near the mouth of the San Clemente tidal creek (36° 19′ 0.1″ S, 56° 46′ 32.2″ W). This is an area with marshes and mudflats affected by low-amplitude (< 1.4 m) semidiurnal tides and commonly used by migratory and resident shorebirds (Ribeiro *et al.* 2004). The southernmost permanent population of fiddler crabs occupies this area in the upper levels of the tidal flats, forming discrete patches (Ribeiro *et al.* 2005) with densities that can average 140 individuals/$m^2$ (Bogazzi *et al.* 2001; Ribeiro *et al.* 2005). We established a 300-m long x 50-m wide observation area along a 1,000-m long x 100-m wide beach, within which we identified six fiddler crab patches ($\bar{x}$ = 1,175.5 $m^2$) separated by interpatch areas without settlements (52.98% of the observation area). The edge of each fiddler crab patch was demarcated with 1-m wooden sticks.

### Monitoring

Each day, our observations began 5 hr before the diurnal low tide and ended with the last bird survey 5 hr after the diurnal low tide to encompass the time window during which the mudflat was exposed. The diurnal low tide occurred between 11:00 and 13:00 hr depending on the day. Every hour, we used 10x50 binoculars to scan a 5 x 10-m area in each patch and registered the number of male and female fiddler crabs active on the surface. We also performed hourly counts of Gull-billed Terns using the observation area (individuals flying over and landing to feed or rest) and recording the number of individuals. Gull-billed Terns that flew over the area without landing were considered to be in transit and were not included in the analysis.

### Focal Observations of Gull-billed Terns

We conducted focal observations of individual Gull-billed Terns using 10x50 binoculars. Observations began when an individual entered the observation area from a predetermined side and ended when the individual exited the area. The predetermined side was defined during the first survey of each day and was the side from which the majority of individuals entered. To avoid double counting, individuals entering the area from outside the predetermined side were not considered. During each observation, we followed the individual as closely as possible by walking across the inter-patch areas or along the edge of the marsh. We maintained a distance of ≥ 5 m to the target zone of the Gull-billed Tern. During each observation, we continuously reported all behaviors of the individual in an audiotape. The registered behaviors included: 1) flight over, move away from, and land on a fiddler crab patch; 2) prey capture attempts and outcomes; and 3) prey items captured. Male fiddler crabs were easily identified when captured by the red color of their enlarged claw.

### Analyses

We fit a generalized linear model (GLM; Hardin and Hilbe 2012) to evaluate the counts of Gull-billed Terns across dates and tidal stage. To avoid multicollinearity, we did not include the behavior of fiddler crabs because it was correlated with the tide. The GLM was fit to a Poisson distribution, log-link function, and quasi-likelihood estimation to control for overdispersion.

With the data from our focal observations, we calculated: 1) the proportion of time spent using fiddler crab patches; 2) the proportion of time spent landed without feeding; 3) prey capture success (number of captures out of total capture attempts); and 4) food capture rate over the focal period (number of prey items captured/hr) for each individual. We calculated the mean and the 95% confidence limits for each of the above calculated variables.

## Results

During 165 hours of field work, we recorded a total of 2,831 sec of behavioral data for 20 individual Gull-billed Terns. We observed at least one Gull-billed Tern using the observation area on 8 of the 15 days (57.1%). We observed that Gull-billed Terns fed exclusively on male fiddler crabs. The occurrence of terns varied between dates without a clear temporal pattern (Table 1; Fig. 1). Gull-billed Terns were more likely to be present in the late afternoon after low tide (Fig. 2A) when the density of fiddler crabs on the surface (Fig. 2B) had begun to decrease and their sex ratio had become male biased (Fig. 2C). Gull-billed Terns

**Table 1. Summary of the generalized linear model (GLM) evaluating the number of Gull-billed Terns occurring at the observation area in eastern Bahía Samborombón, Argentina, near the mouth of the San Clemente tidal creek in relation to dates and tide. The GLM was fit to a Poisson distribution and log-link function. $D^2$ is the explained deviance. The over-dispersion parameter was 0.628.**

| Factor | Scaled Deviance | df | $P$ | $D^2$ |
|---|---|---|---|---|
| Date | 309.79 | 14 | < 0.001 | 51.63 |
| Tidal stage | 127.25 | 1 | < 0.001 | 21.21 |
| Date x tidal stage | 4.70 | 14 | 0.999 | 0.78 |
| Residual | 158.20 | | | |

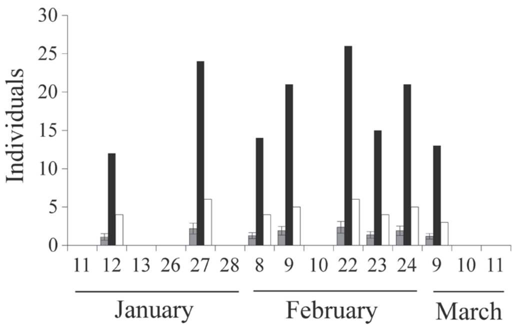


**Figure 1. Counts of Gull-billed Terns using the observation area in eastern Bahía Samborombón, Argentina, near the mouth of the San Clemente tidal creek. Gray bars show the mean and SE for hourly surveys performed on each sampling day. Black bars show the sum of the 11 hourly surveys performed on each day. White bars show the maximum number of terns counted in a single daily survey.**

spent 66.9% of the time (SD = 22.3; confidence limits = 56.6, 77.3) flying over and feeding on fiddler crabs; the remaining time was spent on interpatch movements. Gull-billed Terns landed without feeding 9.3% of the time (SD = 13.5; confidence limits = 2.9, 15.6). The mean food capture rate was 68.93 items/hr (SD = 34.11; confidence limits = 52.96, 84.89), and mean capture success was 29.8% (SD = 15.2; confidence limits = 22.7, 36.9).

## DISCUSSION

In this study, we documented the mudflat use and feeding activity of Gull-billed Terns in a southern Atlantic mudflat inhabited by fiddler crabs. This encompasses the first behavioral study of the species in the region.

The occurrence of Gull-billed Terns in the mudflat area varied across days without a clear temporal trend. When present, Gull-billed Terns occurred mainly between 2 and 3 hr after low tide, similar to patterns observed in Guinea Bissau (Stienen *et al.* 2008), but opposite those in Mauritania, where they occurred mainly before low tide (Ens *et al.* 1993). The variability between sites in the part of the tidal cycle during which Gull-billed Terns feed may be linked to the local availability of other prey items. Gull-billed Terns are opportunistic foragers that can adapt to a wide variety of habitats and exploit high local availability of prey items (Rohwer and Woolfenden 1968; Bogliani *et al.* 1990; Erwin *et al.* 1998). This dietary flexibility may enable Gull-billed Terns to meet their daily energy demands by feeding on the West African fiddler crab (*U. tangeri*; Stienen *et al.* 2008). Similarly, we found that the southwestern Atlantic fiddler crab may represent an important food item for Gull-billed Terns.

Although the diet of Gull-billed Terns has been studied (Ens *et al.* 1993; Erwin *et al.* 1998; Land 1999; Stienen *et al.* 2008), prior to the current study there were no published data available on their selection of male vs. female fiddler crabs. We found that Gull-billed Terns exclusively captured male fiddler crabs. Sex-biased predation may be driven by energetics and digestibility constraints (Zwarts and Blomert 1990) and by the relative availability of both sexes (Backwell *et al.* 1998; Koga *et al.* 2001). During this study, Gull-billed Terns were present mainly when the majority of fiddler crabs on the surface of the mudflat were males. Therefore, the greater numerical availability and conspicuousness of males in comparison to females is the most likely driver of this sex-biased predation.

We found that Gull-billed Terns fed at a mean rate of nearly 70 items/hr. In Guinea Bissau and Mauritania, Gull-billed Terns feed on fiddler crabs at rates ranging between 10 and 40 items/hr (Ens *et al.* 1993; Stienen *et al.* 2008). Prey capture success in our study (almost 30%) was similar to that observed by Stienen *et al.* (2008), and therefore might not explain differences in food capture rates. Alternatively, differences in the size and density of fiddler crab species may promote differences in food capture rates between sites. In Guinea Bissau and Mauritania, the carapace width of fiddler crabs consumed by Gull-billed Terns ranges between 20 and 30 mm (Ens *et al.* 1993; Stienen *et al.* 2008). Although we did not measure the size of prey consumed, the carapace width of the southwestern Atlantic fiddler crab does not exceed 15 mm (Bogazzi *et al.* 2001). Stienen *et al.* (2008) suggested that the size of fiddler crabs

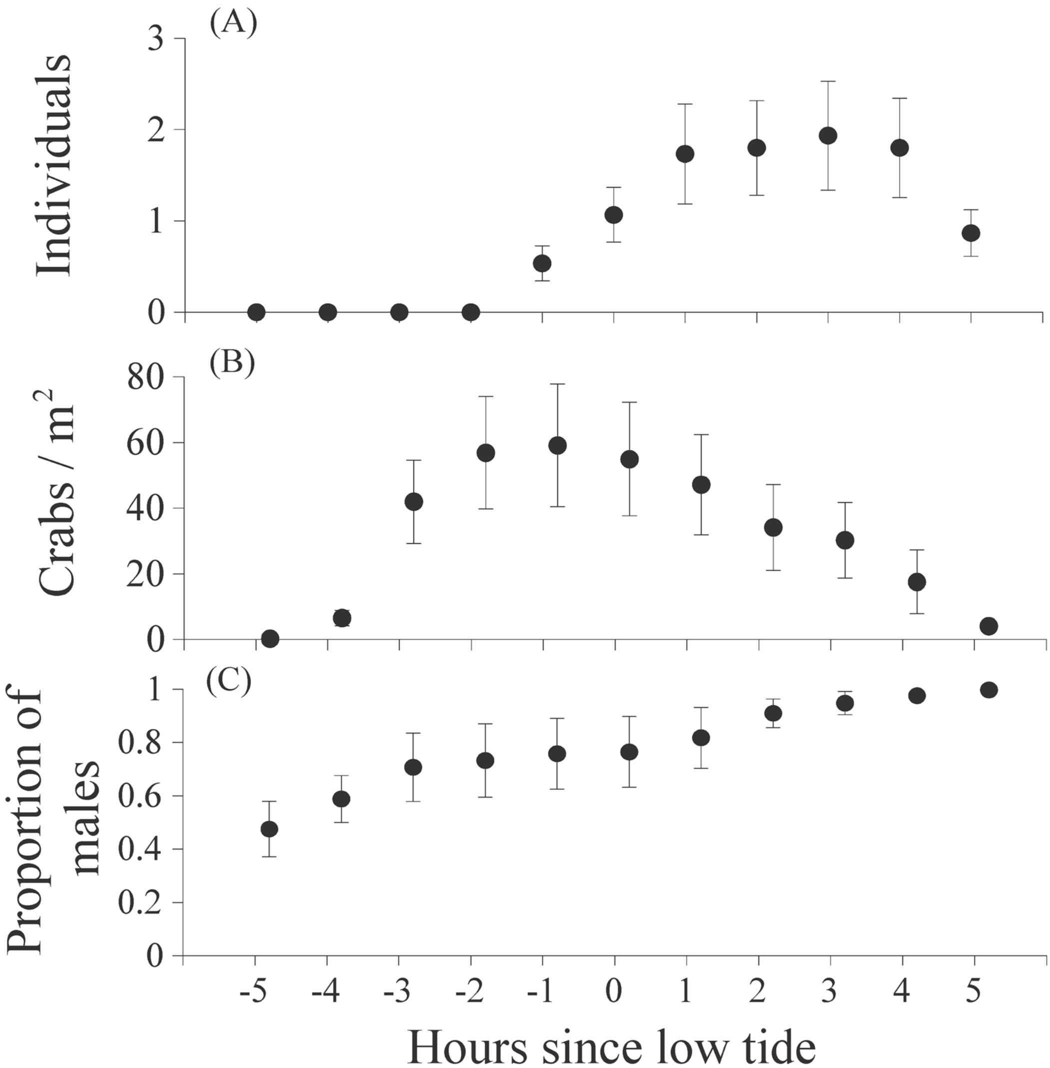


**Figure 2. Mean and SE for (A) the number of Gull-billed Terns using the observation area in eastern Bahía Samborombón, Argentina, near the mouth of the San Clemente tidal creek in relation to the tidal cycle, (B) the surface density of fiddler crabs, and (C) the sex ratio of fiddler crabs (the proportion of crabs that were male). Values were obtained by pooling data across days for the same tidal stage. For simplicity, (B) and (C) show data from only one of the six fiddler crab patches. During sampling days, low tide occurred between 11:00 and 13:00 hr.**

consumed was related to the duration of the resting interval required for digestion, which could be between 15% and 70% of the foraging time. In contrast, at our study site, Gull-billed Terns did not spend more than 10% of their foraging time resting. Therefore, it is likely that longer resting times are not needed for digesting southwestern Atlantic fiddler crabs, but also that greater consumption rates may be required to achieve similar energy content compared to feeding on West African fiddler crabs. Finally, the density of fiddler crabs on our study site was much greater than that reported in Mauritania (< 7/m$^2$; Ens *et al.* 1993). Therefore, differences in the capture rates of Gull-billed Terns may be driven by differences in their encounter rates if they are a function of the local density of different fiddler crab species.

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## LITERATURE CITED

Backwell, P. R. Y., P. D. O'Hara and J. H. Christy. 1998. Prey availability and selective foraging in shorebirds. Animal Behaviour 55: 1659-1667.

BirdLife International. 2016. *Gelochelidon nilotica*. *In* International Union for Conservation of Nature (IUCN). The IUCN Red List of Threatened Species 2016. http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T62026481A86743403.en, accessed 22 July 2017.

Blendinger, P. G. and M. E. Alvarez. 2002. Ensambles de aves de los bañados de Carilauquen (Laguna Llancanelo, Mendoza, Argentina): consideraciones para su conservación. Hornero 17: 71-83. (In Spanish).

Bogazzi, E., O. O. Iribarne, R. Guerrero and E. Spivak. 2001. Wind pattern may explain the southern limit of distribution of a southwestern Atlantic fiddler crab. Journal of Shellfish Research 20: 353-360.

Bogliani, G., M. Fasola, L. Canova and N. Saino. 1990. Food and foraging rhythm of a specialized Gull-billed Tern population *Gelochelidon nilotica*. Ethology Ecology and Evolution 2: 175-181.

Densmore, R. J. 1990. Gull-billed Tern predation on a Least Tern chick. Wilson Bulletin 102: 180-181.

Dies, J. I., J. Marín and C. Pérez. 2005. Diet of nesting Gull-billed Terns in eastern Spain. Waterbirds 28: 106-109.

Ens, S. J., M. Klaassen and L. Zwarts. 1993. Flocking and feeding in the fiddler crab (*Uca tangeri*): prey availability as risk-taking behaviour. Netherlands Journal of Sea Research 31: 477-494.

Erwin, R. M., T. B. Eyler, J. S. Hatfield and S. McGary. 1998. Diets of nestling Gull-billed Terns in coastal Virginia. Colonial Waterbirds 21: 323-327.

Goutner, V. 1991. Food and feeding ecology of Gull-billed Terns (*Gelochelidon nilotica*) in Greece. Revue d'Ecologie (Terre et la Vie) 46: 373-384.

Hardin, J. W. and J. M. Hilbe. 2012. Generalized linear models and extensions, 3rd ed. Stata Press, College Station, Texas.

Iribarne, O. O. and M. M. Martínez. 1999. Predation on the southwestern Atlantic fiddler crab (*Uca uruguayensis*) by migratory shorebirds (*Pluvialis dominica*, *P. squatarola*, *Arenaria interpres* and *Numenius phaeopus*). Estuaries 22: 47-48.

Koga, T., P. R. Y. Backwell, J. H. Christy, M. Murai and E. Kasuya. 2001. Male-biased predation of a fiddler crab. Animal Behaviour 62: 201-207.

Land, M. F. 1999. The roles of head movements in the search and capture strategy of a tern (Aves, Laridae). Journal of Comparative Physiology A 184: 265-272.

Miller, M. P., T. D. Mullins and S. M. Haig. 2013. Genetic structure, diversity and subspecies status of Gull-billed Terns (*Gelochelidon nilotica*) from the United States. Waterbirds 36: 310-318.

Molina, K. C., J. F. Parnell and R. M. Erwin. 2014. Gull-billed Tern (*Gelochelidon nilotica*). No. 140 *in* The Birds of North America Online (P. G. Rodewald, Ed.). Cornell Lab of Ornithology, Ithaca, New York. https://birdsna.org/Species-Account/bna/species/gubter1, accessed 4 July 2017.

Molina, K. C., R. M. Erwin, E. Palacios, E. Mellink and N. W. H. Seto. 2010. Status review and conservation recommendations for the Gull-billed Tern (*Gelochelidon nilotica*) in North America. Biological Technical Publication FWS/BTP-R1013-2010, U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C.

Ribeiro, P. D., O. O. Iribarne and P. Daleo. 2005. The relative importance of substratum characteristics and recruitment in determining the spatial distribution of the fiddler crab *Uca uruguayensis* Nobili. Journal of Experimental Marine Biology and Ecology 314: 99-111.

Ribeiro, P. D., O. O. Iribarne, D. Navarro and L. Jaureguy. 2004. Environmental heterogeneity, spatial segregation of prey, and the utilization of southwest Atlantic mudflats by migratory shorebirds. Ibis 146: 672-682.

Rohwer, S. A. and G. E. Woolfenden. 1968. The varied diet of the Gull-Billed Tern includes a shrub-inhabiting lizard. Wilson Bulletin 80: 330-331.

Stienen E. W. M., A. Brenninkmeijer and M. Klaassen. 2008. Why do Gull-billed Terns *Gelochelidon nilotica* feed on fiddler crabs *Uca tangeri* in Guinea-Bissau? Ardea 96: 243-250.

Suárez, N., C. Marinao, T. Kasinsky and P. Yorio. 2014. Distribución reproductiva y abundancia de Gaviotas y gaviotines en el área natural protegida Bahía San Blas, Buenos Aires. Hornero 29: 29-36. (In Spanish).

U.S. Fish and Wildlife Service. 2008. Birds of conservation concern 2008. U.S. Department of the Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, Virginia.

Wetmore, A. 1926. Observations on the birds of Argentina, Paraguay, Uruguay, and Chile. Bulletin of the United States National Museum 133, Government Printing Office, Washington, D.C.

Yorio, P. 2005. Estado poblacional y de conservación de gaviotines y escúas que se reproducen en el litoral marítimo argentino. Hornero 20: 75-93. (In Spanish).

Zwarts, L. and A.-M. Blomert. 1990. Selectivity of Whimbrels feeding on fiddler crabs explained by component specific digestibilities. Ardea 78: 193-208.