SEABIRDS IN THE GULF OF FONSECA, PACIFIC CENTRAL AMERICA, DURING EL NIÑO 2015/16

JOHN VAN DORT

Zamorano University, Zamorano Biodiversity Center, Carretera a Danlí Km 30, Francisco Morazán, Honduras (john.vandort@gmail.com)

Received 8 December 2017, accepted 28 December 2017

ABSTRACT

VAN DORT, J. 2018. Seabirds in the Gulf of Fonseca, Pacific Central America, during El Niño 2015/16. *Marine Ornithology* 46: 71–77.

Until recently, several seabird species in the orders Procellariiformes, Charadriiformes, and Suliformes were considered rare or unknown from the Gulf of Fonseca, a tropical bay on the Pacific coast of northern Central America. The gulf's shallow waters were not expected to harbor open ocean species, but, in 2015 and early 2016, I found some of these species to be relatively common in the Gulf. This communication summarizes the results of opportunistic observations in the Gulf of Fonseca between May 2015 and October 2016, overlapping with one of the strongest El Niño–Southern Oscillation (ENSO) periods on record. Visits late in the study period, when the ENSO phenomenon was waning, failed to record some of these species, indicating that their presence in the Gulf of Fonseca is not annual, but rather ENSO-related. Statistical support for this hypothesis was found for Least Storm Petrel *Oceanodroma microsoma*. This note includes information on observed wing molt in two species of storm petrel.

Key words: ENSO, Honduras, *Oceanodroma microsoma*, Hydrobatidae, molt, storm petrel

RESUMEN

Recientemente, varias especies de aves marinas en los órdenes Procellariiformes, Charadriiformes, y Suliformes se consideraban raras o desconocidas en el Golfo de Fonseca, una bahía tropical en la costa pacífica del norte de Centroamérica. No se esperaba que las aguas poco profundas del golfo albergaran especies de mar abierto, pero en 2015 y al inicio de 2016 descubrí que algunas de estas especies eran relativamente comunes. La presente comunicación resume los resultados de observaciones oportunistas en el Golfo de Fonseca entre mayo de 2015 y octubre de 2016, período que se superpone con uno de los eventos más fuertes de El Niño–Oscilación del Sur (ENOS) en el registro. En las visitas durante la última parte del período de estudio, cuando el fenómeno ENOS estaba disminuyendo, no se registraron algunas de estas especies, lo que indica que su presencia en el Golfo de Fonseca no es anual, sino que está relacionada con el ENOS. Se encontró soporte estadístico para esta hipótesis para el Paíño menudo *Oceanodroma microsoma*. Esta nota incluye información sobre la muda de las plumas de vuelo en dos especies de paíños.

Palabras clave: ENSO, Honduras, *Oceanodroma microsoma*, Hydrobatidae, molt, storm petrel

INTRODUCTION

Across biogeographic realms, avian distributions in the neotropics are less well-known than those in the nearctic, and, between orders, those of seabirds are generally less well-known than those of landbirds. While many seabirds are among the most numerous birds on Earth, the group as a whole includes many of the world's most threatened avian taxa, and seabirds of the Pacific, especially, have shown steep decreases in abundance (BirdLife International 2013). The first modern effort to describe the inshore and near-shore avifauna of Pacific Central America provided baseline data on seabird communities within 50 km from shore from California to Panama (Jehl 1974). Later studies of seabirds near and off the Pacific coast of Costa Rica and Panama (Loftin 1991, Spear & Ainley 1999, Duffy & Frazier 2014, Young & Zook 2015, Sandoval *et al.* 2016) provided additional detail, but large parts of the shelf waters of Pacific Central America remain poorly known in terms of avian diversity.

The Gulf of Fonseca, a bay on the Pacific coast of northern Central America shared by El Salvador, Honduras, and Nicaragua, is one of those poorly explored areas (Jenner *et al.* 2007). The area boasts the largest Bridled Tern *Onychoprion anaethetus* colony in the eastern tropical Pacific at Los Farallones, near the sea entrance of the Gulf, where other seabirds such as Blue-footed Booby *Sula nebouxii* and Brown Booby *Sula leucogaster* are also found (Komar & Rodríguez 1996). The shallow waters of the Honduran part of the Gulf, however, were not known to harbor seabirds other than those associated with the littoral zone. Unlike neighboring countries El Salvador and Nicaragua, Honduras lacks direct access to the Pacific Ocean, which accounts for the historical scarcity of Pacific open ocean species' records. I was thus surprised to find Black Storm Petrel *Oceanodroma melania* and Wedge-rumped Storm Petrel *Oceanodroma tethys*, both new for Honduras, on an August 2014 boat trip a few kilometers south of Amapala. These findings suggested that the Gulf has unexpected potential.

Here, I present results of opportunistic observations in the Gulf of Fonseca between May 2015 and October 2016, overlapping with one of the strongest El Niño–Southern Oscillations (ENSOs) on record. The US National Oceanic and Atmospheric Administration (NOAA) characterized the 2015/16 ENSO as Very Strong. The Oceanic Niño Index (ONI), a three-month running mean of Extended Reconstructed Sea Surface Temperature anomalies in the

Niño 3.4 region (5°N–5°S, 120°–170°W), showed the phenomenon lasted between November 2014 and May 2016, with sea surface temperature (SST) anomalies in the Central Pacific Ocean rising above 2° between September 2015 and February 2016. Since the displacement effects of ENSO on seabirds elsewhere in the Pacific Ocean are well known—from California (Ainley 1976) and Central America (Spear & Ainley 1999) to the Humboldt Current (Murphy 1936, Ainley *et al.* 1986, Haase 1997, Culik *et al.* 2000, Schreiber 2002)—I hypothesize that such effects may be responsible for some of the occurrence patterns presented here.

STUDY AREA AND METHODS

The Gulf of Fonseca is a relatively large embayment on the Pacific coast of northern Central America, and its waters are shared by El Salvador, Honduras, and Nicaragua. The total water surface area in the Gulf of Fonseca is ~1 600 km^2, and most of the Gulf is shallow, with an average depth of 15 m (Valle-Levinson & Bosley 2003). The Gulf receives the drainage of five rivers: the Choluteca and Nacaome rivers, both in Honduras; the Goascoran River, which forms the border between Honduras and El Salvador; and the Estero Real and Río Negro, both in Nicaragua. The current study focused on an area of approximately 50 km^2, located roughly around 13°13′10″N, 87°34′16″W (Fig. 1).

After an orientation visit on 3 August 2014, I visited waters of the Gulf of Fonseca on 18 separate occasions between 24 May 2015 and 2 October 2016, observing birds offshore during 42.3 h (Table 1). Most observations were carried out at midday, although five surveys started in the morning. Complete observations, including photo documentation and field notes, as well as details of survey locations and observers, are available in eBird (2017), a global data repository of bird observations. These surveys took place >3 km from land in an area that covers the Honduran part of the Gulf of Fonseca, south and southeast of Isla Amapala, except for 13 December 2015, when I visited a larger part of the Gulf of Fonseca, including transects in Nicaraguan and Salvadoran waters. I made most observations from small, open fishing vessels, and often was accompanied by one to six additional observers to whom I refer in the text using their initials; full names appear in the Acknowledgments. Some land-based observations (all from Punta Ratón, Choluteca Department) are included in the results. Most trips disembarked from Punta Ratón; a few trips launched from Playa El Edén near Cedeño, Choluteca, or from Coyolito, Valle Department. Gulf waters were scanned from moving boats with unaided vision and with 8× binoculars; efforts were made to photograph each novel species, sometimes by altering the original route in pursuit of the birds. An area 3–10 km southeast of Amapala proved productive early on and was sampled more frequently. Oceanographic data such as SST and salinity were not collected.

Fig. 1. The study area in the Gulf of Fonseca, located in northern Central America (inset). Most observations were made in the area indicated by the oval. Map data © Google 2017.

I did a linear analysis to evaluate the effect of ENSO on the abundance, here defined as individuals per hour per month, of three species in the Gulf of Fonseca (Black Storm Petrel, Least Storm Petrel *O. microsoma*, and Sabine's Gull *Xema sabini*). In the first set of models, I used the ONI value as the independent variable, and the number of individuals per hour for each species as the dependent variable. Since an exponential relationship between the variables was suggested for all three species, I constructed a second set of models using a logarithmic transformation; hereafter, I will refer to it as a log-linear model of the ONI index. The normality assumption

TABLE 1
Boat-based surveys in the Gulf of Fonseca between May 2015 and October 2016

Date	Start time	Duration (min)	Length of transect (km)
2015			
24 May	13h05	130	20.5
15 June	13h28	132	21.5
21 June	13h37	130	21.4
5 August	15h00	55	0.5
23 August	13h35	143	18.3
26 September	13h15	150	19.0
2 October	11h44	151	10.0
12 October	09h50	135	18.0
2 December	12h35	101	12.8
13 December[a]	10h01	326	59.8
23 December	13h17	132	20.0
2016			
31 January	08h52	227	20.0
12 March	13h00	145	20.0
3 April	08h38	146	34.4
14 May	13h20	118	14.0
16 July	11h25	89	4.0
10 September	09h27	133	22.0
2 October	14h21	97	7.5

[a] The transects on 13 December 2015 included 149 min and 26 km in Nicaraguan waters, and 18 min and 6 km in Salvadoran waters.

for test-residuals was checked using Shapiro–Wilk goodness-of-fit tests. I checked abundance data for auto-correlation using Ljung-Box tests with time lags for the length of each time-series. I selected the optimal model for each species using the Akaike information criteria (AIC). I used the R statistical language, version 3.3.3 (R Development Core Team 2017) for these analyses, and a P value of 0.05 to determine significance.

RESULTS

Black Storm Petrel *Oceanodroma melania*

This species was first recorded in Honduran waters on 3 August 2014, when RJ, OK, MM, and I found three individuals in the Gulf of Fonseca about 5 km south of Amapala. During the study period, Black Storm Petrels were observed on 10 of 11 surveys between May and December 2015 (n = 117), for an average of 4.4 birds h^{-1}, with the highest counts recorded on 24 May (18), 2 October (26), and 12 October (17). In 2016, during 16.5 h divided over seven visits, this species was only observed once, when two individuals were seen on 12 March (i.e., 0.1 birds h^{-1}). However, occurrence of Black Storm Petrels did not show a significant relationship with ONI (linear regression: $F_{1,11}$ = 2.51, P = 0.14; log-linear regression: $F_{1,11}$ = 2.71, P = 0.13; Fig. 2). The log-linear model explained the variation in the abundance data better (linear regression AIC = 69.10, log-linear regression AIC = 68.90). Residuals of this test were not auto-correlated (Ljung-Box Q test, P = 0.40), and were normally distributed (W = 0.88, P = 0.06).

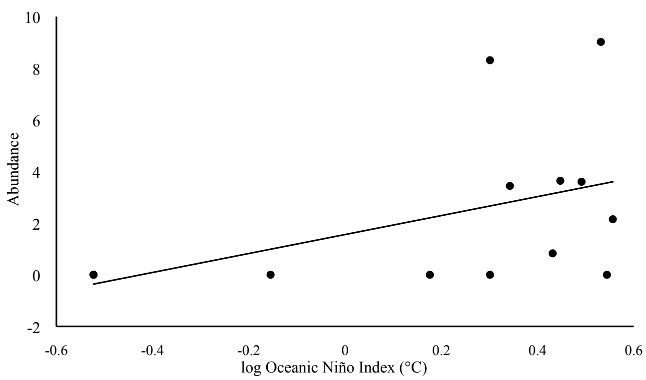

Fig. 2. Relationship between abundance of Black Storm Petrel and Oceanic Niño Index (y = 1.59x log(ONI) + 1.56, R^2 = 0.20).

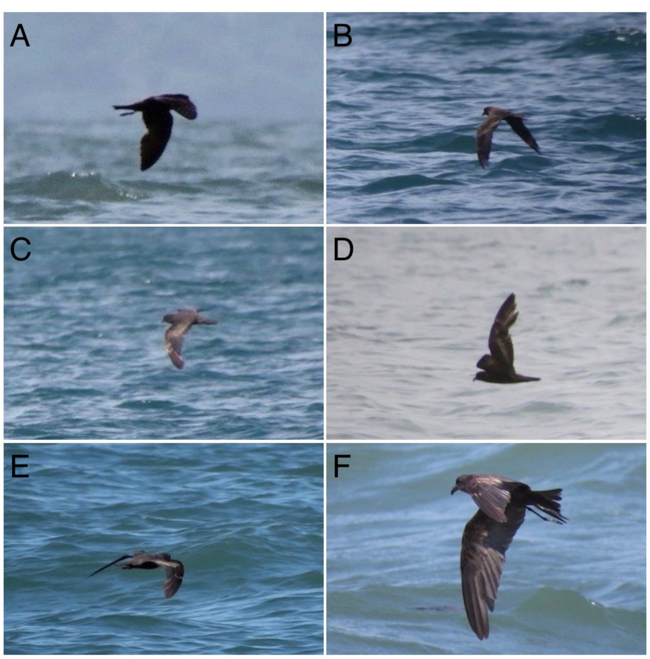

Fig. 3. Wing molt in Black Storm Petrels from the Gulf of Fonseca, 2015: A) p1-3 incoming (24 May); B) p1-8 new, p9-10 retained (15 Jun); C) p6-7 incoming (15 Jun); D) p1-4 incoming (21 Jun); E) p5-6 incoming (5 Aug); F) p7 incoming (2 Oct). All photos by the author.

Many of the Black Storm Petrels photographed in the Gulf of Fonseca between late May and early October 2015 were in active wing molt (Fig. 3); some individuals in October and all in December showed fresh-looking remiges and sooty gray heads contrasting slightly with browner bodies, typical of freshly molted birds (Ainley & Everett 2001, Howell 2012).

Least Storm Petrel *Oceanodroma microsoma*

Least Storm Petrel was first recorded in the Gulf of Fonseca on 15 July 2012, when a single individual was seen by RJ and the author in Nicaraguan waters about 1 km from Los Farallones (Jones & Komar 2013). The species was not recorded again in the Gulf until 29 July 2015, when two individuals were seen by RG in Honduran waters, providing the first record of this species for Honduras (eBird 2017). After that observation, I recorded Least Storm Petrel on every survey between 5 August 2015 and 3 April 2016 (n = 144). It was often the most common storm petrel in the Gulf of Fonseca during this time, with concentrations of up to 20 birds on a single transect, for an average of 5.0 birds h^{-1}. It was sometimes seen close to or even from land. It was last recorded on 3 April 2016; four more trips in May, July, September, and October 2016 failed to detect this species in the Gulf of Fonseca. Least Storm Petrel showed a positive relationship with ONI; abundance increased with an increase in SST, using a linear regression: $F_{1,11}$ = 23.24, P = 0.001, as well as using a log-linear regression: $F_{1,11}$ = 8.06, P = 0.02; Fig. 4. The linear model was the best model (linear regression AIC = 53.66, log-linear regression AIC = 61.26). Residuals of this test were not auto-correlated (Ljung-Box Q test, P = 0.09) and were normally distributed (W = 0.93, P = 0.35).

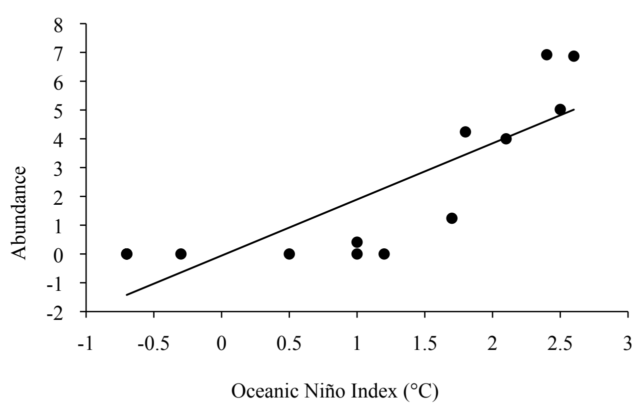

Fig. 4. Relationship between abundance of Least Storm Petrel and Oceanic Niño Index (y = 1.95x + -0.06, R^2 = 0.68).

I photographed individuals showing active wing molt in October and December of 2015 (Fig. 5).

Wedge-rumped Storm Petrel *Oceanodroma tethys*

Wedge-rumped Storm Petrel was first reported for the Gulf of Fonseca and for Honduras on 3 August 2014, when RJ, OK, MM, and I observed a single individual about 5 km south of Amapala. My photos show that the individual appeared to belong to the subspecies *kelsalli* ("Peruvian"), based on comparisons of the relative length of the white rump patch to photos of nominate *tethys* and *kelsalli* (Howell 2012). This is also the more likely of the two subspecies to occur in inshore waters (Spear & Ainley 2007, Howell 2012). I observed this species again on 5 August (one) and 2 October 2015 (one).

Leach's Storm Petrel *Oceanodroma leucorhoa*

Two dark-rumped storm petrels, identified as *Oceanodroma leucorhoa chapmani*, were observed and photographed (photo by AA) about 5 km south-southeast of Amapala on 23 August 2015, feeding in the company of Black and Least storm petrels. The birds stood out from their congeners by their intermediate size and bounding flight style. This taxon is not typically found over shelf waters (Howell 2012), so its presence in the Gulf of Fonseca is unexpected and likely accidental. Interestingly, Jehl (1974) mentions his study's southernmost Leach's Storm Petrel just south of the entrance to the Gulf of Fonseca (17 April 1973), although it is sometimes found farther south (Spear & Ainley 1999, Howell 2012).

Blue-footed Booby *Sula nebouxii*

Blue-footed Booby was first recorded for Honduras in 1962 from Los Farallones in the Gulf of Fonseca (Monroe 1968), when those islands were still considered part of Honduras. After that location became Nicaraguan, Blue-footed Booby was not seen in Honduran waters until 2010 (Gallardo 2014). During the current study, I observed the species regularly in small numbers (maximum five) in Honduran waters of the Gulf of Fonseca throughout the study period. I visited Los Farallones once during the study period, on 13 December 2015, and counted 45 individuals roosting there.

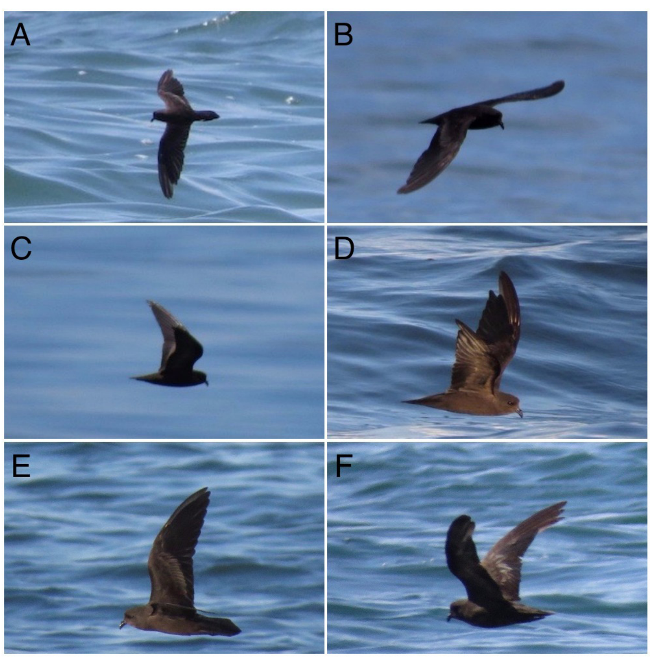

Fig. 5. Wing molt in Least Storm Petrels from the Gulf of Fonseca, 2015: A) p6-7 incoming (2 Oct); B) p7 incoming (12 Oct); C) p9 incoming (12 Oct); D) p7 incoming (13 Dec); E) p8-9 incoming (13 Dec); F) p6-7 incoming (23 Dec). All photos by the author.

Red Phalarope *Phalaropus fulicarius*

Accompanied by AA, KD, RJ, OK, RL, and WO, I observed a Red Phalarope in Nicaraguan waters near Los Farallones on 13 December 2015. We observed possibly the same individual 25 min later in nearby Salvadoran waters. This species commonly winters off Peru (Murphy 1936, Spear & Ainley 2008) and is expected off Middle America only during migration (Jehl 1974). This winter record is the first report for the Gulf of Fonseca.

Parasitic Jaeger *Stercorarius parasiticus*

First reported for Honduras from the north coast in 1971 (Brown & Monroe 1974), this species proved uncommon but regular in the Gulf of Fonseca during the study period. An immature was present at Punta Ratón, Choluteca, where I photographed it on nine consecutive visits between 2 April and 28 June 2015, often while it harassed roosting *Thalasseus* terns. The species was also noted occasionally on boat trips; I observed one on 2 and 23 December 2015, four on 31 January 2016, and two on 3 April 2016.

Sabine's Gull *Xema sabini*

Although known as an offshore transient off the Pacific coast of Central America (Jehl 1974), this species had not previously been reported from the Gulf of Fonseca. RJ and I found six individuals on 5 August 2015, providing a first record for Honduras. I observed the species again in low numbers during the height of the 2015/16 ENSO, on 26 September (three), 2 October (three), 12 October (five), 2 December (one), 13 December (one), and 23 December 2015 (one), for a total of 1.0 bird h^{-1} between August and December 2015. On my seven subsequent trips in 2016, it was not seen again. Sabine's Gull abundance did not show a significant relationship with SST anomaly (linear regression: $F_{1,11}$ = 3.59, P = 0.08; log-linear regression: $F_{1,11}$ = 2.41, P = 0.15; Fig. 6). The linear model was the best model explaining the variation in the abundance data (linear regression

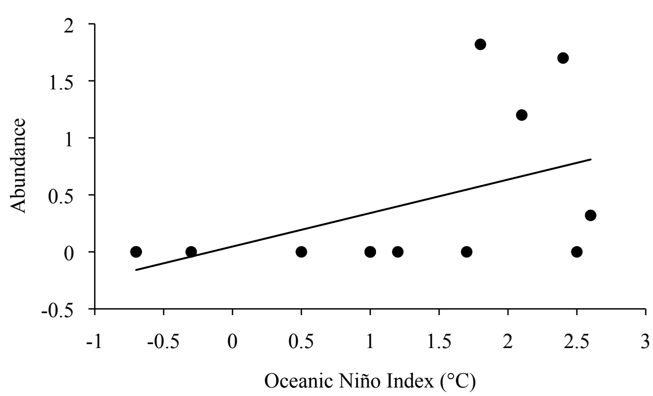

Fig. 6. Relationship between abundance of Sabine's Gull and Oceanic Niño Index ($y = 0.29x + 0.05$, $R^2 = 0.25$).

AIC = 28.70, log-linear regression AIC = 29.81). Residuals of this test were not auto-correlated (Ljung-Box Q test, $P = 0.23$) and were normally distributed ($W = 0.92$, $P = 0.23$).

Arctic Tern *Sterna paradisaea*

I observed one individual at very close range on 26 September 2015, providing a first country record for Honduras, and a first record for the Gulf of Fonseca. A week later, on 2 October, I photographed an Arctic Tern in the same general area, about 5 km southeast of Amapala. These two records represent the only known records from the Gulf of Fonseca.

Bridled Tern *Onychoprion anaethetus*

I saw Bridled Terns regularly on boat trips in the Gulf of Fonseca during the study period, with numbers usually between one and five individuals. This species was first recorded in Honduran waters on 3 August 2014, and was predicted to occur there (Jenner *et al.* 2007), based on the presence of a large colony on Los Farallones in the Nicaraguan part of the Gulf (Komar & Rodríguez 1996). That colony persisted at least until 2012, when *ca.* 600 individuals were estimated, including at least one nearly grown chick (pers. obs.). During one visit, in December 2015, I noticed a small military outpost and communication towers on one of the islets, which had not been present in 2012. This increase in human disturbance levels may have affected the colony.

Sooty Tern *Onychoprion fuscatus*

MM and I observed an adult Sooty Tern in the tern flock at the southern tip of Punta Ratón in Choluteca on 27 May 2015. While Sooty Terns are widely distributed in the eastern Pacific (Gould 1974), this is the first record of this species for the Gulf of Fonseca, and the first record for Honduras since 1971 (Udvardy *et al.* 1973).

DISCUSSION

Prior to 2014, few offshore species were known from the Gulf of Fonseca. While Jenner *et al.* (2007) noted the potential for filling in gaps in the avian inventory of the Gulf of Fonseca, they did not include any seabirds in their list of expected species. Presumably, this was because the area's shallow waters did not seem conducive to these species. Some species found in the current study, including Wedge-rumped and Leach's storm petrel, and Arctic and Sooty tern, appear to be genuinely rare in the Honduran section of the Gulf of Fonseca, while other species proved to be more regular there—some throughout the study period, such as Bridled Tern and Blue-footed Booby. Pacific populations of all four storm petrel species found in the current study are thought to be decreasing, and one of them—Leach's Storm Petrel—was recently uplisted to Vulnerable (BirdLife International 2016).

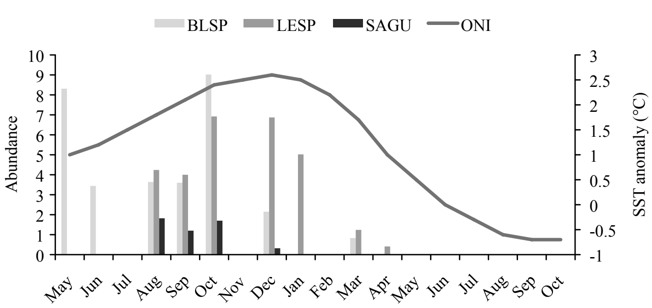

Fig. 7. Number of Black ($n = 128$; BLSP) and Least storm petrels ($n = 143$; LESP), and Sabine's Gulls ($n = 20$; SAGU) observed per hour during boat-based surveys in the Gulf of Fonseca between May 2015 and October 2016, with Oceanic Niño Index (ONI) indicating strength of the 2015/16 ENSO.

Three species—Black and Least storm petrel and Sabine's Gull—occurred regularly in 2015, but were practically absent in 2016. Was their temporary presence in the Gulf of Fonseca ENSO-related? During the study period, Black Storm Petrels were seen in higher numbers earlier on, while Least Storm Petrels were more abundant during the middle of the period (Fig. 7). Regression analyses, however, showed a relationship between abundance and SST anomaly only for Least Storm Petrel, explaining 68% of the variance in abundance, although the result for Sabine's Gull was almost at a significant level. Sabine's Gull was seen regularly for a short period between August and December 2015, and was not seen again in 2016. In Costa Rica, Sandoval *et al.* (2016) found more Sabine's Gulls closer to shore in Pacific waters in 2015 than usual, and speculated this was ENSO-related. In Ecuador, more Sabine's Gulls were noted close to shore between August and December 2015, with 3 249 individuals observed flying south during 208 h of seawatching from shore, compared with 387 individuals seen during 106 h in 2016 (B. Haase, pers. obs.).

The temporal difference in abundance between the two storm petrels was reflected in their wing molt, with Black Storm Petrel molting primaries between May and October 2015 and Least Storm Petrel molting primaries between October and December 2015. Wing molt in Black Storm Petrel has been described from specimens taken at sea, away from the breeding grounds (Ainley & Everett 2001, Howell 2012). Wing molt in this species starts with p1 and progresses outward, takes about five months to complete, and is initiated post-breeding (Bridge 2006). The timing of the wing molt in the Black Storm Petrels that visited the Gulf of Fonseca during the study period appears to be several months earlier than that known from the literature for adults (Howell 2012), and coincided with the regular breeding season in the California and Baja California breeding population (Murphy 1936, Ainley & Everett 2001), indicating that the individuals visiting the Gulf of Fonseca were non-breeders. In storm petrels, as in most tubenoses, the second prebasic molt usually occurs several months earlier than in older age groups (Howell 2012), suggesting that the Black Storm Petrels observed were likely first-cycle birds. Less is known about the timing of wing molt in Least Storm Petrel, but the October–December timing observed in the current study coincides with observations from the Gulf of California (photos B. L. Sullivan, cited in Howell 2012) and contrasts with molt observed in specimens from southern Central America, which started wing molt March–May (Howell 2012).

A breeding biology study of Least Storm Petrel on the Islas San Benito, Baja California, for three consecutive breeding seasons, 2013 to 2015, found that fledging success was consistently high for the three years, with young in 2015 fledging with longer wings, tails, and bills, possibly because of an increased food supply (Bedolla-Guzman *et al.* 2017). In the San Benito study, the fledging period for all three years was mid-October through late November, indicating that most Least Storm Petrels visiting the Gulf of Fonseca between August and early April likely were non-breeders, or came from the Gulf of California population, which breeds earlier than the San Benito population (Bedolla-Guzman *et al.* 2017). Evidently, Black Storm Petrel also had a successful breeding season in 2015 (Bedolla-Guzman *et al.* 2017), so the presence of these two storm petrels in the Gulf of Fonseca during their regular breeding season could not be explained by a failed breeding season.

Seabird densities may be a good predictor of spatial and temporal patterns in marine prey abundance (Cairns 1988), and mobility of seabirds in response to SST anomalies caused by ENSO is well-known (Murphy 1936, Ainley *et al.* 1986, Ribic *et al.* 1992, Haase 1997, Culik *et al.* 2000, Schreiber 2002). Both Least and Black storm petrels are known to range further north (Ainley 1976) and further south (Murphy 1936, Spear & Ainley 1990) during warm-water periods associated with ENSO. Displacement effects may also occur at more local scales. For example, a study of food web cycles during the 2015/16 ENSO in the California Current shows that vessel-based surveys off the coast of Oregon reported reduced seabird densities in the spring of 2015, but average or above-average densities in nearshore waters during the summer of 2015, with the onset of the 2015/16 ENSO (McClatchie *et al.* 2016). Similarly, variation in food supply associated with anomalous climate conditions recorded in 2015 may have driven shelf species such as Black and Least storm petrel, and Sabine's Gull, closer to shore and inside the Gulf of Fonseca during the 2015/16 ENSO phenomenon. Additional coverage of the Gulf's inshore waters is needed to elucidate occurrence patterns of seabirds in this area.

ACKNOWLEDGMENTS

I wish to thank the following observers who accompanied me on field trips, each of whom contributed to the overall tally of birds: Alfonso Auerbach, Olivia Díaz, Katinka Domen, Jacob Drucker, Angel Fong, Robert Gallardo, Roselvy Juárez, Oliver Komar, Robert Lambeck, Esdras López, Mayron Mejía, and William Orellana. I wish to thank Ben Haase, Roselvy Juárez, and Oliver Komar, as well as an anonymous reviewer, for helpful comments on a draft version.

REFERENCES

AINLEY, D.G. 1976. The occurrence of seabirds in the coastal region of California. *Western Birds* 7: 33-68.

AINLEY, D.G., CARTER, H.R., ANDERSON, D.W. ET AL. 1986. Effects of the 1982-1983 El Nino-Southern Oscillation on Pacific Ocean bird populations. *Proceedings of the XIX International Ornithological Congress* Ottawa: National Museum of Natural Sciences, pp. 1747-1758.

AINLEY, D.G. & EVERETT, W.T. 2001. Black Storm-Petrel (*Oceanodroma melania*), version 2.0. In RODEWALD, P.G. (Ed.) *The Birds of North America*. Ithaca, NY: Cornell Lab of Ornithology. doi:10.2173/bna.577.

BEDOLLA-GUZMAN, Y., MASELLO, J.F., AGUIRRE-MUÑOZ, A., LAVANIEGOS, B.E. & QUILLFELDT, P. 2017. Breeding biology, chick growth, and diet of the Least Storm Petrel *Oceanodroma microsoma* on Islas San Benito, Mexico. *Marine Ornithology* 45: 129-138.

BIRDLIFE INTERNATIONAL. 2013. *State of the World's Birds: Indicators for our Changing World*. Cambridge, UK: BirdLife International.

BIRDLIFE INTERNATIONAL. 2016. *Hydrobates leucorhous*. The IUCN Red List of Threatened Species 2016. e.T22698511A86230533. doi:10.2305/IUCN.UK.2016-3.RLTS.T22698511A86230533.en

BRIDGE, E.S. 2006. Influences of morphology and behavior on wing-molt strategies in seabirds. *Marine Ornithology* 34: 7-19.

BROWN, H.C. & MONROE, B.L. 1974. Bird records from Honduras. *Condor* 76: 348-349.

CAIRNS, D.K. 1988. Seabirds as indicators of marine food supplies. *Biological Oceanography* 5: 261-271.

CULIK, B., HENNICKE, J. & MARTIN, T. 2000. Humboldt Penguins outmanoeuvring El Niño. *Journal for Experimental Biology* 203: 2311-2322.

DUFFY, D.C. & FRAZIER, J.G. 2014. Seabird distribution in the Gulf of Papagayo, Costa Rica, during non-upwelling conditions. *Marine Ornithology* 42: 57-62.

eBird. 2017. eBird: An online database of bird distribution and abundance [web application]. Ithaca, NY. [Available online at: http://www.ebird.org/. Accessed 14 October 2017).

GALLARDO, R.G. 2014. *Guide to the Birds of Honduras*. Tegucigalpa: Mountain Gem Tours.

GOULD, P.J. 1974. Sooty Tern (*Sterna fuscata*). In: KING, W.B. (Ed.). Pelagic Studies of Seabirds in the Central and Eastern Pacific Ocean. *Smithsonian Contributions to Zoology* 158: 6-52.

HAASE, B. 1997. The impact of the El Niño Southern Oscillation (ENSO) on birds: update from Ecuador 1997. *Cotinga* 8: 64-65.

HOWELL, S.N.G. 2012. *Petrels, Albatrosses & Storm-Petrels of North America: A Photographic Guide*. Princeton, NJ: Princeton University Press.

JEHL, J.R. 1974. The near-shore avifauna of the Middle American west coast. *Auk* 91: 681-699.

JENNER, T., KOMAR, O. & NARISH, A. 2007. Noteworthy bird records from the Gulf of Fonseca. *Cotinga* 28: 13-20.

JONES, L. & KOMAR, O. 2013. Summer: June through July 2012. *North American Birds* 66: 739-742.

KOMAR, O. & RODRÍGUEZ, W. 1996. A major Bridled Tern (*Sterna anaethetus*) colony in the Gulf of Fonseca. *Colonial Waterbirds* 19: 264-267.

MONROE, B.L. 1968. A distributional survey of the birds of Honduras. *Ornithological Monographs* 7.

MURPHY, R.C. 1936. *Oceanic Birds of South America*. Vol. 2. New York, NY: American Museum of Natural History.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA). 2017. Historical El Niño / La Niña episodes (1950–present) [Available online at: http://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php. Accessed 14 October 2017].

R CORE TEAM. 2017. R: A language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing. [Available online at https://www.R-project.org/].

RIBIC, C.A., AINLEY, D.G. & SPEAR, L.G. 1992. Effects of El Niño and La Niña on seabird assemblages in the Equatorial Pacific. *Marine Ecology Progress Series* 80: 109-124.

SANDOVAL, L., ACOSTA-CHAVES, V.J., OCAMPO, D., MORA, C., CAMACHO, A., MARTÍNEZ, D. & SÁNCHEZ, C. 2016. Unusual records of waterbirds in Costa Rica: possible connection to El Niño 2015–2016. *Marine Ornithology* 44: 167-169.

SCHREIBER, E.A. 2002. Climate and weather effects on seabirds. In: SCHREIBER, E.A. & BURGER, J. (Eds.) *Biology of Marine Birds*. Boca Raton, LA: CRC Marine Biology Series.

SPEAR, L.B. & AINLEY, D.G. 1999. Seabirds of the Panama Bight. *Waterbirds* 22: 175-198.

SPEAR, L.B. & AINLEY, D.G. 2007. Storm-Petrels of the eastern Pacific Ocean: species assembly and diversity along marine habitat gradients. *Ornithological Monographs* 62: 1-77.

SPEAR, L.B. & AINLEY, D.G. 2008. The seabird community of the Peru Current, 1980–1995, with comparisons to other eastern boundary currents. *Marine Ornithology* 36: 125-144.

STILES, F.G. & SMITH, S.M. 1977. New information on Costa Rican waterbirds. *Condor* 79: 91-97.

UDVARDY, M.D.F., DE BEAUSSET, C.S. & RUBY, M. 1973. New tern records from Caribbean Honduras. *Auk* 90: 440-442.

VALLE-LEVINSON, A. & BOSLEY, K.T. 2003. Reversing circulation patterns in a tropical estuary. *Journal of Geophysical Research: Oceans* 108(C10): 2156-2202.

WEICHLER, T., GARTHE, S., LUNA-JORQUERA, G. & MORAGA, J. 2004. Seabird distribution on the Humboldt Current in northern Chile in relation to hydrography, productivity, and fisheries. *ICES Journal of Marine Science* 61: 148-154.

YOUNG, B.E. & ZOOK, J.R. 2015. Observation frequency and seasonality of marine birds off the Pacific coast of Costa Rica. *Revista de Biología Tropical* 64: 235-248.