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Cover Photograph: A vagrant, immature Fork-tailed Flycatcher in Santo Domingo, Dominican Republic, shown here with its congener competitor, the Gray Kingbird. Photograph © Luis Paulino.

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Observations of a Transequatorial Migrant, *Tyrannus savana* Vieillot 1808 (Fork-tailed Flycatcher), in an Urban Setting on a Tropical Island

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Abstract - Fork-tailed Flycatcher (*Tyrannus savana*, Vieillot 1808) is an easily recognized, widespread inhabitant of grassland and open terrain throughout its extensive range from southern Mexico south to Argentina. In the Caribbean, although sightings are fluid and can increase daily on some islands, especially those close to source continents and during peak migration, its numbers have continued to increase over a 19-yr period in the Caribbean Basin (2002–2021). We report a 2018 sighting of a vagrant Fork-tailed Flycatcher in the Dominican Republic's capital city of Santo Domingo. Our recent observations of this vagrant attest to the important natural and anthropogenic regulatory ecosystem services provided by migratory species in general. These include the potential control of arthropod plagues and disease vectors, as well as supportive services such as pollination and seed dispersal. Conversely, the city of Santo Domingo provides reciprocal ecological services to resident and migratory birds alike.

Introduction. Fork-tailed Flycatcher (*Tyrannus savana,* Vieillot 1808) is comprised of four subspecies; three sedentary species: *T. s. sanctaemartae, circumdatus* and *monachus*, and one long-distance migrant: the nominate subspecies *T. s. savana* (Gómez-Bahamón et al. 2020, Jahn and Tuero 2020, Zimmer 1937). Owing to the restricted ranges of two of the three sedentary subspecies, *T.* s. *sanctaemartae* in northwestern Colombia and *T.* s. *circumdatus* in the State of Amazonas and northern Brazil (Gómez-Bahamón et al. 2020, Jahn and Tuero 2020), only the non-migratory but wide-ranging *T. s. monachus* and the long-distance transequatorial migrant *T. s. savana* will be discussed here.

The sedentary *T. s. monachus* ranges and breeds from North America (southern Mexico) throughout Central America (except El Salvador) to South America, primarily Venezuela, Colombia, Surinam, and north-central Brazil, including several land-bridge and offshore islands (BirdLife 2016, Gómez-Bahamón et al. 2020, Mobley 2004, Jahn and Tuero 2020, Teul et al. 2007). Central American populations generally breed from March to August (Jahn and Tuero 2020) but from April to August in Belize (Teul et al. 2007) and March to June in Costa Rica (A.E. Jahn, Indiana University, 2022, in litt.). Northern South American populations of *T. s. monachus* generally breed from March to May in Venezuela (Restall et al. 2006), January to May in Colombia (Mobley 2004). Annual molt takes place primarily from July to September (Jahn and Tuero 2020).

T. s. savana has an expansive distribution and migratory range but breeds mainly from September to December in central Brazil (Marini et al. 2009), southern and southeastern Brazil, northern and eastern Bolivia, Paraguay and Uruguay; October-January in Argentina

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(Mezquida 2002). Southern populations migrate north to Colombia, Venezuela, the Guianas and the State of Amazonas (Jahn and Tuero 2020, Marini et al. 2009, Mobley 2004, Ridgely and Tudor 1994). *T. s. savana* overwinters in the State of Amazonas, a large portion of northern South America, i.e., within the Orinoco River Basin (Jahn et al. 2013) and Trinidad and Tobago, occasionally appearing in the West Indies (Ridgely and Tudor 1994). *T. s. savana* molts primarily from April to July (Jahn et al. 2016, Pyle 1997).

The nominate subspecies, and to a lesser extent *monachus*, occur regularly in North America (Jahn and Tuero 2020, McCaskie and Patten 1994, Shepherd and Smith 1996), with most sightings occurring in fall (September–November) and a few in spring and early summer, e.g., May–June (Jahn and Tuero 2020, McCaskie and Patten 1994). During migration, roosts of 10,000 Fork-tailed Flycatchers have been documented (Jahn and Tuero 2020).

Historically, *T. s. savana* was reported occasionally from the West Indies (Jahn and Tuero 2020, Ridgely and Tudor 1994). However, there has been a sharp increase of Fork-tailed Flycatcher sightings of both *T. s. savana* and *T. s. monachus* throughout the region in recent years (eBird 2019). There is at least one previous record (subspecies not mentioned) from the Dominican Republic in 2005 from Punta Cana (a verbal description without photograph; in Latta et al. 2006).

In the past (1976–2017), all of our observations of vagrant birds (rare or accidental species) in the Dominican Republic, especially within and around Santo Domingo, consisted of Nearctic-Neotropical migratory species, mostly warblers and shorebirds. However, during our current research (2016–present), we observed this austral long-range migratory Fork-tailed Flycatcher that, although reported from North America as early as 1834 (J. J. Audubon, in McCaskie and Patten 1994), prior to 1975 had not been documented in the Caribbean (see ebird.org checklist: Jack Kelly, Grenada, 26 June 1975, with photo). Herein, we report a much more recent sighting.

Urban Bird Project. Our observations of a vagrant Fork-tailed Flycatcher took place in the Dominican Republic's capital city of Santo Domingo (Fig. 1). This sighting is a result of our international Urban Long-term Research Area (ULTRA) and green areas (Baghdadi and

Figure 1. Left: Map showing geospatial coordinates of the island of Hispaniola and the general location of the Fork-tailed Flycatcher sighting. The inset depicts the Caribbean Basin and Hispaniola's geographical position within the Greater Antilles. Right: Satellite image of Santo Domingo's commercial San Carlos sector within i-Tree plot SC-16 known as "Or Solar" (18°28′37.71‴ N, 69°53′48.89‴ W) where the immature Fork-tailed Flycatcher was observed. It is noteworthy that this intercontinental vagrant used an urban gray infrastructure area (Baghdadi and Zribi 2016) over several days, rather than relocating to one of the more anticipated urban green areas to rest and forage. Satellite imagery was taken from Landsat 7 and Landsat 8, extracted from Google Earth Engine, 2018.

Zribi 2016) avian research project initiated in September 2016 and currently underway within four sectors of the city. The Fork-tailed Flycatcher was observed within the highly commercial sector of San Carlos (Fig. 1) at i-Tree (Nowak et al. 2008) plot SC-16 named "Or Solar" (18°28′37.71″ N, 69°53′48.89″ W). The "Or Solar" plot is a diverse matrix comprised of 60% commercial/industrial and a 40% transportation ground usage with an average of only 7.5% tree and shrub cover (range: 5–10%), an average of 30% built ground cover, e.g., buildings, cement and pavement (range: 10–50%), and an average of 10% grassy ground cover overall.

Weather Conditions and Disclaimer. All wind and temperature readings on Tuesday, 23 October, 2018 were taken with a Kestrel 4500 NV pocket Weather Tracker® (The use of trade or firm names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service). See the following link for more detailed wind and temperature readings as well as meteorological parameters in addition to those we recorded on our Kestrel: https://weatherspark.com/h/d/27168/2018/10/23/Historical-Weather-on-Tuesday-October-23-2018-in-Santo-Domingo-Dominican-Republic#Figures-Temperature

Statistical Analysis of eBird Data. Fork-tailed Flycatcher sightings were compiled over the 121-year period covered by the eBird.org (2019) online database from 1900 to mid-August 2021. However, for a more balanced design, we excluded the partial year 2021, which constituted only 7.5 mo. (January to mid-Aug.). To ensure a standardized and more robust analysis of the data, only years covered from the inception of eBird in 2002 onward to the year 2020 are

Figure 2. An immature Fork-tailed Flycatcher photographed in the commercial San Carlos sector (i-Tree plot SC-16). It was observed either perching alone on a utility cable or, in between bouts of sallying for aerial insects, it rested together with its congener in the kingbird genus *Tyrannus*, the year-round resident Gray Kingbird. It also hover-hunted for arthropods and foraged on palm fruit in a raceme of a Royal Palm, and is seen here displaying in its bill a Royal Palm seed with a fleshy and nutritious mesocarp. This species, accidental in the Dominican Republic, is providing the capital city (and potentially beyond) regulatory and supportive ecosystem services by negatively impacting numbers of potentially harmful arthropods and dispersing seeds, such as those of the Royal Palm eaten by resident and migratory birds alike. In reciprocity, the city of Santo Domingo provides many ecosystem services to resident and migratory birds, including diverse food sources, natural and anthropogenic perches such as public utility cables shown here. Photographs © Luis R. Paulino.

included in the statistical analyses. We categorized as dependent variables all sightings of Fork-tailed Flycatcher and the corresponding checklists submitted to eBird.org each month from 2002 to 2020. The total numbers of checklists and party hours per year were taken as random independent variables. General linear models were run in R (R Core Team 2017) for regression and comparisons using data previously tested for their probability distribution. We chose the model that best-fit the distribution of the observations using the AIC method. All statistically generated graphs and comparisons were completed in R, except Figures 3 and 8, which were created in XLSTAT (Addinsoft 2021).

Field Observations. On Tuesday, 23 October 2018, at 0728 h during a Santo Domingo ULTRA (Grimm et al. 2000) urban bird survey, within one of ca. 70 *i-Tree* plots (Nowak et al. 2008), our research field team observed an immature Fork-tailed Flycatcher (*Tyrannus savanna*; Fig. 2). We conclude that this visitor was an immature because *T. savana* employs a complex basic strategy in the Wolfe-Ryder-Pyle molt system (Wolfe et al. 2010, A.E. Jahn, Indiana University, 2022, in litt.). Molt limits are visible in various photos of the flycatcher in

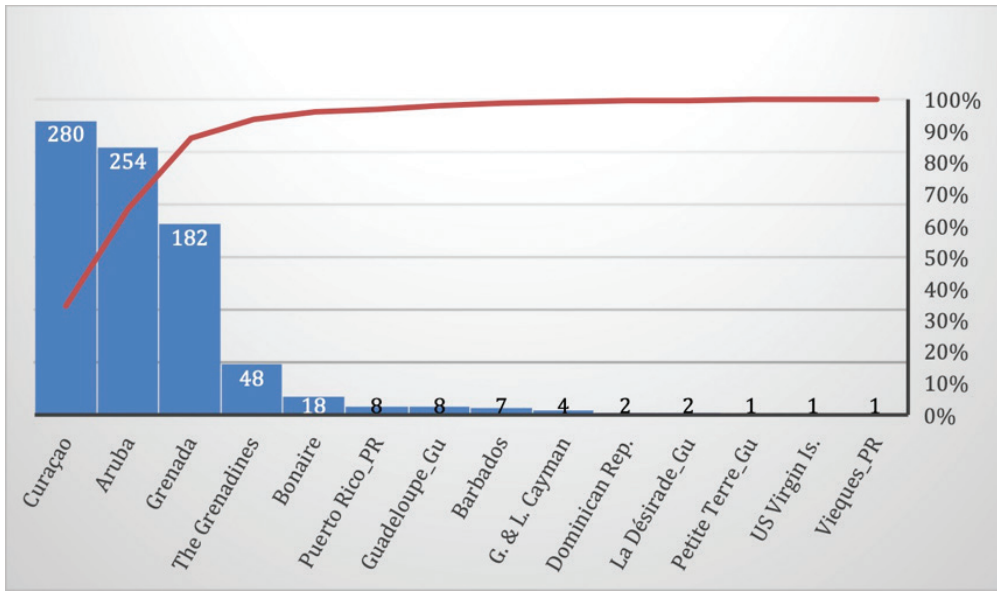

Figure 3. Results of Fork-tailed Flycatcher sightings by Caribbean Island. Data compiled from eBird.org (2019) revealed that between 26 June 1975 and mid-August 2021, 816 Fork-tailed Flycatchers (the white and black numbers inside and outside of the bars, respectively) were reported on 16 Greater Caribbean islands. The purpose of this Pareto diagram is to distinguish the importance of the "vital few from the trivial many" islands. As anticipated, the closest islands to South American source populations, i.e., the first five islands on the x-axis, e.g., Curaçao, Aruba, Grenada, the Grenadines group (Mayreau and Union) and Bonaire, constitute 96% of the 816 Fork-tailed Flycatcher sightings in the Greater Caribbean region; and the first two islands (Curaçao and Aruba) account for almost 80% of sightings. Not all islands are shown in the graph because they are included in larger political groupings. For example, whereas there were no Fork-tailed Flycatcher sightings from St. Vincent during this period, there were 48 sightings in total on two Grenadine islands (Mayreau and Union Island). The "G. & L. Cayman" entry on the x-axis represents the Grand and Little Cayman Islands group. The right vertical axis has percent demarcations. A red cumulation frequency curve representing the cumulative frequency distribution of the grouped islands was used to sum the percentages generated from each island.

Figure 2. Thus, this vagrant is in its first cycle formative (FCF) plumage (Howell et al. 2003, Pyle 1997, Wolfe et al. 2010).

On the day of observation, the sky was clear, the temperature averaged 27 °C, and wind speed averaged 2 km/h. The Fork-tailed Flycatcher was first sighted in *Roystonea regia* (Kunth) O.F. Cook (royal palm tree) as it hover-hunted among several racemes foraging on palm fruits and insects attracted to them (Fig. 2). The flycatcher foraged among 24 Gray Kingbirds (*Tyrannus dominicensis*, Gmelin) and a single Palmchat (*Dulus dominicus*, Linnaeus). The Gray Kingbirds frequently attacked their congener, a similar behavior reported by Colón López (ebird.org 2010) on nearby Puerto Rico. The avian foraging aggregation was ca. 8 m off the ground. Individual Gray Kingbirds and the Fork-tailed Flycatcher occasionally flew up and perched on electrical wires ca. 15 m above ground level (Fig. 2).

eBird Data Results. From 26 June 1975 (ebird.org checklist: Jack Kelly, Grenada; photo) to mid-August 2021, 816 sightings of the Fork-tailed Flycatcher on 16 Caribbean islands were submitted to the eBird online database (Sullivan et al. 2009). Most sightings come from the southern Netherlands Antilles (Curaçao, Aruba, Bonaire), Grenada and the Grenadines (Mayreau and Union), all of which are islands closest to the South American continent. Sightings diminish northward and westward throughout the Lesser and Greater Antilles. Not surprisingly, islands closest to *T. s. monachus*' breeding grounds have received the bulk of the birds that digress from traditional migration routes (Fig. 3). Although Cornell University's online database "ebird.org" (Sullivan et al. 2009) was in operation by 2002, the number of eBird checklists reporting Fork-tailed Flycatcher remained stable, not increasing significantly for more than

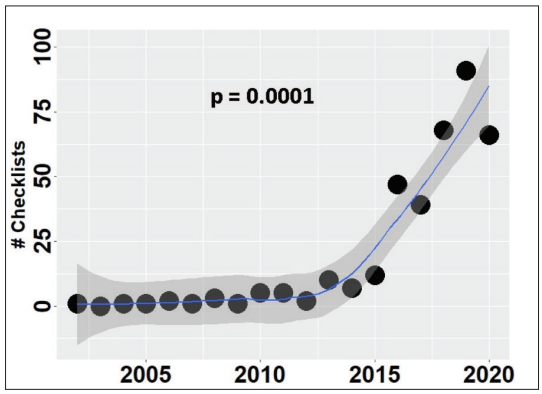

Figure 4. Number of checklists reporting Fork-tailed Flycatcher submitted to eBird each year. Although Cornell University′s online database, ebird.org (Sullivan et al. 2009) was in operation by 2002, the number of eBird checklists reporting Fork-tailed Flycatcher did not increase significantly until more than a decade later, in 2016, and continued to increase prominently to 2020.

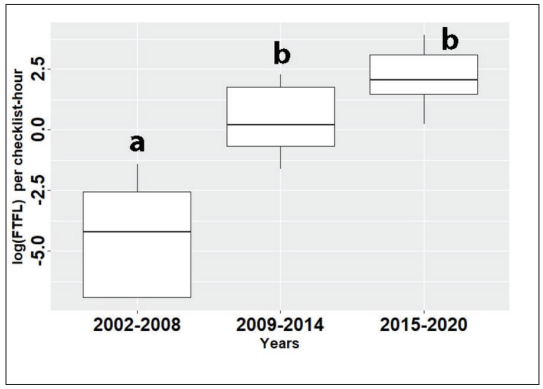

Figure 5. Total number of Fork-tailed Flycatchers per checklist-hour divided into three comparative yearly ranges from 2002 to 2020. Fork-tailed Flycatcher numbers per checklist-hour did not increase significantly in the Caribbean until about a decade after the advent of eBird ($p < 0.0001$). Distinct letters refer to significant differences between years ($p < 0.05$). The three yearly range periods are the results of the observed data distribution among histogram bins (buckets); horizontal bars within boxes are medians; lower and upper limits of each box are the first and third quartiles, respectively.

another decade, i.e., until 2016 ($t = 3.821$, $p = 0.0001$; Fig. 4) A similar pattern was found in the number of Fork-tailed Flycatchers per checklist-hour ($t = 4.535$, $p = 0.0003$; Fig. 5). Conjointly, we observed an increase in the number of Fork-tailed Flycatchers detected each year ($t = 5.911$, $p < 0.0001$) (Fig. 6).

To test whether the number of Fork-tailed Flycatcher individuals reported per checklist increased over the 19-year period (2002–2020), we compared the number of Fork-tailed Flycatchers reported per checklist per year (Fig. 7). There was a significant correlation ($t = 3.481$, $p = 0.003$). As further confirmation of a significant increase of Fork-tailed Flycatcher sightings during the last 10-yr period of our analysis, we compared the median number of Fork-tailed Flycatchers per checklist during the first decade (2002–2010) to the median number submitted during the second decade of the study (2011–2020). There was a significant increase in the median number of Fork-tailed Flycatchers sighted within the last years of our survey period (Fig. 8).

Origin of the Fork-tailed Flycatcher Vagrant. It remains uncertain whether or not the Santo Domingo Fork-tailed Flycatcher is a wayward individual of the nominate and migratory subspecies *T. s. savana*, or a vagrant of the non-migratory but vagile subspecies *T. s monachus* (Gómez-Bahamón et al. 2020; Zimmer 1937). However, because our observations took place in October, when austral spring migration of *T. savana savana* occurs in South America as they migrate south to their breeding grounds (Jahn and Tuero 2020, Tuero et al. 2019), the Santo Domingo bird most likely is of the nominate subspecies *T. s. savana*. It could have undertaken a reverse migration, which occasionally occurs, especially in juvenile and immature migratory birds (Nilsson and Sjöberg 2016).

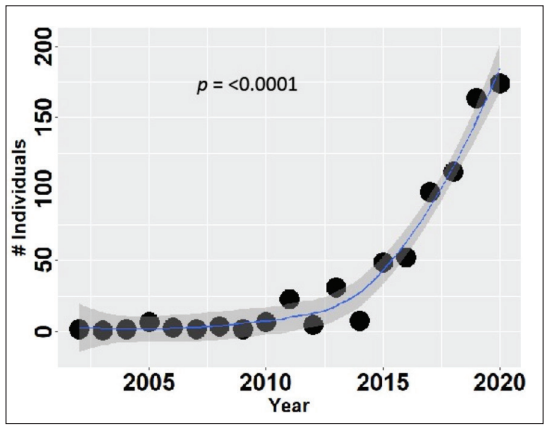

Figure 6. Number of Fork-tailed Flycatcher Individuals reported in eBird checklists between 2002 and 2020. Similar to the number of eBird checklists reporting Fork-tailed Flycatcher sightings each year (Figure 4), numbers of individual flycatchers reported did not increase significantly (p = < 0.0001) until more than a decade later in 2017 and 2018 when numbers doubled from 50 to a mean of 100 (range: 87–112), and then almost doubled again by 2020.

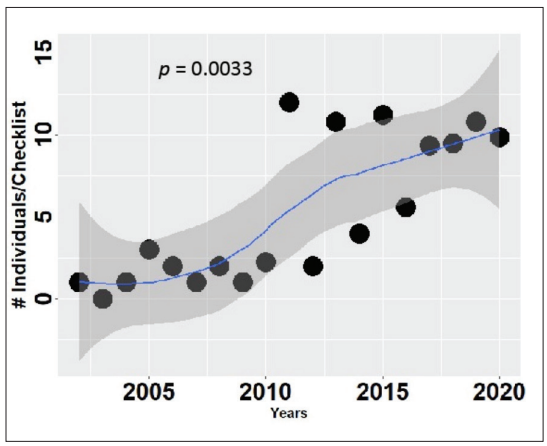

Figure 7. Number of Fork-tailed Flycatchers per checklist over a 19-yr period. Numbers varied between 0 and 3 per checklist for almost the first decade until 2010, averaging 1.44, whereas during the second half of the study (2011–2020) the average was 8.5 Fork-tailed Flycatchers per checklist, which was significant at $\alpha = 0.05$ (p = 0.005; Addinsoft 2021: Wilcoxon Signed Rank Test, Hollander et al. 1999).

South American populations of *T. s. monachus* breed earlier (Jan–May in Colombia, March–May in Venezuela) than Central American populations (March–August). Yet, even though *T. s. monachus* begins to breed earlier in northern South America than Central America, the breeding seasons in both regions end at about the same time (A.E. Jahn, Indiana University, 2019, in litt.). Likewise, although the Greater Antilles are much closer to the Yucatán peninsula than Colombia or Venezuela and annual feather molt might take place earlier in either its South American breeding or non-breeding grounds, one cannot be certain of the origin of the Santo Domingo vagrant because vagrants of all avian species are capable of "island hopping" (A.E. Jahn, Indiana University, 2019, in litt.; Arendt 2006: Ch. 6, p. 71).

History of Fork-tailed Flycatcher eBird Sightings in the Caribbean. Based on contemporary knowledge and escalating vagrant sightings in both North America and the Caribbean, it is possible that the Fork-tailed Flycatcher, historically accidental in the Caribbean but apparently rapidly increasing in number (Fig. 6), may be increasing its migratory range northward as well. Such sightings of austral species appearing in diverse geographical locations and varied ecological environments in North America and the Neotropics continue to increase and may continue to mount as the effects of global climate change acerbate. Increasingly acyclic precipitation regimes and warming temperatures are causing worldwide plant and

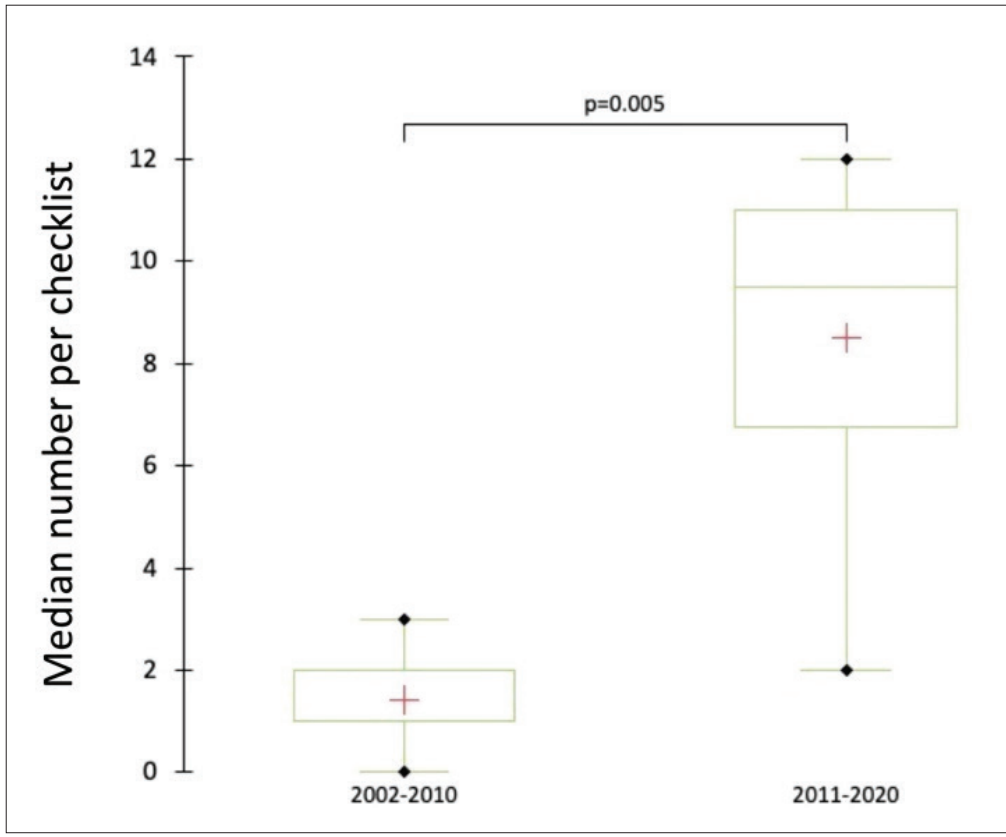

Figure 8. Visual results of the Wilcoxon Signed Rank Test (Addinsoft 2021) comparing the median number of Fork-tailed Flycatchers per checklist during the first decade (2002–2010) and the second decade of the study (2011–2020). Red crosses within boxes correspond to the means; central horizontal bars are the medians; lower and upper limits of each box are the first and third quartiles, respectively.

animal phenology mismatches, resulting in resource constraints and food shortages for many bird species (Franklin et al. 2022, Youngflesh et al. 2021). Noteworthy and during similar time periods, is mention of a handful of *Elaenia parvirostris* von Pelzeln, 1868 (South American Small-billed Elaenia) showing up for the first time in the USA in April, 2012 (Chicago, Illinois) and again in November, 2021 (Waukegan, Illinois), as well as Quebec, Canada in October, 2021 (Davis 2021). Fork-tailed Flycatcher numbers may continue to increase exponentially as evidenced in Figure 6, as the repercussions of global warming and climate change, often referred to as Anthropogenic climate change (ACC), continually escalate (Cotton 2003, Parmesan and Hanley 2015). Arguably, however, many additional factors undoubtedly govern this species' migration patterns, population dynamics and behavior. Thus, research into alternative governing mechanisms must be conducted before a definitive conclusion can be made.

Study Limitations. Our results are based on different variables and sampling efforts, e.g., number of checklists submitted and number of Fork-tailed Flycatcher reported each year, per checklist and sampling hours, all of which varied among years. This led us to limit our conclusions to the number of checklists and components of sampling hours solely involving reports of Fork-tailed Flycatcher. Also noteworthy, is that the lack of reports of Fork-tailed Flycatcher in decades prior to our study is not considered as an absence of the species. But rather, it reflects the period preceding the advent of eBird, the popular geospatial tool used worldwide by thousands of contemporaries to permanently record and disseminate avian abundance, distribution and population trend data, together with other spatiotemporal information.

Conclusions. Our results support a predominant increase in Fork-tailed Flycatcher numbers in the Caribbean Basin, especially during the latter years of our review period. Pairing that with the fact that the number of individual Fork-tailed Flycatchers per checklist continues to increase (t=3.481, p=0.0033), suggests there is an effect resulting from the combination of the number of checklists, plus the number of individuals per checklist, both of which reflect the overall increase of Fork-tailed Flycatcher sightings in recent years. As a result, increasing numbers of Fork-tailed Flycatcher contributions reported by eBirders every year are expanding our knowledge of the species' population dynamics and giving us a better understanding of the Fork-tailed Flycatcher's presence, abundance and distribution in the Caribbean Basin.

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