

The Status of Magnificent Frigatebirds in the Interior of Florida

The Influence of Storms

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ABSTRACT

Magnificent Frigatebirds *Fregata magnificens* have occurred in the interior of Florida about once a year since the 1970s; the first report was in 1926. All but seven counts ranged from 1–7 birds; most low counts were associated with the occurrence of storms. The seven high counts ranged from 11–127 birds; all of these counts were directly related to major storms (tropical cyclones, depressions, and subtropical cyclones) in June, September, and October. All but one of these seven storms landed on, or approached, the central or southern Gulf coast of Florida, where local frigatebirds are numerous. Excluding high counts during specific storms, almost three frigatebirds per count in the interior of Florida occurred during other major storms, almost double the number observed during more typical weather. The seasonal pattern of occurrence of Magnificent Frigatebirds in the interior of Florida generally coincided with the tropical cyclone season (June–November), although the correspondence was imperfect. The peak number of occurrences was in September, the peak month for tropical cyclones in Florida, although a higher proportion occurred during major storms in June. The status of Magnificent Frigatebirds in the interior of Florida is compared to their status in the interior of other regions of the United States. This study has shown that Magnificent Frigatebirds that occur in the interior of Florida are non-random vagrants.

INTRODUCTION

The Magnificent Frigatebird *Fregata magnificens* is primarily a coastal marine species in Florida. Birds that occur in the interior are unusual, and most of these occurrences are storm-related (Robertson and Woolfenden 1992, Stevenson and Anderson 1994, Robertson and Wilmers 1996). Nevertheless, the relationship between the occurrence of Magnificent Frigatebirds in the interior of Florida and weather has not been investigated. In this paper I examine the relationship that storms (both tropical cyclones and less severe storms) and more typical weather may have with the occurrence of Magni-

ficent Frigatebirds in the interior of Florida and compare these patterns to the status of Magnificent Frigatebirds in the interior of other regions of the United States (e.g., McCaskie 1970, Mlodinow 1998).

METHODS

I obtained data on inland occurrences of Magnificent Frigatebirds in Florida through 1999 from Howell (1932), Stevenson and Anderson (1994), *Audubon Field Notes* and its successors *American Birds* and *Field Notes* (cf. Loftin et al. 1991), the field observations section of the *Florida Field Naturalist*, archives at Tall Timbers Research Station (TTRS), and other pertinent sources, e.g., Funderburg (1966), Weigley and Weigley (1966), Fellers (1988). I examined the original citations for each occurrence and assumed all frigatebirds in the interior of Florida were reported and correctly identified. I analyzed each occurrence separately, but also classified occurrences into two groups for further analysis. I categorized one occurrence per weather event (e.g., number of birds on the day of a storm) as a single event. I categorized two to four occurrences (the maximum number reported) at multiple localities per weather event as a multiple event. I classified weather events into two categories, a storm or more typical weather (i.e., the apparent absence of storms), and also subdivided a storm into two groups: major storms which includes tropical cyclones, tropical depressions, and subtropical cyclones with winds equal to or greater than 63 km/h, and less severe storms as the second group.

I examined data on tracks of tropical cyclones in the North Atlantic Ocean in Neumann et al. (1981) (data from 1981–1996 were extracted from annual reports published in *Monthly Weather Review* and for 1997–1999 from *Weatherwise*) to determine which occurrences were associated with major storms. I also examined hurricane season summaries of North Atlantic tropical cyclones in *Monthly Weather Review*, weather data in *Storm Data* (since 1959), and *Daily Weather Maps* (since 1969) for additional clarifications when desired. I determined whether the remaining occurrences were associated with less severe storms or more typical weather by examining weather data obtained from monthly summaries of *Local Climatological Data Florida* (since 1929), *Storm Data*, and *Daily Weather Maps*.

RESULTS

Magnificent Frigatebirds have been documented to occur inland in Florida on 61 occasions since 1926 (Howell 1932); 34 occurrences (56%) are from central Florida, the remainder from north ($n = 13$, 21%) and south ($n = 8$, 13%) Florida and the Panhandle ($n = 6$, 10%) (regions as defined in Robertson and Woolfenden 1992). The number of occurrences of Magnificent Frigatebird in the interior of Florida by decade has significantly increased (Spearman's $r = 0.9$, $P = 0.002$), especially since the 1970s ($n = 44$, 72% of total). Of the 61 occurrences, 49 (80%) occurred during storms. Thirty-two occurrences are single events (32 weather events); of these single events, 10 (31%) occurrences were during more typical weather. Twenty-nine occurrences are multiple events (11 weather events); of these, two (7%) occurrences were during more typical weather, a significant difference ($\chi^2 = 4.26$, $P < 0.05$) from the higher proportion of occurrences of single events during more typical weather. Most (10 of 11) multiple events were associated with storms; nine of these were major storms, with four in June, three in September, and one each in August and November. All frigatebirds found in the interior of Florida remained no longer than one day, except for birds from two occurrences during tropical cyclones that possibly lingered at the same locality for a second day.

The number of frigatebirds per occurrence ranged from 1-127; almost half ($n = 29$; 48%) of all counts were of one frigatebird. Only seven counts exceeded seven birds; all but the lowest of these seven high counts (11, 18, 23, 27, 30, 45, 127) were associated with multiple events during storms. Excluding high counts, the mean number of frigatebirds per occurrence was 2.44 ± 1.94 SD ($n = 54$), which did not differ by region (one-way ANOVA on log-transformed numbers: $F = 0.62$, $df = 3,50$; $P = 0.6$). Again excluding high counts, as the severity of weather increased, the number of birds increased: the mean number of birds that occurred among major storms, less severe storms, and more typical weather was almost significantly different (major storms: 2.81 ± 1.91 SD ($n = 37$); less severe storms: 2.2 ± 2.68 SD ($n = 5$); more normal weather: 1.58 ± 1.51 SD ($n = 12$); one-way ANOVA on log-transformed numbers: $F = 2.96$, $df = 2,51$; $P = 0.06$).

In Florida, most ($n = 56$, 92%) inland frigatebirds have occurred from 2 May to 23 November; none of the three occurrences in May were associated with storms. The two peak months were June, with 15 of 17 occurrences associated with seven major storms (six in the peninsula), and September, with 18 of 21 occurrences associated with 13 major storms (10 in the peninsula) (Fig. 1); six of seven high counts occurred in these two months, the other in October. No inland frigatebirds occurred in the Panhandle or north Florida after September, except on 21 November 1985 (a flock of six at Lake Jackson, Leon County, was associated with Hurricane Kate). In contrast, 12 (20%) of all inland occurrences occurred in central or south Florida after September. The unusually early date on 15 March 1986 was of one bird seen 8 km west of Pompano Beach, Broward County, following a large-scale synoptic system (squall line) in central Florida on 14 March, which produced hail and strong onshore winds in Broward County on 15 March (*Climatological Data Florida, Storm Data, Daily Weather Map*; Langridge 1986). The four late reports from 22-30 December were single birds that occurred in central Florida; one occurrence was associated with a storm.

DISCUSSION

An increase in observer effort, not an increase in the number of Magnificent Frigatebirds since coastal populations in Florida may possibly have declined since the 1980s (Robertson and Woolfenden 1992, Robertson and Wilmers 1996), is probably responsible for the

increase in the number of occurrences of frigatebirds in the interior of Florida since the 1970s when they have been reported approximately once a year. A disproportionate number of occurrences of Magnificent Frigatebirds might be expected in the interior of central and south Florida because of proximity to larger coastal populations in these regions compared to north Florida or the Panhandle (Robertson and Wilmers 1996), yet only a small proportion of frigatebirds have been reported in south Florida. Observer effort has been concentrated in the interior of central Florida which has abundant, accessible large lakes where many frigatebirds have been seen and a high human population density, in contrast to much less observer effort in the interior of south Florida, which has few large lakes except for Lake Okeechobee which is undersampled, a lot of inaccessible land, and a much lower human population density except along the immediate coast. All or almost all frigatebirds inland in Florida presumably return to the coast quickly on the day of their arrival inland; the most distant point inland in Florida from the coast is 120-130 km (Winsberg 1990). Most occurrences of frigatebirds are directly related to storms, especially major storms, which confirms the statement of Robertson and Woolfenden (1992). Although the Magnificent Frigatebird is the most numerous marine species to occur in the interior of Florida following tropical cyclones and other major storms (D. B. McNair unpubl. data; cf. Louisiana; Marantz and Kratter 1998, Remsen 1998), and now satisfy the criteria of Robertson and Woolfenden (1992) of a regular ("annual or almost so") inland visitor, nonetheless, frigatebirds that occur inland in Florida are vagrants.

The distinct seasonal pattern of inland occurrences of Magnificent Frigatebirds in Florida, coupled with the direct relationship of many occurrences with major storms (most are tropical cyclones), corresponds imperfectly with the tropical cyclone season (June-November) in Florida. Inland occurrences of frigatebirds in Florida peaked in September, the peak month for tropical cyclones in Florida (Neumann et al. 1981, Artusa 1988, Williams and Duedall 1995). However, excluding the Panhandle from consideration because of the low number of occurrences, the proportion of inland occurrences of frigatebirds in the Florida peninsula during major storms since 1926 is lower in September (10 out of 29 storms, 34%) than in June (six out of nine storms, 67%). The sharp decline of inland frigatebirds in October, when tropical cyclones are still numerous in Florida (23 in the peninsula since 1926), coincides with a pronounced decrease in the number of frigatebirds in Florida after September, including the southwest Gulf coast (Harrington et al. 1972, Clapp et al. 1982, Robertson and Woolfenden 1992). The absence of inland frigatebirds in north Florida and the Panhandle after September except for one report also coincides with a decline in the number of birds along northern coasts after September. While fewer tropical cyclones occur in the Florida peninsula in July compared to other months from June to October, the low number of inland occurrences of frigatebirds in August is difficult to explain since frigatebirds are then numerous along the coast of Florida and tropical cyclones are fairly frequent (18 in the peninsula since 1926; e.g., see Fig. 22 in Artusa 1988). It is possible that this trough during July and August exists because observers are less active during the two hottest and most humid months in Florida.

The large numbers of Magnificent Frigatebirds inland in June and September (and once in October) during five storms that landed on, or approached, the Gulf coast of Florida south of Cedar Key, occurred when coastal frigatebird populations are numerous on the central and southern Gulf coasts of Florida (Eisenmann 1962, Harrington et al. 1972, Clapp et al. 1982, Robertson and Woolfenden 1992,

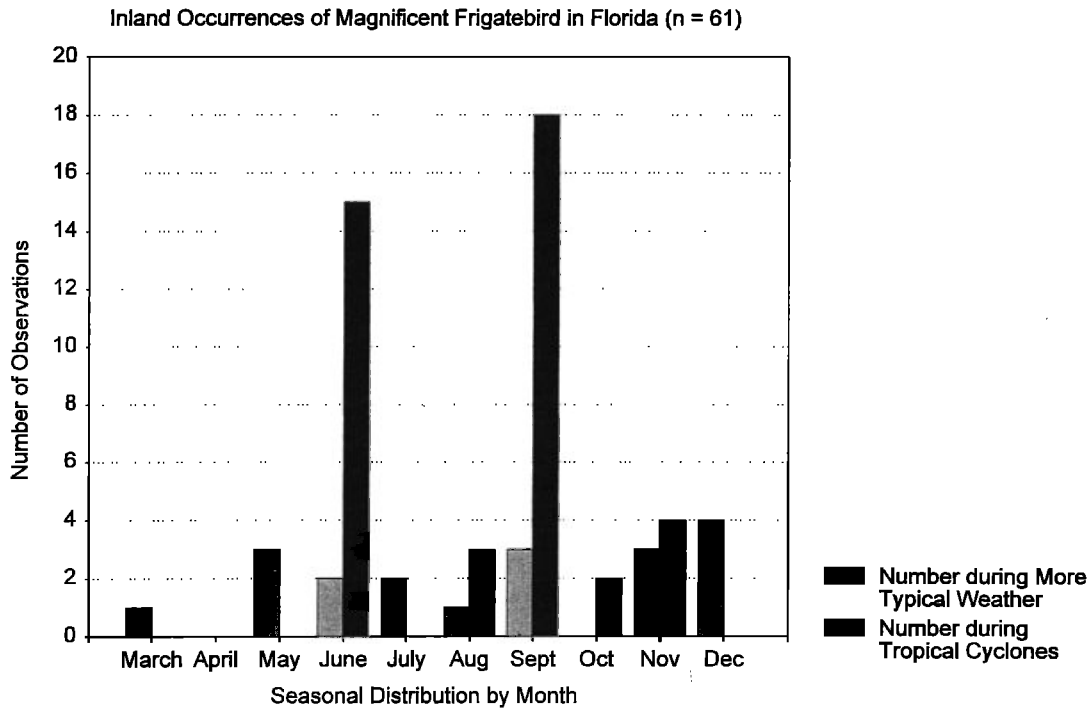


Figure 1. Seasonal distribution by month for Magnificent Frigatebirds that have occurred in the interior of Florida, based on first date of observation.

Robertson and Wilmers 1996). Two of these storms originated in the central and eastern Gulf, and only traveled over open water where frigatebirds are thought to be generally scarce (Eisenmann 1962, Buhman and Hopkins 1978, Clapp et al. 1982, Childs 1998, Pranty 1999), before reaching the Gulf coast of Florida. It is likely that frigatebirds seen inland during these storms included local birds. Origins of frigatebirds during the other three storms are less certain. The largest count, of at least 127 birds in Polk County in central Florida (Fellers 1988), was associated with Hurricane Elena which originated in southeast Cuba. Elena did not land on the coast of the Florida peninsula, but stalled offshore, approaching no closer than about 80 km, near Cedar Key. Eighteen birds in Alachua County in north Florida were associated with Hurricane Earl. Earl originated in the southwest Gulf of Mexico, passing close to the Chandeleur Islands of Louisiana where Magnificent Frigatebirds are locally abundant during summer (Clapp et al. 1982, Robertson and Wilmers 1996), before coming ashore in the Panhandle of Florida at the boundary of Bay and Gulf counties from where Earl moved into southwest Georgia. Eleven birds in Highlands County in south-central Florida in mid-October were associated with Hurricane Irene. Irene originated in the northwest Caribbean Sea, crossed western Cuba and the Florida Keys, then came ashore on the southern peninsula where the storm passed just to the south of Lake Okeechobee before reaching the Atlantic Ocean.

These seven high counts of frigatebirds in the interior of Florida that are associated with specific storms, the correspondence of larger numbers associated with stronger storms for the remaining observations (a mean difference of over one bird per occurrence compared to more typical weather), the disproportionate number of occurrences at multiple localities during storms, and a mean number of birds per occurrence in the interior of north Florida and the Panhandle not less than in central or south Florida suggest that storms

do have an effect on the actual number of frigatebirds that occur in the interior of Florida (*contra* Brinkley 1999), even though usually only single individuals or small flocks (≤ 7) are reported. Characteristics of specific storms that are associated with large numbers of frigatebirds inland in Florida require further study.

Other than in Florida, large flocks of Magnificent Frigatebirds only have occurred in the interior of the United States in the coastal plain of other states that border the Gulf of Mexico and in the American Southwest in southeast California and Arizona (Mlidonow 1998). Both geographical regions lie adjacent or in proximity to coastal frigatebird populations in the Gulf of Mexico and the Sea of Cortez in northwest Mexico, 120 km south of California and Arizona. Otherwise, counts of Magnificent Frigatebirds in the interior of the United States are low, almost always of one bird (Mlidonow 1998; E. S. Brinkley, unpubl. data). Even during Hurricane Gilbert, which had more occurrences of Magnificent Frigatebird associated with it in the interior of western and eastern North America than any other tropical cyclone, only two occurrences at any single locality were of greater than one bird, of two birds each in Iowa and Oklahoma (Mlidonow 1998; E. S. Brinkley, unpubl. data). Most Magnificent Frigatebirds reported in the interior of the United States are associated with water, e.g., Salton Sea, California (Mlidonow 1998; this study). Frigatebirds are averse to traveling over land even during powerful storms, and prefer to return quickly to open seas (as in Florida; this study). On this basis, the mean of almost three birds per occurrence in the interior of Florida during strong storms is actually rather impressive.

In the coastal plain of the United States bordering the Gulf of Mexico, the largest flocks in the interior are closely associated with both major storms and the largest populations of local frigatebirds, in Florida (this study) and in southeast Louisiana where the highest inland counts of 132 and 61 birds occurred at New Orleans in

September 1998 during and after Hurricane Earl (Jackson 1999), which originated in the western Gulf and passed over the Chandeleur Islands where local frigatebirds are concentrated (op. cit.). In Texas, where frigatebirds are not as numerous as in Florida and Louisiana, nor where they occur year-round as they do in southern Florida, the largest numbers are also associated with tropical cyclones, usually from mid-August to early October, but the numbers are much lower than in Florida or Louisiana, with maxima of nine and five birds during Hurricanes Beulah and Francis (Mlodonow 1998, Lasley et al. 1999).

Unlike most non-random inland occurrences of Magnificent Frigatebirds in Florida and other states bordering the Gulf of Mexico that were associated with tropical cyclones or other major storms, few frigatebirds in the interior of the American Southwest (where observer coverage has also greatly improved over the last several decades) are associated with tropical cyclones which are rare in this region (McCaskie 1970, Kaufman 1977, Patten and Minnich 1997, Patten 1998). The largest number reported during a tropical cyclone was 21 birds east of Yuma, Arizona, in late September 1997 during tropical storm Nora (Patten 1998). The mechanism of dispersal of most frigatebirds, including most large flocks (maximum of 22 birds at Salton Sea, late July 1979; Mlodonow 1998), to the Sonoran Desert (Salton Sea and elsewhere) of southeast California and Arizona is usually different. Magnificent Frigatebirds are associated with annual southerly monsoon air-flows through the Sea of Cortez in conjunction with increases in sea surface temperatures (see Patten and Minnich 1997) that account for an extremely strong non-random pattern of occurrence from June to September, with a peak in July and August when these winds may be accompanied by local thunderstorms (McCaskie 1970, Mlodonow 1998). This weather-induced seasonal distribution of observations of Magnificent Frigatebirds in the interior of the American Southwest is much more concentrated than in Florida, despite the few observations associated with tropical cyclones which would otherwise favor a concentrated period of occurrence.

Other than geographic proximity to local populations of Magnificent Frigatebirds, differences in the geographic configuration of the American Southwest and the Gulf of Mexico (especially the Florida peninsula) in conjunction with the timing and direction of movement contribute toward substantial differences in the seasonal distribution of frigatebirds in the two regions. Magnificent Frigatebirds that disperse into the interior of the American Southwest (Sonoran Desert) are only moving north, funneled by high-elevation land masses on both sides of the narrow peninsular-shaped Sea of Cortez. This movement is especially noticeable during "incursion" years, e.g., 1979 (Mlodonow 1998). In contrast, Magnificent Frigatebirds that disperse to the interior of the Florida peninsula are moving both north and south into a low narrow land mass almost surrounded by water. The absence of large flocks and the scarcity of Magnificent Frigatebirds in the interior of Florida in the absence of storms probably occurs because Florida's geographic configuration is reversed from the American Southwest. Frigatebirds cannot be funneled into the Florida peninsula, despite the prevailing southerly winds during summer when thermals are common (Winsberg 1990).

Magnificent Frigatebirds are adapted to using small thermals over open water for gliding (and soaring) flight by both day and night, since frigatebirds cannot land on water (Pennycuik 1983, 1987). Lesser Frigatebirds *F. ariel*, based on recoveries of banded birds, move long distances over open ocean (Sibley and Clapp 1967). The morphology of Magnificent Frigatebirds is highly similar to Lesser

Frigatebirds. Specific adaptations such as low wing-loading (40% more wing area than any seabird of comparable mass; Harrington et al. 1972), high aspect-ratio, long-forked tail to increase lift and maneuverability, and special muscle groups (Kuroda 1961) undoubtedly also allow Magnificent Frigatebirds to move long distances over open seas. This ability would account for the establishment of the isolated concentration of summering birds in the Chandeleur Islands of Louisiana, which cannot be accounted for on the basis of published observations along the coast of the Gulf of Mexico of Frigatebirds probably glide and soar high directly over the Gulf of Mexico from the Yucatan (where large numbers breed on Alacran Reef; Robertson and Wilmers 1996) to Louisiana. Thus, frigatebirds are probably more numerous offshore in the Gulf of Mexico (cf Fritts et al. 1983) than currently documented (Eisenmann 1962, Buhrman and Hopkins 1978, Clapp et al. 1982, Childs 1998, Peake 1996), based on their adaptation to gliding and soaring flight over open water.

Thermals are also numerous over land (mainly type I thermals, Kerlinger 1989), especially during summer in the Florida peninsula which has the highest rate of thunderstorms in the nation (Winsberg 1990). Yet frigatebirds are scarce over land in Florida except during major storms, although some birds have appeared during more typical weather (In Texas, Mlodonow [1998] suggests that some birds within 80 km of the coast also occurred during typical weather) The ability of frigatebirds to glide or soar on thermals or use horizontal wind shear associated with the edge of thunderstorms would allow them to stray over land regularly, yet most frigatebirds in the Gulf of Mexico recognize land boundaries as only a few birds have wandered short distances inland during more typical weather. Just further south of the United States, however, on the long narrow (< 90 km) peninsula of Baja California, large flocks of Magnificent Frigatebirds regularly travel over land from June to August (Clark and Ward 1993) (a few flocks have also occurred over land in southeast Arizona, Mlodonow 1998). Unlike Florida, frigatebirds are not averse to traveling over land in Baja California. The use of thermals in an arid landscape on a narrower peninsula may contribute toward this difference. Regardless, the basis for this difference requires investigation.

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