

Occurrence and abundance of tubenoses (Procellariiformes) at Guadeloupe, Lesser Antilles, 2001–2004

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Abstract

This paper presents observations of tubenoses (Procellariiformes) of nine species recorded 2001–2004 in year-round seawatches from Terre-de-Bas, part of Petite-Terre Nature Reserve, located between the islands of Désirade and Marie-Galante in the Guadeloupe archipelago. The context of these observations, both historically (for Guadeloupe) and regionally in the Lesser Antilles, is also considered herein.

Introduction

Although pelagic seabird enthusiasts tend to consider the Caribbean Sea an avifaunally poor environment (e.g., Ballance 2004), the eastern, Atlantic-facing coasts of the Lesser Antilles in fact host a variety of shearwaters and petrels, many of these being migratory species that nest in the North Atlantic or South Atlantic Ocean. Summarizing these species' status, Raffaele et al. (1998) noted that many were under-represented in the literature, owing to their occurrence far offshore. For example, they regarded Audubon's Shearwater (*Puffinus lherminieri*) as "not likely to be seen except from a boat far offshore" (Raffaele et al. 1998).

Levesque began to look for seabirds from shore in 2001, when he assumed his position as a warden at Petite-Terre Nature Reserve in

the Guadeloupe archipelago, French West Indies. Preliminary experience in mainland France had taught him that seawatching from a coastal vantage point might be productive—provided one is armed with patience, good optical equipment, and some luck. Not long after beginning in February 2001, his effort was rewarded, and within three months' time, the numbers of tubenoses he recorded had redefined the regional status of several species. A year-round survey was thus set up, then repeated in 2002, 2003, and 2004 in order to determine both constancy and interannual variation in the occurrence of the area's seabirds. In all, nine species of tubenose (Procellariiformes) were observed during this survey.

Methods

Observations were carried out from the islet of Terre-de-Bas, part of Petite-Terre Nature Reserve, which lies between the islands of Désirade and Marie-Galante at the southeastern corner of the Guadeloupe archipelago; at 16° 15' N 61° 7' W, this is also one of the easternmost points on Guadeloupe (Map 1). The Continental Shelf is rather narrow east of Terre-de-Bas, with ocean sea-floor depths of 20 m, 88 m, 376 m, and 456 m at distances of one, 2, 3, and 4 nautical miles (nmi) offshore (1.8, 3.7, 5.5, and 7.4 km), respectively (M. Dévarieux, pers. comm.). Prevailing local winds are trades and thus have a strong easterly component that varies from northeasterly to southeasterly, but winds have a true easterly direction about 30% of the time. Wind speed ranged from 18–30 km/hr 60% of the time, reaching 30–40 km/hr about 2% of the time; June and July are the windiest months.

The sampling protocol required 15-minute nonstop observation from the top of the highest cliff (ca. 7 m above sea level) with a tripod-mounted Swarovski AT80 or

ATS65 HD spotting scope with a 20–60x zoom lens used at 30x during search, occasionally switched to higher magnification for identification of distant birds. Within each clock hour from 0600 to 1800 (plus a minority of early and late sessions from 0530 and up to 1830 in late spring and summer), two consecutive 15-minute survey periods were separated by a break of up to three minutes. The original protocol called for even distribution of 15-minute periods across days, months, and years for consistent coverage. Actual observation effort deviated from this model because main passage periods were given extra coverage for better quantification and because wardening responsibilities fortuitously left more free time early and late in the day, when movements were heaviest (Figures 1, 2). Sampling was done with the telescope pointed to the south ($\pm 20^\circ$ according to sun glare), but it was briefly shifted to follow birds for identification or for counting and then restored. Simultaneous observations from the study site and from a boat at sea using GPS indicated that the relative sizes of shearwaters were identifiable by telescope up to 4 nmi (7.4 km) offshore and that much of the visible passage occurred within 1–3 nmi (1.8–5.5 km) from shore. Specific identification was based on plumage and structural characters (Harrison 1985, 1987; Raffaele



Map 1. All observations treated in this paper were made on the small island of Terre-de-Bas between the islands of Désirade and Marie-Galante in the Guadeloupe archipelago.

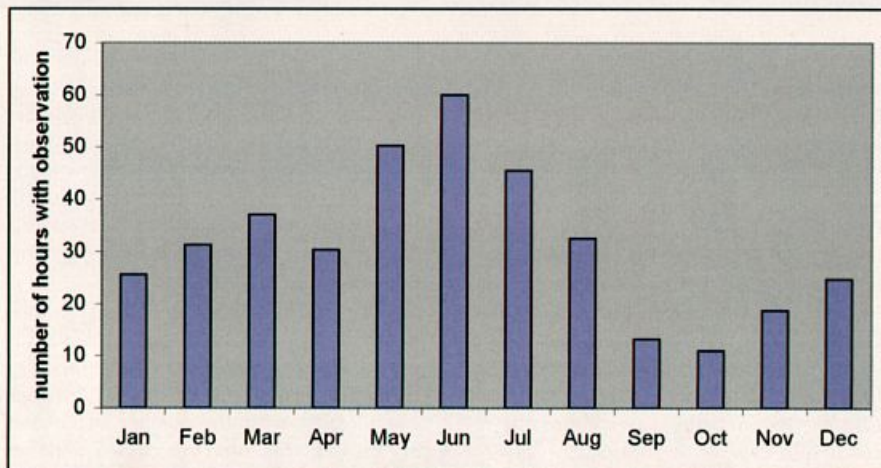


Figure 1. Distribution of the observation effort per month. The effort was kept low in autumn (down to 11 hours in October, i.e. on average one 15-minute observation period every three days) due to the very low frequency of birds detected at that time of the year; the effort was intensified during periods that proved to be most productive.

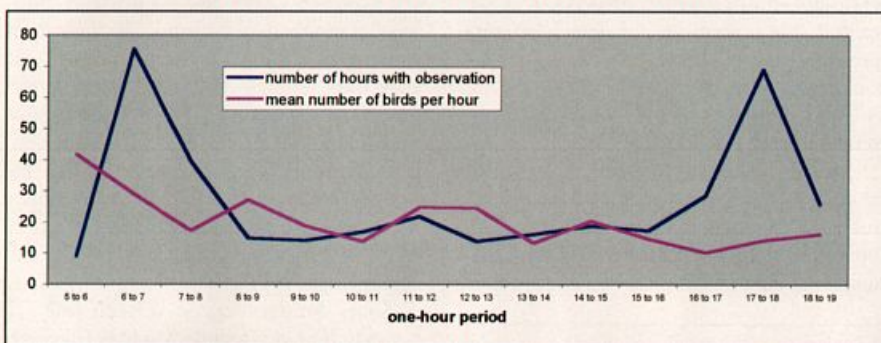


Figure 2. Distribution of observation effort and average bird frequency through the day. The observation effort peaks in the first and last part of the day due to work schedule on the Nature Reserve, leaving more free time before 8 a.m. and after 5 p.m. Low observation effort in the very first and last hours of the day is linked to seasonal variations in dawn and sunset time. The mean number of birds per hour tends to decrease throughout the day ($r = -0.71$).

et al. 1998; Sibley 2000), but flight behaviors were also carefully scrutinized and eventually also used for identification. At such distances, for instance, distinguishing Manx (*Puffinus puffinus*) from Audubon's Shearwaters based on plumage characters was often challenging; structure and flight patterns were thus the main features used to tell these species apart. Manx Shearwater alternates a brief series of strong, shallow beats of

straight wings and long glides on slightly arched wings; its trajectory arcs above sea level during the glide as wind strengthens, and under strong winds it mostly glides, arcing sharply upward from the sea surface up to many meters high, then veering sharply downward again. Conversely, Audubon's Shearwater undertakes much shorter, shallower glides on more arched wings, interspersed with frequent series of faster wing-

beats than Manx—and these bursts of flapping were also of greater duration than Manx's. This flight behavior is typical of the species in both low winds and at higher wind speeds. While the first author was responsible for most of the field observations, the second author, who has extensive experience with Atlantic shearwaters, joined for the survey for 10 days in April 2004 to verify identification characters.

Without exception, when birds occurred close enough to shore to allow plumage characters to be studied, we found that the identification based on plumage characters corresponded to the identification based on flight action and structure. Pelagic trips in spring 2004 (up to 33 nmi [60 km] offshore) were also conducted in order to check the identification characters used in shearwater and storm-petrel identification; seabirds were attracted close to the vessel with fish oil and small pieces of fish.

Data obtained during each 15-minute period, including all sampling zeros, were pooled per hour and per month, leading to the calculation of the mean number of individuals of a given species observed per hour during a given month. Multiplied by the number of hours with daylight and the number of days per month, this database also permits a rough estimate of the number of birds that passed through the study area over a given period.

Results in Context

Shearwaters and petrels

From April 2001 to December 2004, 7513 shearwaters and petrels (Procellariidae) were sampled during 380 hours of seawatching; 88 per cent of these (6611) were identified to species. Unidentified birds were scored as "large shearwaters" (Cory's/Greater) or "small black-and-white shearwaters" (Manx/Audubon's) (Table 1).

Black-capped Petrel (*Pterodroma hasitata*)—Three individuals were seen in early 2004 (7 and 14 January, 4 February); four

Table 1. Monthly distribution of shearwaters, petrels, and storm-petrels off Petite-Terre, Guadeloupe, 2001-2004, with level of sea-watching effort (hours per month). Numbers in square brackets indicate unconfirmed identifications.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
Manx Shearwater	5	85	2245	139	56	4					3	6	2543
Audubon's Shearwater	3	3	2	98	339	125	3		1	2	2	3	581
Manx/Audubon's Shearwater	9	20	30	49	49	30	3	1		5	5	5	206
Greater Shearwater					3	1547	501						2051
Cory's Shearwater		1		2	18	463	91	5			42	5	627
Sooty Shearwater	1				5	3					1		10
Greater/Cory's Shearwater					9	268	88			2	7	3	377
Black-capped Petrel	2	1											3
gadfly petrel (<i>Pterodroma</i> sp.)	2	1	1										4
Bulwer's Petrel						1 [+1]	[1]						1 [+2]
Wilson's Storm-Petrel		3	63	359	282	51	4	1		2			765
Leach's Storm-Petrel			5	26	14	1							46
unidentified storm-petrel		7	33	97	138	19	1	1				1	297
Total number of birds	22	121	2379	770	913	2513	692	8	1	11	60	23	7513
Total number of hours	25.5	31.25	37	30.25	50.25	60	45.5	32.5	13.25	11	18.75	24.75	380

more gadfly petrels (*Pterodroma* sp.) seen in the same period were also most likely this species. Black-capped Petrel had not been reported near Guadeloupe since breeding ceased to be reported in the eighteenth century or early nineteenth century (Pinchon 1976). According to Raffaele et al. (1998), a few pairs of this endangered species may still breed on nearby Dominica, although there are no confirmed recent reports apart from a few birds reported off this island (A. R. Keith, pers. comm.).

Bulwer's Petrel (*Bulweria bulwerii*)—One was seen 11 June 2003 following a period of strong easterly winds (50–80 km/hr) lasting several days, and two more singles were suspected that year on 12 June and 5 July. Bulwer's Petrel was previously recorded at sea near Curaçao (13 May 1970; Voous 1983), at sea off Dominica (21 April 2003; Norton et al. 2003), and as a corpse on an islet off Trinidad in January 1961 (French 1991). Although reported as a vagrant in Barbados by Raffaele et al. (1998), those reports are now considered "unsupported" (four reports; three confirmed but just east of the Barbados Exclusive Economic Zone) in the forthcoming Barbados checklist (Buckley et al., in press). Similarly, it cannot be added to the

list of species recorded in Guadeloupe yet: according to the criteria in place for the French West Indies, any species new to the area needs to be either photographed or seen by at least two experienced observers.

Large shearwaters

Out of 3065 large shearwaters recorded during the study, 2688 (88%) were identified to species: 2051 Greater Shearwaters (*Puffinus gravis*), 377 Cory's Shearwaters (*Calonectris diomedea*). Another 637 were logged as unidentified large shearwaters (Greater or Cory's). (No individuals resembling the recently split Cape Verde Shearwater [*Calonectris edwardsii*] were observed, but differences from Greater/Cory's would likely be difficult to perceive at a distance. In many cases of distant shearwaters recorded as Cory's, we cannot rule out *edwardsii*.) Somewhat surprisingly, only 10 Sooty Shearwaters (*Puffinus griseus*) were recorded during the survey. All three large shearwater species were observed in each study year.

Greater Shearwater (Figure 3) occurred in June and July (extremes 26 May and 23 July). The highest count was with 261 in 2.5 hours on 11 June 2003. One may thus estimate that about 14,150 Greater Shearwaters

pass east of Guadeloupe each year. Until the present study, this species was considered uncommon, although regular, at Guadeloupe (Feldmann et al. 1999), with all previous records in May–July, even though the highest count was only four individuals off the Caribbean (west) coast 7 July 1994 (Association pour l'Étude des Vertébrés des Antilles, archives).

Cory's Shearwater (Figure 4) is also primarily a spring migrant (24 April–20 August), occurring mostly in June–July. Because the peak of its occurrence overlaps considerably with the passage of Greater Shearwater, this survey recorded a rather high proportion (13–29% annually) of unidentified large shearwaters during these two months. In contrast to Greater Shearwater, however, Cory's also occurred in much smaller numbers year-round. The daily maximum was 120 in 2.75 hours on 8 July; one may thus estimate that about 3000 Cory's Shearwaters pass east of Guadeloupe in June and July annually. These observations contrast starkly with earlier appraisals of the species' status in Guadeloupe, where there were only two previous records: one on 16 May 1992 and one on 22 May 1993 (Feldmann et al. 1999).

Sooty Shearwaters were seen only 10 times in four years, mostly in May (five, earliest 19 May) and June (three, latest 11 June), with odd late-autumn and winter records on 11 November 2004 and 26 January 2002. All observations were of single birds. These data are in keeping with limited previous information. Feldmann (1998) included the species on the list of the birds of Guadeloupe, although the database of the French West Indies naturalist society AEVA (Association pour l'Étude des Vertébrés des Antilles) lacked any detailed records until Yésou reported one in mid-March 1998.

Small black-and-white shearwaters

Manx and Audubon's Shearwaters are usually easily told apart, and out of 3330 small shearwaters, only 206 (6%) were left unidentified. Most identified birds were Manx, of which 2543 were recorded, while 581 Audubon's Shearwaters were recorded.

The first Manx Shearwater recorded at Guadeloupe was found dead at Désirade Island on 30 April 1997; it had been banded in 1978 as a flying bird (born before that year, age otherwise unknown) at a colony in Saint Kilda, Scotland (Keith and Keith 2003; J. Clark, British Trust for Ornithology, pers. comm.). Earlier recoveries of Manx banded in the United Kingdom come from Trinidad and Grenada. No Manx was recorded alive in waters surrounding Guadeloupe until 2001 (Levesque and Jaffard 2002), and so it is surprising that Manx proved to be the most abundant procellariiform in the present sur-

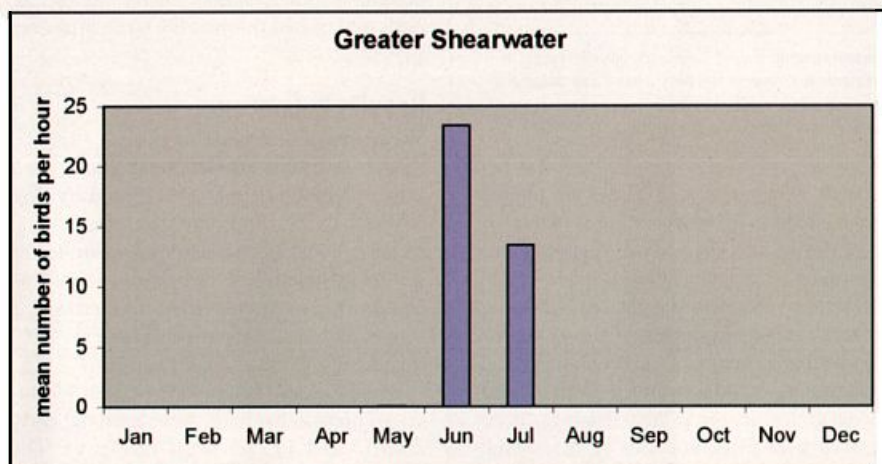


Figure 3. Observations of Greater Shearwater by month, 2001-2004.

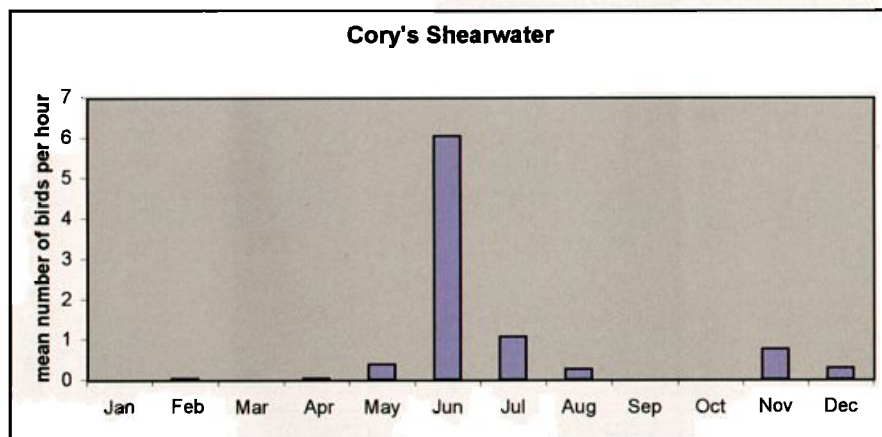


Figure 4. Observations of Cory's Shearwater by month, 2001-2004.

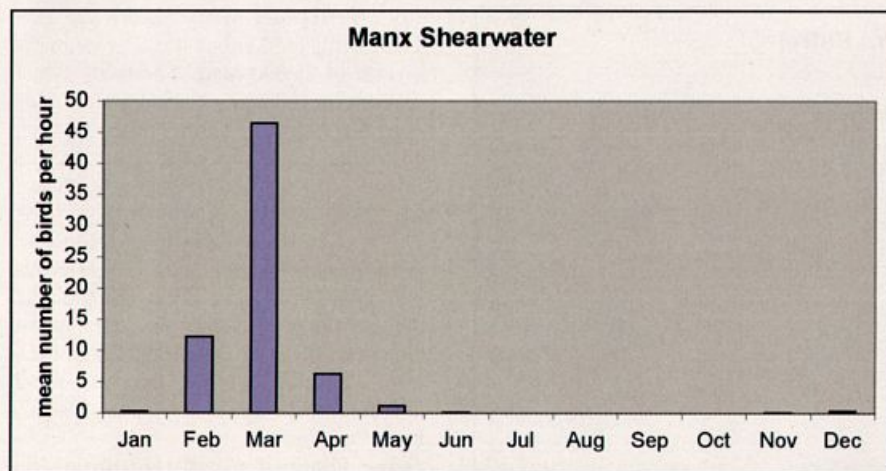


Figure 5. Observations of Manx Shearwater by month, 2001-2004.

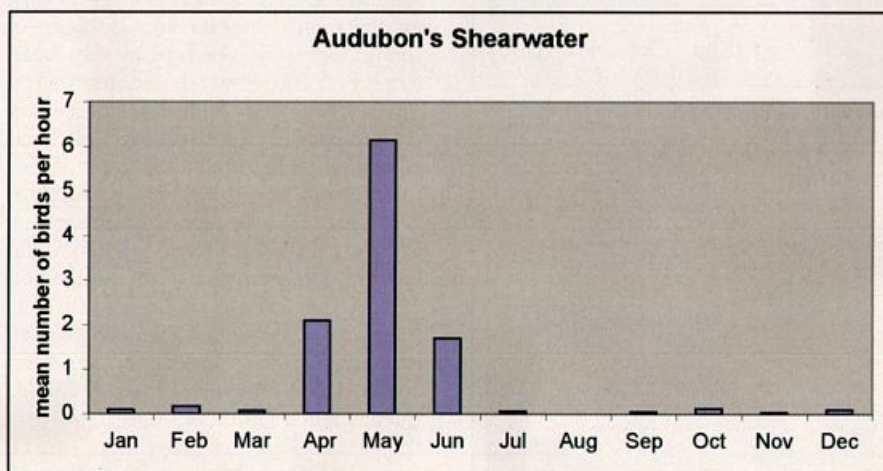


Figure 6. Observations of Audubon's Shearwater by month, 2001-2004.

veys—34% of all tubenoses recorded and 40% of all shearwaters—and thus probably the most abundant seabird off Guadeloupe (no systematic counts of terns have been undertaken, however). Manx has been recorded from 5 November through 10 June, sometimes in flocks of up to 18 birds, but it remains scarce outside its spring passage from February to May, peaking in March (Figure 5). The daily maximum was 597 in four hours on 3 March 2004 during strong northeasterly winds (up to 80 km/hr) that had begun the previous day. We estimated that on average an astonishing 26,000 Manx Shearwaters pass in February–May each year, three-quarters of them in March.

Audubon's Shearwater is the only shearwater known to breed in the Lesser Antilles. The nearest known colonies are in Dominica and Martinique, 66 and 149 km from the study area, respectively, but breeding is also suspected at Marie-Galante Island, which is just 24 km away. The species was recorded year-round during our study but proved very scarce outside the 4 April–9 July period (Figure 6). While the other shearwaters were recorded at all times of day (Figure 7), it is

remarkable that 72% of Audubon's Shearwaters were recorded prior to 0800 hrs, including 65% during the first hour after dawn. Research on the species' breeding biology in Martinique (R. Brithmer, pers. comm.; the late P. De Mercey, pers. comm., *vide* M. Pascal) indicates that hatching occurs from late March into April and fledging in June and July—thus with a fledging period in agreement with the 62–100 (mean=75) days as given by Harris (1969). This strongly suggests that most if not all of the Audubon's

Shearwaters observed during the present study were not migrants but local breeders dispersing to foraging areas at dawn. If this interpretation is correct, it is conceivable that individual birds may be routinely recorded multiple times. In that case, the number of different birds passing the study site during their April–June peak period cannot be estimated.

Storm-petrels

The 1068 storm petrels logged during the four years of the survey almost certainly under-represent their actual abundance in the study area, as such tiny seabirds can be difficult to detect at a distance. That 28% of those recorded were not identified to species likewise relates largely to the distances of observation involved. Nevertheless, the records shed light on the migration timing and relative abundance of the two regular species.

Wilson's Storm-Petrel (*Oceanites oceanicus*) accounts for 94% of identified storm-petrels recorded. It has been recorded from 14 February to 8 August, with peak numbers in April and May (Figure 8). An influx occurred on 25 April 2001, when 245 individuals were seen in only three hours. This passage excepted, the species' frequency is rather constant in April and May (at 4.7 ± 1.7 birds/hr), and it can be estimated that on average about 8000 individuals pass Guadeloupe in March–June each year, a figure in contrast to earlier statements that the species is rare at Guadeloupe (Feldmann 1998). Outside this spring passage, a few were seen in the June–August period; "two" on 13 October 2004 possibly referred to only one individual; and one unidentified storm-petrel on 7 December 2004 was possibly this species, although Leach's might be more likely in the latter case, inasmuch as Raffaele et al. (1998) list Leach's as a "rare non-breeding resident from November to June."

Leach's Storm-Petrels (*Oceanodroma leucorhoa*) were recorded in far fewer numbers (46) than Wilson's, all of them between 12 March and 4 June, with the highest frequency (average of 0.5 bird/hr) in April (Figure 9). Interannual variability was high, however,

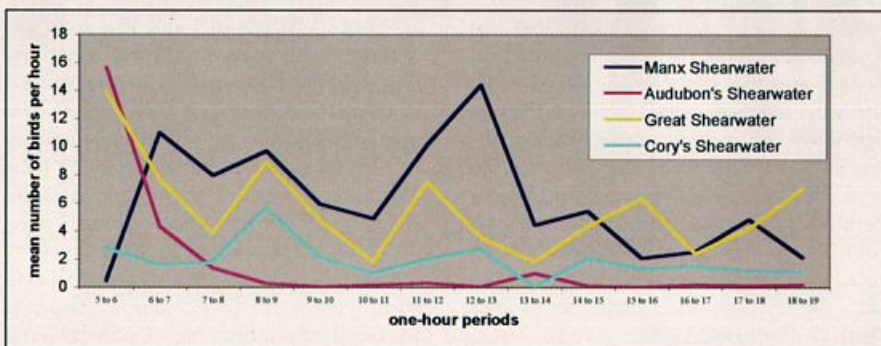


Figure 7. Average shearwater distribution of records according to time of the day. The low frequency of Manx Shearwaters in the very first hour of the day is related to the shorter day (and thus later time of dawn), in March, when the species mostly occurs.

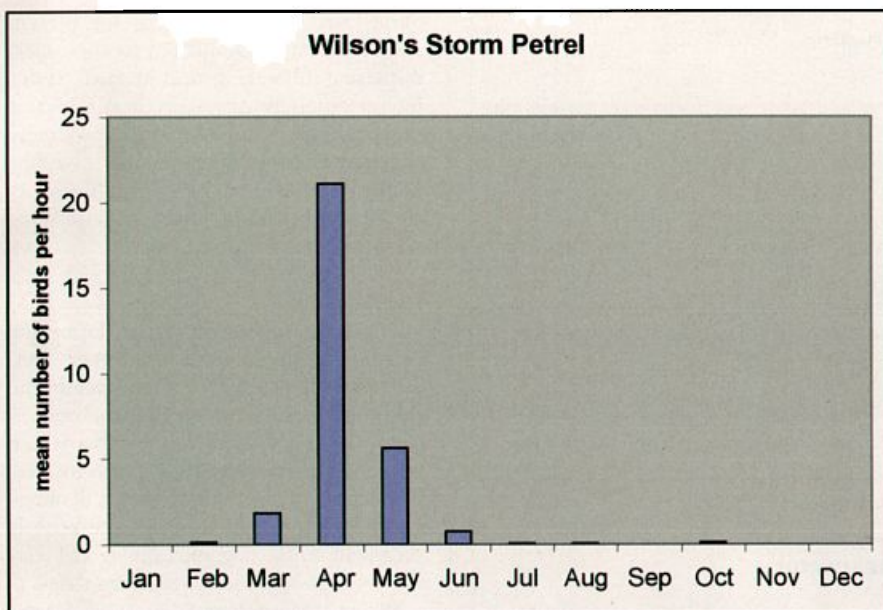


Figure 8. Observations of Wilson's Storm Petrel by month, 2001-2004.

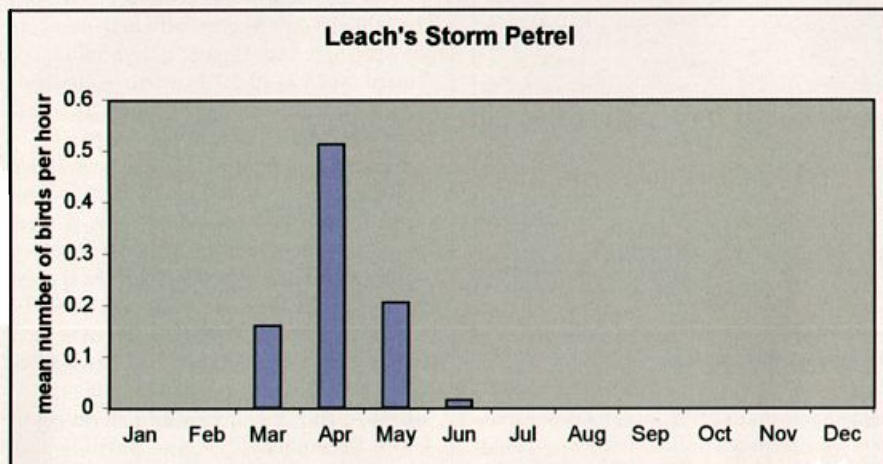


Figure 9. Observations of Leach's Storm-Petrel by month, 2001-2004.

with none in 2003 but twice the average number in April–May 2004. We thus estimate that Leach's Storm-Petrels off Petite-Terre in spring have ranged from zero to at least 800 birds per year during the study period. Furthermore, vessel-based observations several km offshore indicate that the actual Wilson's:Leach's ratio is probably about 10:1, rather than the 17:1 ratio observed from shore. This suggests that a significant proportion of distant, unidentified storm-petrels might be Leach's. Whatever the actual abundance of Leach's, the figures again contradict earlier assessments of the species' status in Guadeloupe, where it has been considered "rare" (Feldmann 1998). No Band-rumped Storm-Petrels (*Oceanodroma castro*) were recorded or even suspected, either from the coast or during boat-based offshore observations. Considering its regional status (Raffaele et al. 1998), it is certainly possible that some of the unidentified storm-petrels were this species.

Discussion

This four-year survey has revealed that many species previously considered rare in fact occur in large numbers in coastal waters off the Guadeloupe archipelago. The past deficiencies in our understanding of the status and distribution of tubenoses here may be most directly explained by the absence of systematic observations in spring from appropriate vantage points. It is now clear that many pelagic seabirds move through nearshore waters east of Guadeloupe. The observed seasonal pattern of most species agrees with previous knowledge about their migrations in the northwestern Atlantic Ocean generally, e.g., the northward post-breeding migration of austral breeders (Greater and Sooty Shearwaters, Wilson's Storm-Petrel); the boreal-summer dispersal westward of nonbreeding or post-breeding Cory's Shearwaters; and the return migration of boreal breeders such as Leach's

Storm-Petrel and Manx Shearwater (Lee 1995, Keith and Keith 2003). The estimated average of 26,000 Manx Shearwaters each year in Guadeloupe's coastal waters indicates that a sizeable portion of the breeding population passes along the Lesser Antilles' Atlantic coasts when returning northward from South American wintering grounds. This species' distribution in the North Atlantic during the nonbreeding season has typically been mapped as extending no farther west than ca. 40° W (e.g., Cramp and Simmons 1977, Brooke 1990, Carboneras 1992). It is now clear that it extends much farther to the west, at least during north-bound migration.

The information collected during the present study also raises several questions. Although Sooty Shearwaters migrate in large numbers into the Northern Atlantic in spring, they were observed in very small numbers compared to Greater Shearwaters. The scarcity of Sooty Shearwaters around Guadeloupe suggests that their typical migratory routes lie farther offshore, and land-based counts from other sites (e.g., eastern Bermuda) appear to confirm that inference. Clearly, ship-based pelagic studies would improve our knowledge of the distribution of this species and of others, such as Audubon's Shearwater, which is observed only rarely inshore outside of the nesting season. The distribution of pelagic seabirds extends much farther offshore at sea than the relatively short range that can be scanned with a spotting scope from shore: what can be seen from shore surely is only part of a broader movement, and the numbers of storm-petrels, petrels, and shearwaters frequenting the deep Atlantic waters well east of the Lesser Antilles might prove to be much higher than those we have estimated for our study site in Guadeloupe. Studies of these seabirds' distribution and phenology that include various biotic and abiotic oceanographic parameters (such as seawater currents, sea surface temperature, nutrient richness, and plankton and fish densities) would provide a better understanding of these birds' habits and habitats than we have now.

We believe it likely that other east-facing sites along the Caribbean arc will prove to be productive for seawatching. For example, in April 2004 we briefly tried observing from the eastern point of Désirade Island, which lies farther east than Petite-Terre and closer to highly productive waters where Humpback Whales (*Megaptera novaeangliae*) congregate within 3 km or so of the coast. This short visit allowed us to record species never detected from Terre-de-Bas (e.g., groups of Willets [*Catoptrophorus semipalmatus*] in active migration over the ocean) and led us to suspect that Désirade Island may be even

more productive for seawatching than Terre-de-Bas. We encourage observers to seawatch in these locations at any time of year; March–July appears to have the greatest potential.

Acknowledgments

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