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Retrospective weather analysis explains regular occurrence of House Swifts *Apus nipalensis* and swiftlets *Aerodramus* spp. in north-western Australia

Nigel A. Jackett

School of the Environment, and Research and Recovery of Endangered Species (RARES) Group, University of Queensland, St Lucia QLD 4072, Australia
Email: n.jackett@uq.edu.au

Abstract. Predicting the occurrence of species involves consideration of many environmental and biological factors. For rare, mobile and dispersive trans-continental species, the challenges involved are even greater. Daily weather observations between November 2017 and April 2023 were analysed to identify patterns associated with 48 observations of House Swifts *Apus nipalensis* and swiftlets *Aerodramus* spp. – species considered national vagrants – at a site in northern Western Australia. Relatively strong winds from the north-east associated with a tropical cyclone or low-pressure system were conducive to House Swift and swiftlet occurrence, between December and May. It is anticipated that the weather conditions identified will assist with predicting future occurrences, and thereby facilitating research opportunities for these enigmatic taxa.

Introduction

Vagrants are individuals considered outside of their normal distribution. Research indicates vagrancy is a consequence of complex interactions between a variety of factors (Bozó & Csörgő 2024). Weather conditions, exploratory behaviour, population size, feeding habits and habitat use, genetic defects, and responses to climate change are all expected causes of vagrancy (Ralph & Wolfe 2018; Veit *et al.* 2022; Bozó & Csörgő 2024). Although a natural phenomenon, vagrants in Australia have sometimes been regarded in a negative context, being considered biosecurity risks, and often lack legislative protection. Such policies are potentially failing species responding to environmental change (Davis & Watson 2018).

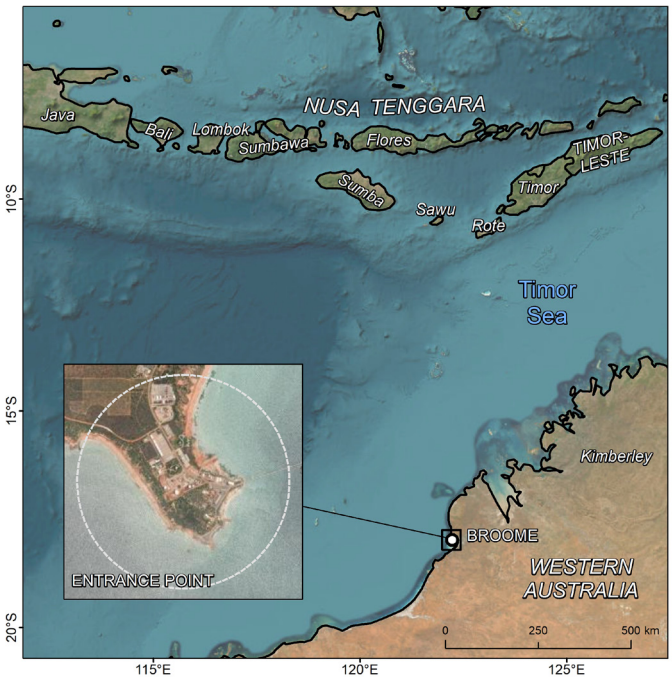

Figure 1. Location of Entrance Point study area, Broome, Western Australia, and Nusa Tenggara, Indonesia.

The swifts and swiftlets (Apodidae) are a group of highly mobile and often dispersive aerial feeders with a history of vagrancy (Robertson 1980; Choi *et al.* 2009; de Boer *et al.* 2014; Szabo *et al.* 2017). Australia is home to two breeding species (Higgins 1999), two regularly occurring summer migrants (Yamaguchi *et al.* 2021; Ktitorov *et al.* 2022; Kyne *et al.* 2022), and several considered rare migrants or vagrants (Bravery 1971; Bartram 1988; Thorburn 2015; Johnstone & Greatwich 2018; Kyne *et al.* 2022). The breeding species are both swiftlets *Aerodramus*/*Collocalia* spp. with non-migratory populations in north-eastern Australia (Tarburton *et al*. 2023) and Christmas Island (Higgins 1999), both far from north-western Australia.

In recent years, House Swifts *Apus nipalensis* and swiftlets *Aerodramus* spp. have been reported annually, but irregularly, at Entrance Point ~6 km to the south-west of Broome, Western Australia (Figure 1). These birds are all likely to originate from breeding populations in Asia. This paper uses retrospective analyses of weather observations from a nearby long-term weather station to determine conditions likely to attract these birds, improving the ability to predict future occurrences.

Methods

Entrance Point is located ~6 km to the south-west of Broome, Western Australia, on the southern tip of the Broome Peninsula (Figure 1). Weather-observation data were sourced from the Bureau of Meteorology Station 3102 (BROOME NTC AWS) located at Broome Port (–18.0015, 122.2176). The location of the Station was within ~1.5 km of all House Swift and swiftlet observations, and therefore considered appropriate for assessing local conditions. The dataset included half-hourly observations for wind speed (km/h), maximum wind gusts (km/h), wind direction (degrees true), and mean sea-level pressure (hPa), between 1 November 2017 and 30 April 2023. A strong positive correlation (r = 0.95) was determined for wind speed and wind gusts. However, for completeness, both variables were considered in the analyses. The selected

date range captured the entirety of six wet seasons (1 November–30 April) and five dry seasons (1 May–31 October).

Entrance Point is regularly visited by birdwatchers throughout the year, and 1346 checklists, comprising 178 species, have been entered within the study area (1-km radius of –18.0031, 122.2069) on eBird (Sullivan *et al.* 2009). eBird was searched for records of the following species and identifiable groups: 'House Swift *Apus nipalensis'*, 'White-nest/Germain's Swiftlet (Edible-nest Swiftlet) *Aerodramus fuciphagus/germani'*, 'swiftlet sp. *Collocalia/Aerodramus* sp.' and 'dark swiftlet sp. *Aerodramus* sp.'. For analysis purposes, records of the latter three groups were combined to form the category 'swiftlets'. As House Swifts and swiftlets are considered rare migrants or vagrants to north-western Australia, records were included in the study only if (a) they were supported by photographs showing unambiguous identification features, or (b) were observed at a time (± 1 day) when either House Swifts and/or swiftlets were photographed (and therefore demonstrably present in the area), and (c) had information relating to the time of a sighting. Twenty-two observations of House Swifts and 19 observations of swiftlets satisfying these criteria were compiled. Additional contributions (House Swift: n = 4, swiftlets: n = 3), were sourced from George Swann, an experienced Kimberley bird guide and ornithologist, who similarly recorded data that met these criteria, but did not upload records to eBird.

Weather observations corresponding to the time of House Swift or swiftlet sightings were attributed to each record. Variations in weather variables at Entrance Point, including when House Swifts or swiftlets were observed, were analysed in R Studio.

Results

Weather observations

Observations of both House Swifts and swiftlets were made in all years from 2018 to 2023 and predominated in the wet season (Figure 2). House Swifts were recorded between 9 December and 26 May, and swiftlets were recorded between 9 December and 14 April.

Swiftlets were typically observed during lower wind speeds than for House Swift (Figure 3), with mean wind speeds being 24.7 ± standard error 2.3 km/h and 31.8 ± 2.3 km/h for swiftlets and House Swifts, respectively (Table 1). Swiftlets were also most frequently observed during lighter wind gusts than when House Swifts were observed (Figure 3), with mean wind gusts being 32.9 ± 3.0 and 40.7 ± 2.8 km/h for swiftlets and House Swift, respectively (Table 1).

The predominant wind direction associated with the occurrence of both taxa was from the north-east. The mean wind direction for swiftlets was 32.4 ± 8.8°, and for House Swifts 40.8 ± 13.1° (Figure 3). North-easterly winds (30–60°) are relatively rare at this location based on the weather dataset, comprising 1.9% of all wind direction records (Figure 4).

Observations of both taxa were generally made during periods of relatively low mean sea-level pressure (MSLP) (Figure 2), likely because of the presence of a tropical low or cyclone within the north-western region of Australia. However, not all intense periods of low pressure resulted in observations of House Swifts or swiftlets. The mean MSLP was similar for both swiftlets (1002.8 ± 0.8 hPa) and House Swifts (1002.5 ± 0.7 hPa) (Table 1), being ~7 hPa lower than the average across the study period (1009.3 hPa).

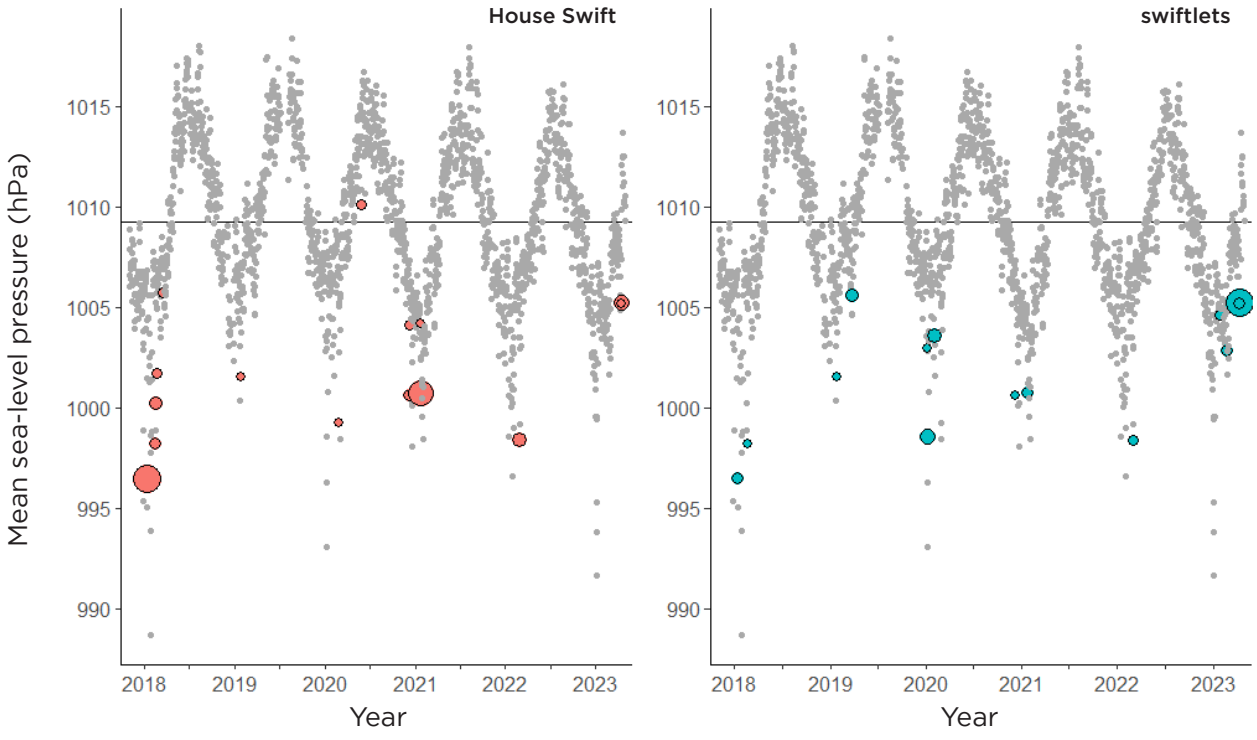

Figure 2. Daily mean sea-level pressure (grey dots) and associated House Swift and swiftlet observations (red and blue circles, respectively) at Entrance Point. Size of circles indicates relative abundance (1–30). Horizontal line indicates daily average mean sea-level pressure (1009.3 hPa) across the study period.

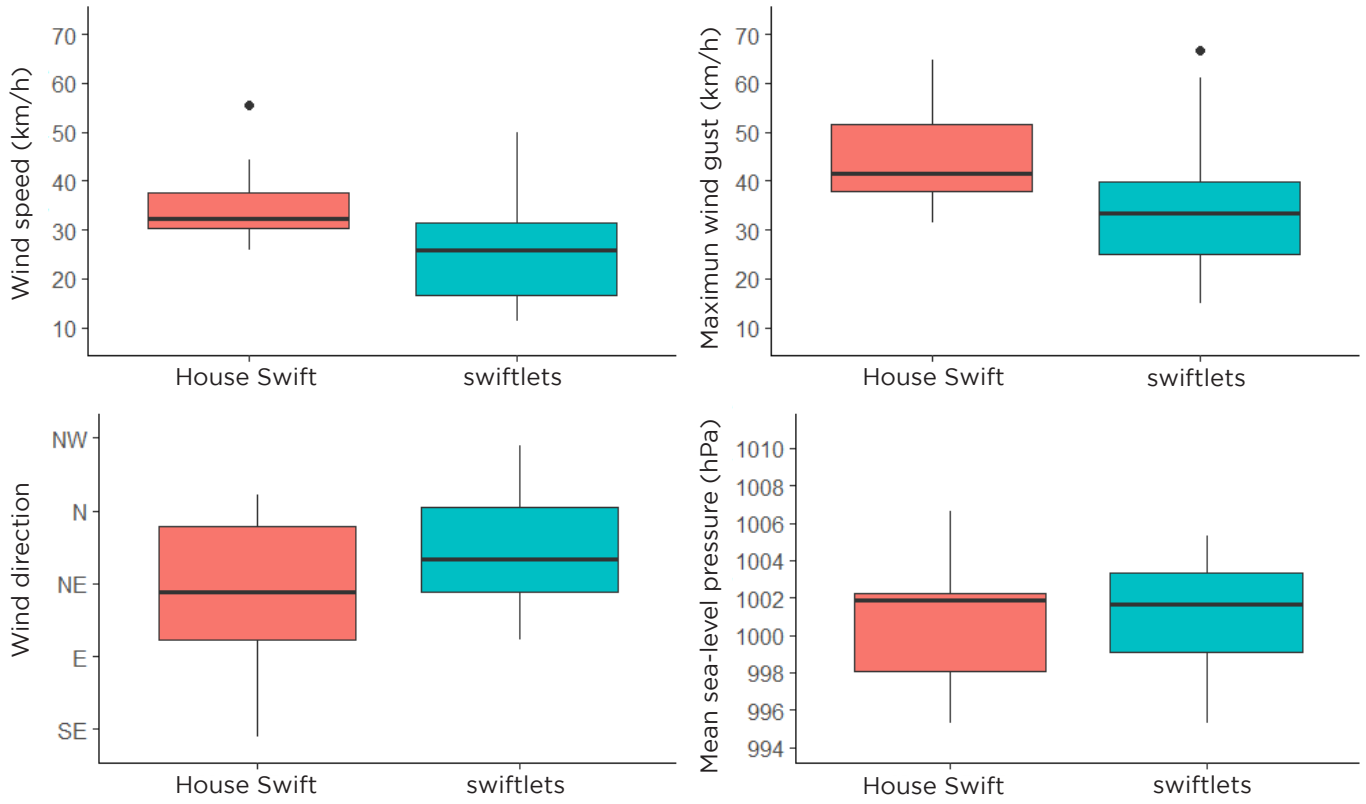

Figure 3. Weather variables associated with observations of House Swift and swiftlets at Entrance Point, Western Australia. Wind direction: E = east, N = north, NE = north-east, NW = north-west and SE = south-east. Black dots indicate outliers.

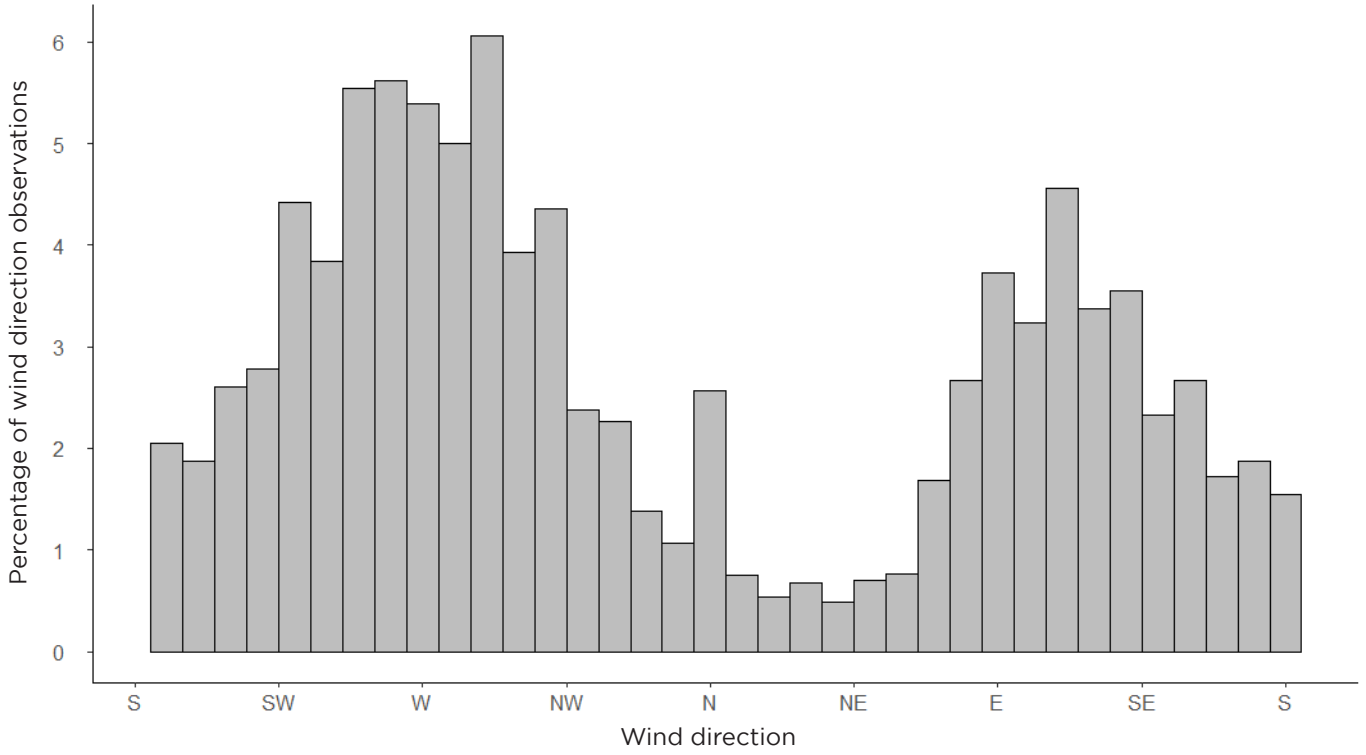

Figure 4. Wind direction frequency during the study period. E = east, N = north, NE = north-east, NW = north-west, S = south, SE = south-east, and SW = south-west.

Species identification of swiftlets

No swiftlets were identified to species level with certainty during the study period and none were recovered as injured or dead birds, although two House Swifts (first: Western Australian Museum specimen A40252; second: discarded by finder) were collected post-cyclone during the study period. Additionally, no swiftlets were captured for measurements and/or genetic material, and no vocalisations were recorded. However, based on available images (Figures 5–6) and observations made during sightings of swiftlets at Entrance Point, it is likely that multiple swiftlet taxa were observed.

Table 1. Comparison of weather attributes associated with the occurrence of House Swift and swiftlets at Entrance Point, Western Australia. Standard error in parentheses.

Weather attributes	House Swift *Apus nipalensis*	Swiftlets *Aerodramus* spp.
Wind speed (km/h)		
Mean	31.8 (± 2.3)	24.7 (± 2.3)
Range	1.8–55.4	9.4–50.0
Wind gusts (km/h)		
Mean	40.7 (± 2.8)	32.9 (± 3.0)
Range	5.4–70.3	14.8–66.6
Wind direction (degrees true)		
Mean	40.8 (± 13.1)	32.4 (± 8.8)
Range	230–140	320–110
Mean sea-level pressure (hPa)		
Mean	1002.5 (± 0.7)	1002.8 (± 0.8)
Range	995.3–1010.9	1002–1008.4

Figure 5. (a) Relatively small, dark-rumped swiftlet observed at Entrance Point (6 February 2020); Western Australian Museum specimens of Edible-nest Swiftlet *Aerodramus fuciphagus micans* collected from (b) Timor, and (c) Sawu Island, Indonesia. Photos: Nigel A. Jackett

Discussion

The origin of both House Swifts and swiftlets at Entrance Point remains unresolved. However, these data support the earlier view that they are storm-driven, trans-Timor Sea visitors from Indonesia (Thorburn 2015; Johnstone & Greatwich 2018). Their occurrence in north-western Australia may be the result of expanding populations, exploratory behaviour, or involuntary movements facilitated by extreme weather events (Veit *et al.* 2022; Bozó & Csörgő 2024). The noted breeding expansion of House Swifts into Wallacea may eventually extend to the Kimberley region of Western Australia where suitable breeding habitat exists (Johnstone & Greatwich 2018).

The farming of swiftlets for their nests in Indonesia has substantially increased (Thorburn 2014), and predominates in Sumatra, Java, Kalimantan and Nusa Tenggara (Lesser Sunda Islands) (Mardiastuti 2016). Thorburn (2015) suggested that swiftlets observed in northern Australia may derive from farmed colonies in Nusa Tenggara. However, swiftlet farming is effectively confined to Lombok within Nusa Tenggara (Ani Mardiastuti pers. comm. 2024), implying that Lombok (a more distant island of Nusa

Figure 6. Row (a). Examples of Himalayan Swiftlets (likely *Aerodramus brevirostris innominatus* based on distribution) from photographs held in the Macaulay Library at the Cornell Lab of Ornithology: left to right, Zhejiang, Shanghai, Tianjin and Zhejiang in China. Row (b). *Aerodramus* swiftlets with similar structure to Himalayan Swiftlets from Broome, Western Australia: left to right, January 2017, January 2018, February 2020, and December 2020. Photos: (a), left to right, 浙江 重要鸟讯汇整, Craig Brelsford, Min Zhao and Leijun Zhuang; (b), far left, Damien Baxter, others Nigel A. Jackett

Tenggara from Australia) would be the nearest plausible source of house-farmed swiftlets reaching Kimberley shores.

Nusa Tenggara also has naturally occurring (i.e. not introduced through farming) populations of the Edible-nest Swiftlet *A. fuciphagus* – the only known breeding *Aerodramus* species of Nusa Tenggara east of Lombok. Such populations are likely to have specific cave-nesting requirements (Rheindt *et al.* 2014), and therefore may maintain their genetic (and phenotypic) distinctiveness through an absence of gene flow with building-dependent farm-swiftlets (Goh *et al.* 2018).

One subspecies of Edible-nest Swiftlet, the relatively dark-rumped *A. f. micans,* occurs from Sumba to Timor (Nusa Tenggara islands to the immediate north of the Kimberley). Phenotypically similar individuals to these Edible-nest Swiftlets have been observed at Entrance Point (e.g. Figure 5). As this taxon is the nearest *Aerodramus* to the Kimberley, it may be included in the observations.

Observations of swiftlets during the study period also involved noticeably long-winged and long-tailed individuals comparable with those of the migratory subspecies of Himalayan Swiftlet *A. brevirostris innominatus* (e.g. Figure 6). This taxon migrates between its breeding grounds in east-central and south-central China, as well as northern Vietnam, and its non-breeding grounds in South-east Asia. Although not included in *Birds of the Indonesian Archipelago: Greater Sundas and Wallacea* (Eaton *et al.* 2017), a large migratory, southward movement of ~2860 *Aerodramus* swiftlets observed in mid October in Sumatra was likely this species (Holmes 1996), perhaps intimating that a non-breeding population in Indonesia remains undiscovered.

The differences in body size between House Swift and swiftlets may explain the subtleties in occurrence at Entrance Point. House Swifts, being relatively larger-bodied and longer-winged, may have greater resistance than swiftlets to involuntary movements during adverse

weather conditions, which is supported by observations of swiftlets often occurring during relatively mild weather. Possibly, swiftlets may precede the arrival of House Swifts if weather conditions strengthen, and if the geographical origins of all the birds are the same.

Improved capacity to predict and correctly identify when these birds, especially the swiftlets, are likely to occur in north-western Australia may in turn permit opportunities to gather novel biological data (e.g. photographs, sound recordings, tracking of movements, DNA, museum specimens). The two House Swifts found either deceased or immobile in Broome following cyclones suggest that some attrition occurs during such events. Although no swiftlet corpses have yet been found, it is likely that they may suffer a similar fate during adverse weather. Specimens of these taxa are of high research value. Every effort should be made to preserve any recovered individuals, with basic metadata of locality and date recorded, for later accession to a suitable museum collection.

Although likely that the described weather associations may facilitate the occurrence of these species across much of north-western Australia, the geographic aspect of Entrance Point is exceptional, being a southern-oriented peninsula along the northern Western Australian coast (Figure 1). The north-easterly winds associated with House Swift and swiftlet observations likely concentrate individuals of these taxa at Entrance Point, whereas alternative wind directions likely result in individuals being concentrated or scattered in other locations. Identifying other unique peninsulas or landforms, and considering wind direction, may assist in the detection of these species elsewhere along the north-western coast during the passing of low-pressure systems.

The analysis of weather conditions, coupled with observations of species, provides a method for better understanding the movements of birds considered highly mobile and irregularly detected. Far from being typically *vagrant*, these results show that swiftlets of extra-Australian origin are potentially regular, and increasingly frequent, visitors to north-western Australia. Similarly, the annual occurrence of House Swift observations during the study period supports the findings of Kyne *et al.* (2022) that their frequency is increasing. However, unlike the related Pacific Swift *Apus pacificus* and White-throated Needletail *Hirundapus caudacutus*, House Swifts, or the swiftlets present in this study, do not benefit from Migratory or Threatened status under the *Environment Protection and Biodiversity Conservation Act 1999*. Davis & Watson (2018) provided recommendations for policy makers to ensure protections exist for such species. Further ecological research of these taxa, including taxonomic resolution of the swiftlets, is recommended.

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