Australian Field Ornithology 2024, **41**, 34–45
http://dx.doi.org/10.20938/afo41034045

Rapid southward range expansion of the Fairy Gerygone – a consequence of climate change?

Richard A. Noske

Centre for Biodiversity and Conservation Science, University of Queensland, St Lucia QLD 4072, Australia
Email rnoske@tpg.com.au

Abstract. Until the 1920s, the Australian range of the Fairy Gerygone *Gerygone palpebrosa* was thought to extend south from Cape York to Cardwell (18.3°S), Queensland. However, by 1981 the species was known to occur as far south as Tin Can Bay (25.9°S), and, by 1990, the Sunshine Coast (26.6°S). Sightings of individuals in the Brisbane region (27.5°S), 170 km south of Tin Can Bay, during 2011 and 2012 prompted a review of the southern range limits of the species, and consideration of causes for its southward range expansion. I collated records south of the 26°S parallel using three databases (eBird, WildNet and Atlas of Living Australia), then selected 30 sites that represented their spatial and temporal extent, noting their elevation, distance to the nearest coastline or watercourse, and vegetation according to the Regional Ecosystem classification. Sightings in the Brisbane region have been mostly along rivers or creeks emptying into Moreton Bay, suggesting that dispersal occurs southward along the coast, then inland via watercourses. Rather than being gradual, range expansion in this species has been characterised by 'leaps' of 45–59 km at intervals of 6–16 years. Since the early 1970s, at least five other tropical bird species have expanded their range southwards to Coastal Central Queensland. The most likely explanation for such range expansions is birds exploiting 'new' areas with suitable thermal regimes that have become available due to global warming. In the Fairy Gerygone, this process may be facilitated by (1) this species' partiality for forest edge and riparian habitats, and (2) reduced competition with other gerygone species due to differences in preferred habitats and bill morphology.

Introduction

Although it is well-established that many birds and other animals in the Northern Hemisphere have shifted their geographic ranges polewards in response to increasing temperatures associated with global climate change (Hickling *et al.* 2006; Hitch & Leberg 2007; Chen *et al.* 2011; Coristine & Kerr 2015; Massimino *et al.* 2015; Glushenkov 2017), evidence of this process occurring among Australian birds is scant and largely anecdotal (Chambers *et al.* 2005; Olsen 2007). Comparing reporting rates and distribution maps from the second national bird atlas (1998–2002: Barrett *et al.* 2003) with the first one (1977–1981: Blakers *et al.* 1984), Silcocks & Sanderson (2007) showed that several eastern Australian species had extended their range southwards by as much as 2–3° of latitude or 200–300 km over two decades, a rate of ~100–150 km per decade. Using modelling, VanDerWal *et al.* (2013) showed that the climatic niche spaces of 464 Australian bird species shifted by up to 7.9 km per year between 1950 and 2010, with a mean velocity of 1.27 km per year. Species with geographic ranges adjacent to the eastern coast experienced the anticipated net poleward shift but, across much of the remainder of the continent, species showed no consistent directional trend (VanDerWal *et al.* 2013).

Although range shifts imply changes at both ends of a species' range, in Australia little attention has been paid to species whose range is expanding on one front but apparently unaffected at the other. One such species is the Mangrove Gerygone *Gerygone levigaster*, whose New South Wales range expanded southwards from Tweed Heads in 1942 to Botany Bay by 1982 (Hindwood & McGill 1956; Higgins & Peter 2002). Similarly, in Victoria, the Brown Gerygone *G. mouki* was shown to have undergone a substantial southward and westward expansion of its range from East Gippsland to Melbourne between 1977 and 2009 (Appleby & O'Brien 2015).

Although widespread in New Guinea, the Fairy Gerygone *G. palpebrosa* has a restricted distribution in Australia, which until the 1920s was thought to extend from Cape York to Cardwell, Queensland. After the discovery of this species near Rockhampton, ~650 km south of Cardwell, however, Chisholm (1925, p. 165) asked, rather prophetically: "Has it been consistently working southwards…?". Much later, McGill (1970, p. 123) asserted that the distribution of the Fairy Gerygone was "slowly extending southwards", and subsequently provided details (McGill 1984). Possibly unaware of McGill's (1970) claim, Nix (1985) recorded the species around Tin Can Bay, ~380 km south-east of Rockhampton, in 1981. Nix's records constituted a significant extension of the species' known range, and were included in the first Atlas of Australian Birds (Blakers *et al.* 1984).

Higgins & Peter (2002) described the range of the Fairy Gerygone as extending south to Tin Can Bay, and made no mention of any historical change in its range. During the second national bird atlas from 1998 to 2002, however, Fairy Gerygones were recorded in all coastal 1° cells from Cape York south to, and including, the 1° cell south of Tin Can Bay (Barrett *et al.* 2003). Moreover, the reporting rate for this species had almost doubled during the 20 years between the two atlases, being the ninth highest change among the 78 species that had increased nationally (Table 10 in Barrett *et al.* 2003).

My sightings of a Fairy Gerygone in eucalypt forest in the Brisbane region, 170 km south of Tin Can Bay, during 2011 and 2012 prompted a review of the southern range limits and habitats of the species, and consideration of the cause of its southward range expansion.

Methods

Stimulated by the unexpected discovery of a Fairy Gerygone in western Brisbane in 2011–2012, and after contacting local ornithologists, I instigated a series of field trips to ascertain its current distribution, status and habitat preferences in South-east Queensland. Nine trips were made, mostly to the Sunshine Coast and hinterland from August 2015 to January 2018. As the species was established in the Hervey Bay region (25.4°S) by the 1980s (see below), I extracted online data from south of the 26°S parallel only. The following databases were accessed, with number of records to December 2021: eBird (2021; *n* = 601), Atlas of Living Australia (2021; *n* = 520) and WildNet (2021; *n* = 24). Excluding duplicated records and multiple records from the same site resulted in records for 143 sites. Additional records from 2022 and 2023 were included only if they referred to the southernmost sites where the species had been recorded previously.

Sites with different names but the same coordinates to within two decimal points of latitude and longitude (~111 m) were combined because of the possibility of errors in GPS readings. A subsample of 30 sites was selected to represent the spatial and temporal extremities of the species' range expansion, including the earliest records, outlying records in the south and west, and areas with records over several years. After locating each site using its geographical (latitude, longitude) coordinates on Google Earth, I obtained the site's approximate elevation (m above sea level) and distance (km) to the nearest coastline and nearest watercourse. Similarly, I characterised the vegetation at each site by locating it on the Queensland Globe (Queensland Government Department of Resources 2022) and obtaining its Regional Ecosystem (RE) code. If the coordinates fell in open forest or woodland, but within 100 m of closed forest, the latter was chosen as the more likely RE, given the species' preference for rainforest edges and ecotones (Higgins & Peter 2002). Descriptions of the vegetation, including dominant plant species, of each RE were extracted from Queensland Government (2022).

Results

Details of the range expansion of the Fairy Gerygone (Figure 1) are presented below in chronological order.

Range expansion before 1990

The first confirmed records of Fairy Gerygones south of Cardwell were in October 1924, during the Royal Australasian Ornithologists Union's (RAOU) annual Congress and Campout in the Rockhampton district. Here, the species was found in the "scrub" at Fairy Bower (23.42°S) and Olsen's Caves (23.15°S), near Rockhampton, as well as further north at Byfield and Yeppoon (Chisholm 1925; Wolstenholme 1925). Yet during the late 1880s, Broadbent (1888, p. 21) observed a "species of Gerygone…. at the junction of Louisa Creek with the Fitzroy [River]" that he was unable to identify. As Broadbent (1888) had also recorded the White-throated Gerygone *G. olivacea* in the region, this unidentified bird was possibly a Fairy Gerygone, as supposed by Chisholm (1925). By the early 1970s, >50 years after the RAOU sightings, the species was regarded as a common breeding resident in the Rockhampton region (Longmore 1978). Although Nix (1972, p. 119) failed to find the species "despite a keen search in all likely habitats" in the relatively pristine Shoalwater Bay Training Area, just north of Byfield, in 1971, Schodde *et al.* (1992) found it abundant to uncommon in 12 out of 27 habitat types sampled in the same area during 1991 and 1992.

Although McGill (1970) had described the southern range limit of the Fairy Gerygone as Mary River (from ~25.5 to 26.0°S), he did not provide any sources of information, and neither Storr (1973) nor Ford (1978) acknowledged the claim. However, by mid 1971, the species was known to occur on the Burnett River (25.13°S) (Eric Zillman & Stephen Garnett pers. obs.) and Duingal Creek, Booyal (25.22°S) (WildNet 2021), and, in 1972 and 1973, was reported from lowland rainforest in the Gin Gin area (24.98–25.02°S) (eBird 2021; WildNet 2021), west of Bundaberg. Further north, the Australian Museum Rainforest Fauna Survey found it at Rundle Range (23.48°S) and Eurimbula (24.18°S) in 1975 (Nix 1985), and, in the following year, it was described as 'common' at Lowmead (24.53°S) (Roberts 1976). These records were apparently accepted by Storr (1984) who, in his revised Queensland bird list, mentioned Lowmead and Gin Gin as within its range. In 1976, it was also recorded at the Causeway Swamp on the coast in Woodgate National Park (25.17°S) (WildNet 2021).

In November 1981, Nix (1985) found the Fairy Gerygone at Seventeen Seventy (24.17°S) and Baffle Creek (24.35°S) and, using call-playback, attracted pairs at three sites along the Great Sandy Strait, just north of Tin Can Bay (25.82–25.90°S). Of the nine Queensland Bird Reports covering the years from 1983 to 1991, however, only two list the species, and both records were from the Hervey Bay area (25.27–28.00°S), well north of Tin Can Bay (Redhead 1988; Britton 1992). Interestingly, the species was *not* recorded around Maryborough (25.53°S) between 1972 and 1980 (Jones 1981).

Post-1990 range expansion between 26 and 27°S

The first published sightings south of the 26°S parallel were in 1990, when Fairy Gerygones appeared simultaneously on the Sunshine Coast and in the subcoastal hinterlands of the Noosa and Gympie regions to the north and west, respectively. Although the first record on the Sunshine Coast was from the mouth of the Maroochy River (26.64°S; Figure 1, Table 1) in November 1990, this species was not recorded again at this site until 27 years later, in October 2017 (eBird 2023). In September 1990, it was also sighted on a rural property along Bunneys Lane, Kin Kin (26.24°S; Figure 1), 18 km east of Gympie, where the species was seen almost annually until 2000, when surveys ceased (N. Marr in Muir 1993; Marr & Hembrow 1998 in WildNet 2021; ALA 2021).

Eight years later, in October 1998, it was reported from Upper Widgee (26.21°S, 152.43°E), 23 km west of Gympie (WildNet 2021). This site differed from previous records in being situated 64 km inland from the nearest coastline (Figure 1, Table 1). In the following year (April 1999), it was reported from Eumundi State Forest (now Eumundi

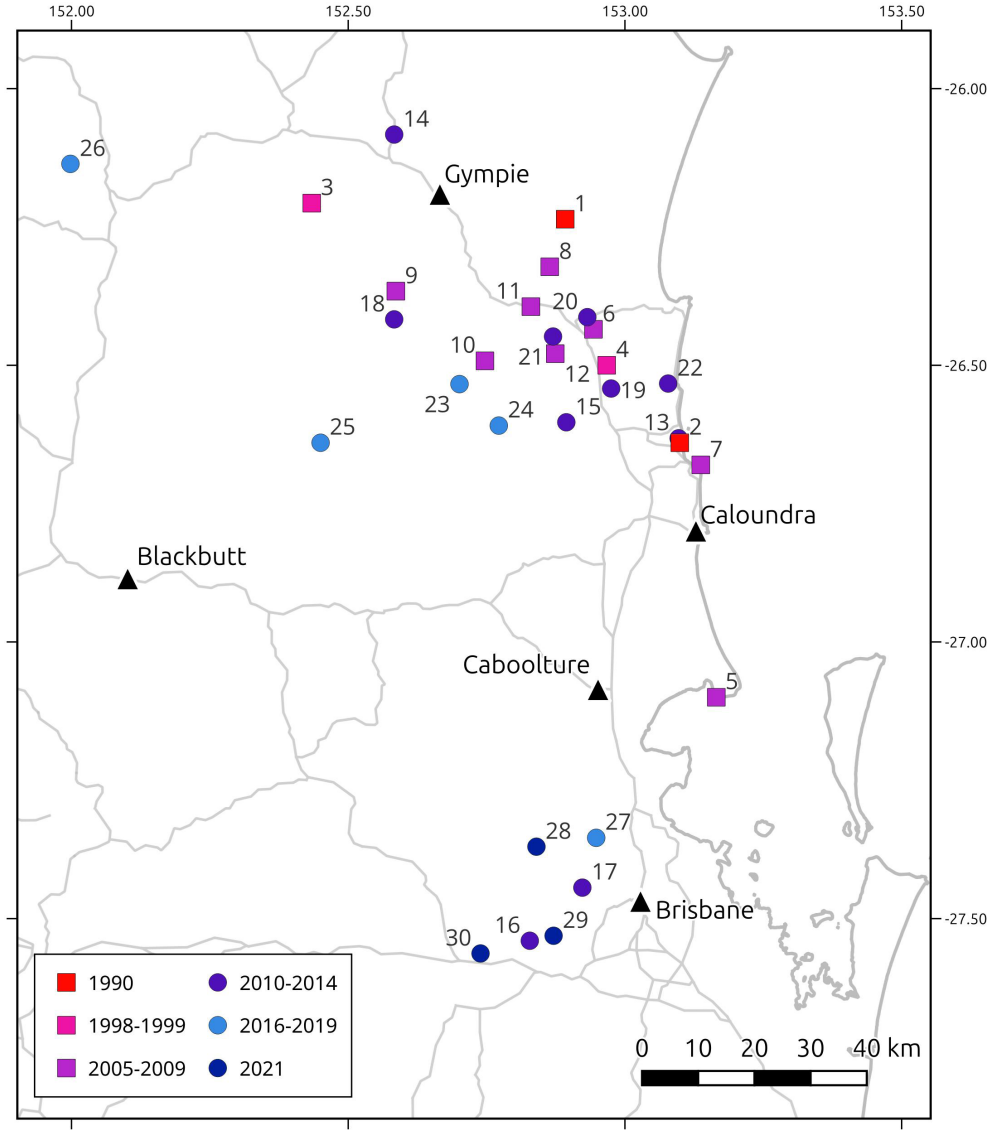

Figure 1. Map of South-east Queensland between latitudes 26 and 28°S, showing earliest known records of Fairy Gerygones from each site (for site numbers refer to Table 1). Intervals are of 4–5 years from 2005 to 2019, but any records during 1991–1997 and 2000–2004, as well as 2015 and 2020, are not shown.

Conservation Park) (26.50°S, 152.97°E), 44 km south-east of Gympie (ALA 2021) (Figure 1, Table 1). The next new sites were also from the Gympie region. In October 2003, a Fairy Gerygone was observed during a Birds Queensland campout at Numabulla Farm (26.49°S), Brooloo, 39 km from the coast (Crossley 2004) and, in June 2005, another was recorded on Lukes Road, Cooroy (26.44°S) (Wildlife Queensland Sunshine Coast & Hinterland Inc. 2021).

In June 2006, the species was found at Point Cartwright, Mooloolaba (26.68°S), a small peninsular headland, where two to six indicuduals have since been reported almost annually (Figure 1, Table 1). Despite the small area of dense dune vegetation (~2.5 ha) and its distance from the nearest patch of suitable coastal vegetation (~6 km to the mouth of the Maroochy River by land), sightings of fledglings (RAN pers. obs.) indicate that this small isolated population is breeding and probably self-sustaining. By 2010, the species was known to be widespread on the Sunshine Coast (G. Roberts pers. comm.), such as at Twin Waters Resort, Mudjimba (26.63°S; Figure 1, Table 1), where three singing pairs were counted in August 2010 (eBird 2021: S19336157) and six pairs along a 3-km stretch in January 2012 (Roberts 2012).

Although the Fairy Gerygone had been recorded well inland in the Gympie region as early as 1998 (Upper Widgee: see above; Figure 1, Table 1), it was another 10 years before further sightings were reported there. Two years after bird banding began on a private property off Spiller Road, Imbil (26.49°S), 35 km from the nearest coast, two Fairy Gerygones were captured and banded in 2009, when they were heard infrequently in one or two locations only (J. Coleman *in litt.*). Since then, up to six birds have been caught annually, and the species has been observed in all parts of the property, though mostly in riparian or gallery rainforest (J. Coleman *in litt.*). Nesting of at least two pairs was confirmed in November 2020 (P. Lloyd *in litt.*).

Further west, single sightings were made at Curra (26.08°S), 52 km inland from the nearest coastline, and at Bella Creek (26.42°S), 49 km inland, in 2010 and 2013 (eBird 2021), respectively (Figure 1, Table 1). At Kempwood Cottage (26.45°S) near Cooroy, 22 km from the nearest coast, one pair has been reported annually since 2014, with >170 records representing 64 months over the following 8 years. More recently, the species was reported from Taabinga (26.59°S, 151.81°E;

Table 1. Locational characteristics, elevation and Regional Ecosystem (RE) represented at 30 selected sites of Fairy Gerygone records in South-east Queensland. NE = north-east, SE = south-east, SW = south-west; na = not applicable. See Table 2 for abbreviations for REs.

Site no.	*Year of first record*	*Latitude (°S)*	*Longitude (°E)*	*Site name*	*Distance to coast (km)*	*Distance to water (km)*	*Elevation (m, asl)*	*RE*
1	1990	26.236	152.892	Kin Kin, Bunneys Lane	11	0.1	38	NVA
2	1990	26.640	153.099	Mouth of Maroochy River	0.1	na	8	DUN
3	1998	26.207	152.434	Upper Widgee	64	0.1	101	RIP
4	1999	26.500	152.967	Eumundi Conservation Park	40	0.1	13	GAR
5	2005	27.100	153.165	Bribie Island, Red Beach	0.3	na	8	PAF
6	2005	26.435	152.943	Cooroy, 4 km SE	15	0.1	114	NVA
7	2006	26.680	153.137	Point Cartwright	0.1	na	10	DUN
8	2007	26.322	152.864	Old Pinbarren School	20	0.1	100	GAR
9	2007	26.366	152.586	Amamoor Forest Road	46	0.1	120	GAR
10	2009	26.492	152.747	Imbil, Spiller Road	35	0.2	99	GAR
11	2009	26.394	152.830	Pomona, 4 km SW	24	0.1	130	NVA
12	2009	26.479	152.874	Cooroy, 7 km SW	22	0.6	145	NVA
13	2010	26.632	153.097	Mudjimba	0.4	0.1	10	PAF
14	2010	26.083	152.583	Curra	52	0.1	72	EUC
15	2010	26.603	152.894	Mapleton, 4 km NE	20	0.1	221	GAR
16	2011	27.540	152.828	Karana Downs	35	0.4	23	RIP
17	2012	27.444	152.923	Araucaria Track	20	0.8	95	NVA
18	2013	26.417	152.583	Bella Creek	49	0.6	150	NVA
19	2013	26.542	152.975	Ninderry	12	1.2	35	GAR
20	2014	26.413	152.932	Cooroy, Gum Tree Drive	15	0.1	100	GAR
21	2014	26.448	152.870	Kempwood Cottage	22	1.0	179	NVA
22	2014	26.533	153.078	Stumers Creek, Coolum Beach	1.4	0.1	10	PAF
23	2016	26.534	152.701	Brooloo, Bellbird Hollow	39	0.5	142	GAR
24	2016	26.609	152.772	Coolabine, Mary Valley Vista	33	0.3	150	NVA
25	2018	26.640	152.450	Peach Trees, Winch Gully	65	0.2	490	NVA
26	2019	26.136	151.998	Nangur National Park	104	na	306	MVF
27	2019	27.354	152.948	Bunya Crossing Reserve, Bunya	13	0.1	20	CVF
28	2021	27.370	152.840	Samford, Greenwood Crescent Park	24	0.1	73	CVF
29	2021	27.531	152.871	Hawkesbury Road Nature Refuge	31	0.2	65	AMV
30	2021	27.563	152.739	Kholo Gardens, Muirlea	43	0.1	30	EUC

~460 m asl), near Kingaroy, 128 km inland from the coast, and at Nangur National Park, 104 km from the coast (26.14°S; Figure 1, Table 1) in 2017 and 2019, respectively (eBird 2021).

Range expansion south of 27°S (Brisbane region)

Between Dularcha National Park, just west of Caloundra, and Greater Brisbane, there is a gap of ~30 km to a cluster of records at the southern end of Bribie Island and Toorbul high-tide wader roost on the adjacent mainland. Although the species was first recorded in the seasonally inundated paperbark forest behind Red Beach (27.09°S; Figure 1, Table 1), Bribie Island, in April–May 2005 (Figure 2; eBird 2021), it was not seen there again until September–October 2013, 7.4 years later, when two birds were regularly recorded until March 2014. After another gap of 6.6 years, in October 2020, another pair appeared in the same location as the latter birds. One or both of these birds remained in the area until at least June 2021, and another was re-sighted in March 2022, but there has been no evidence of breeding. However, although this area and several other hotspots are visited frequently by birdwatchers, most of the northern half of Bribie Island

Figure 2. Male Fairy Gerygone, Red Beach, Bribie Island, 23 April 2005. Photo: Tom Tarrant

Figure 3. Male Fairy Gerygone, Enoggera Reservoir, Brisbane, 31 October 2012. Photo: Richard A. Noske

remains unexplored, providing the possibility that the species has already established a breeding population.

The Fairy Gerygone was first reported from Greater Brisbane on 20 November 2011, when one bird was seen on a private property in eastern Karana Downs (27.54°S; Figure 1, Table 1), only 400 m from the Upper Brisbane River (D. Stewart & S. Gillman pers. comm.). Six months later, on 30 May 2012, I saw an adult male (Figure 2) along the Araucaria Track (27.44°S) on the edge of Enoggera Reservoir at the headwaters of Enoggera Creek. This creek meanders ~20 km before emptying into the Brisbane River, ~15 km from its mouth in Moreton Bay. Although not encountered during surveys over the following 5 months, a Fairy Gerygone (presumably the same individual) was re-sighted and photographed ~400 m from the previous location on 31 October 2012 (Figure 3), but was not seen again over the following 24 monthly surveys.

After a hiatus of 7 years, a pair was discovered at Bunya Crossing (27.35°S; Figure 1, Table 1) on the middle reaches of the South Pine River, ~10 km north-north-east of the Enoggera Reservoir sites, on 11 September 2019. Here this pair inhabited a small area (<2 ha) of degraded rainforest and riparian woodland for at least 8 months, during which the female was seen carrying nest material twice (pers. obs.), but no nest was found. One year later, a Fairy Gerygone was found at Greenwood Crescent Park (27.37°S; Figure1, Table 1), Samford, also on the Upper South Pine River, 11 km west of Bunya Crossing (18 km upstream by river), on 20 September 2021. In the following month, another bird was observed from 8 to 15 October 2021 (A. Jensen pers. comm.) on the edge of the suburb of Griffin within 200 m of Freshwater Creek, a 20-m-wide creek that empties into Hays Inlet, ~1.5 km north of the Pine River mouth. On 6 August 2022, a Fairy Gerygone was found and photographed at Tinchi Tamba Wetlands Reserve (eBird 2023: S116407515), ~3.5 km from the mouth of the Pine River at Hays Inlet (4.9 km due south of the Freshwater Creek site), and by 2 September 2023, two were present (eBird 2023: S148737618).

A decade after the first Fairy Gerygone was discovered in the Brisbane region at Karana Downs (see above), single birds appeared at two sites within 10 km of the original site. One was present from 6 to 22 May 2021 at Kholo Gardens, only 200 m from the banks of the Brisbane River, and the other from 22 September to 11 October 2021 at Hawkesbury Road Nature Refuge, ~2 km from the river (Figure 1, Table 1). Together with Karana Downs, these sites mark the southern boundary of the species to date (at ~27.5°S). All four sites are situated close to a straight line of 22 km between Enoggera Reservoir and Kholo Gardens.

Just over a decade after a Fairy Gerygone was last sighted at Enoggera Reservoir (see above), a female was sighted on 14 January 2023, only ~160 m from the October 2012 site (eBird 2023; S126085039). Finally, from 10 to 12 May 2023, a bird was photographed on the South Pine River at Kumbartcho Sanctuary (eBird 2023, e.g. S137166312), only ~500 m upstream from the Bunya Crossing site, where there was a pair 3 years earlier.

Of the 143 sites south of the 26°S parallel, 65 (45%) had multiple records, of which 45 spanned >6 months of regular sightings. The maximum period of records for a single site (Maroochy River mouth, 26.64°S) was 27 years.

Characteristics of selected sites

The elevation of the 30 selected sites ranged from 8 to 490 m asl (mean 101.9 m ± standard error 18.6 m) and distance from the nearest coast was 0.1–104 km (mean 28.5 ± 4.2 km) (Figure 4). The elevation of each site was not significantly correlated with its distance from the coast (r = 0.622, df = 28, P >0.05). The majority (84%) of non-coastal sites (n = 25) were situated 50–800 m (mean ± standard deviation: 209 ± 232 m) from a watercourse.

The most frequently represented vegetation community was notophyll vine forest (Tables 1, 2), either with Hoop Pine *Araucaria cunninghamii* as a common emergent (30%), or along watercourses, where it formed gallery rainforest (26.7%). Sites in the former community occurred at a wide range of altitudes (38–490 m asl) and distances from the coast (11–65 km), whereas those in the latter were slightly more restricted in altitude (13–221 m asl) and distances from the coast (12–46 km). An additional four sites (13.3%) were classified as microphyll vine forests, including the site that was furthest from the coast (Tables 1, 2). Of five coastal sites on sandy soils, three were in wetlands overwhelmingly dominated by tall Broad-leaved Paperbarks *Melaleuca quinquenervia*, and two comprised low forests or thickets on sand dunes, often dominated by Tuckeroo *Cupaniopsis anacardioides*. Three

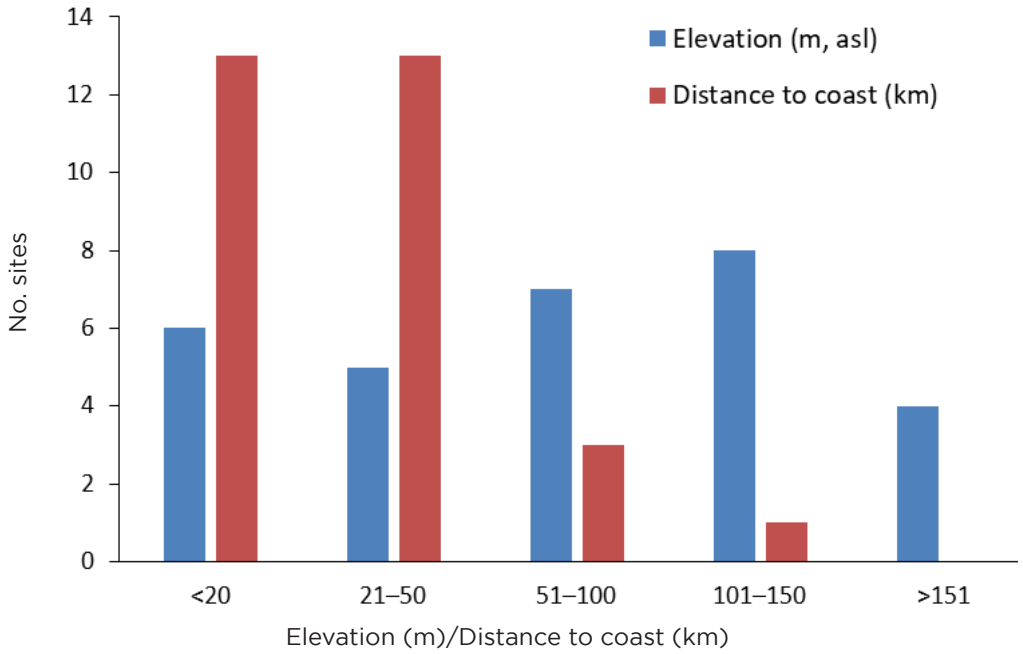

Figure 4. Elevation (m above sea level) and distance from nearest coast (km) of 30 selected sites with Fairy Gerygones in South-east Queensland.

Table 2. Description of Regional Ecosystems (RE) at 30 selected sites of Fairy Gerygone records in South-east Queensland. Full names of plants and abbreviations are listed in Appendix 1.

RE abbreviation	*No. sites*	*RE*	*RE description*	*Plant species abbreviations*
NVA	9	12.11.10	Notophyll vine forest	Arc, Art, Beo, Brd, Dib, Dip, Gml, Grr
GAR	8	12.3.1a	Gallery rainforest (complex notophyll vine forest)	Art, Beo, Caa, Cro, Dym, Elg, Fim, Fiw, Grr, Syf, Toc
PAF	3	12.2.7	Paperbark open forest on sand plains	Meq
RIP	3	12.3.7/7b	Narrow fringing woodland	Cac, Eut, Waf
DUN	2	12.2.14	Strand and fore dune low open forest	Acd, Aci, Cae, Cup, Hit
CVF	2	12.3.16	Complex notophyll to microphyll vine forest	App, Art, Dif, Drd, Dym, Jap, Mad, Mea, Plp, Toc
AMV	1	12.11.11	Araucarian microphyll vine forest on metamorphics	Arc, Cup, Dep, Dig, Drd, Exd, Gob, Rhr, Fla, Olp, Vil
MVF	1	12.8.13	Microphyll vine forest ± Hoop Pine	Arc, Cup, Dep, Dig, Drd, Exd, Fla, Gob, Olp, Vil
EUC	1	12.9/10.2	Open eucalypt forest on sedimentary rocks	Coc, Euc

inland sites were classified as narrow fringing woodland, dominated by River She-oak *Casuarina cunninghamiana* and/or Forest Red Gum *Eucalyptus tereticornis.*

Discussion

Characteristics of range expansions in Fairy Gerygone and other gerygone species

Historical and recent records clearly indicate that the Fairy Geryone has been expanding its range southward since at least the early 1970s. This expansion is consistent with predictions based on the species' modelled climatic envelope, which shows habitat suitability declining markedly on Cape York Peninsula (Reside *et al*. 2016) while increasing along the coast in the south of its range, extending into northern New South Wales (modelling underlying Garnett & Franklin 2014; D. Franklin pers. comm.). Using the earliest confirmed records for three localities, the velocity of its spread from Rockhampton (by 1924) to Gin Gin (1973) was 5.1 km per year, and from Gin Gin to Bribie Island (2005) 8.7 km per year, with a combined velocity of 6.5 km per year over the total distance of 528 km. These velocities are much higher than the mean velocity of the shift in climatic niche space estimated for the species sampled by VanDerWal *et al*. (2013).

However, the range expansion of the Fairy Gerygone has not been linear in space or time (Figures 1, 5). Instead, it appears to have progressed in spatial and temporal

Figure 5. Year of first records of Fairy Gerygones at 143 sites south of 26°S.

'leaps', rather than in gradual increments, as indicated by the earliest record from the Sunshine Coast at the Maroochy River mouth (26.6°S) in the same year (1990) as the earliest record from the Gympie region (Bunneys Lane, Kin Kin, 26.2°S), ~50 km to the north. Similarly, the first record from Bribie Island (2005) came within 14 months of only the second report of the species from the Sunshine Coast, at Point Cartwright (2006), 46 km to the north. Thus, there was a lag of 16 years between the first reports from Maroochy River mouth and Point Cartwright, despite these sites being only ~5 km apart. The first records from the Brisbane region, at Karana Downs and Enoggera Reservoir, were only 6 months apart (2011–2012), yet 45–59 km south-south-west, respectively, of the Bribie Island site. Thus 'leaps' of 45–59 km apparently occurred at intervals of 6–16 years.

In addition, rather than populations becoming established soon after sites were first 'colonised', 7–10 years would typically pass between sightings at several of the southernmost sites. At Bribie Island, there was a remarkably consistent gap of *c*. 7 years between the first and second, and second and third records. The gap between the first two records in the Brisbane region (Enoggera Reservoir and Karana Downs) and the third (Bunya Crossing) was also 7 years. Finally, the intervals between the second and third sightings at Enoggera Reservoir, and between the Karana Downs and Hawkesbury Road Nature Refuge (4.4 km away) sites, were 10 years. The question of whether the timing of these 'leaps' is related to weather events is beyond the scope of this report.

Significantly, the range expansion of the Fairy Gerygone appears to be occurring along two fronts: firstly, southward along the coast, using littoral vine thickets and subcoastal rainforests; and, secondly, inland, probably following watercourses upstream, using riparian vegetation. The first record from the Gympie region (Bunneys Lane, Kin Kin, 152.9°E) in 1990 preceded reports from Gympie and sites to the west by 8–20 years (Upper Widgee: 152.4°E, 1998; Brooloo: 152.7°E, 2003; Imbil: 152.7°E, 2009; Curra: 152.6°E, 2010). Most sites in the Brisbane region to date are along the South Pine and Brisbane Rivers, suggesting that the birds use such watercourses as dispersal routes or corridors. Although the upper South Pine River is only 10–30 m wide, it is typically fringed by River She-oak and Weeping Lilly Pilly *Waterhousea floribunda* with an understorey of rainforest plants, providing a narrow corridor through the largely cleared urban and semi-rural landscape.

Range expansions have been recorded in two other *Gerygone* species, suggesting that members of this genus are more adaptable than other small insectivorous Australian passerines, possibly reflecting their apparently rapid and relatively recent speciation (Nyári & Joseph 2012). Since at least the mid 1930s, the Mangrove Gerygone has been expanding its range southward along the New South Wales coast (Hindwood & McGill 1956; Blakers *et al.* 1984; McGill 1984; Higgins & Peter 2002). The first definite record in New South Wales was at Brunswick Heads (28.5°S) in 1936, by which time the species was already common (Cooper *et al.* 2016). By 1944, it had reached Macksville (30.7°S) and, by 1982, Kurnell in Botany Bay (34.0°S) (McGill 1984), expanding its range southwards at an average rate of 9.6 km per year. Unlike the southwards expansion of the Fairy Gerygone reported in the present paper, however, the progression of the Mangrove Gerygone has been incremental, with no obvious 'leaps'. This may be related to that species' specialised habitat of mangroves, which are distributed more or less continuously along the coast, whereas much of the coastal vine thicket habitat of the Fairy Gerygone has been cleared for urban development. In Victoria, the Brown Gerygone was thought to be restricted to East Gippsland until the late 1970s, when it appeared at an increasing number of sites to the south and west as far as Melbourne (Appleby & O'Brien 2015). Moreover, new populations at western sites occupied habitats that differed in vegetation type, structure, composition and naturalness

from those typically occupied in East Gippsland (Appleby & O'Brien 2015).

Although many sites in the Brisbane region have supported Fairy Gerygones over periods of ≥6 months, there appear to be no confirmed breeding records south of Point Cartwright (26.7°S). One factor that might conceivably hinder successful breeding and the establishment of breeding populations of Fairy Gerygones on the southern edge of their range is brood parasitism, as this species is a major host of the highly host-specialised Little Bronze-Cuckoo *Chalcites minutillus* in tropical parts of Queensland (Brooker & Brooker 1989). In South-east Queensland, the major host (historically) of this cuckoo is the eucalypt-woodland-inhabiting White-throated Gerygone, and there are few records of brood parasitism by this cuckoo of either the Brown Gerygone or Mangrove Gerygone (Brooker & Brooker 1989), which principally inhabit rainforest and mangroves, respectively. As the Fairy Gerygone shares some habitats with the White-throated Gerygone, it is conceivable that as the former colonises new areas in South-east Queensland it will be increasingly parasitised by the Little Bronze-Cuckoo.

Other tropical species exhibiting southward range expansions

Briggs & Noske (2021) presented evidence that five tropical bird species have expanded their ranges southwards into the Rockhampton region of Central Queensland since the early 1970s when Longmore (1978) resided there. Three are sedentary and strongly associated with mangroves (Little Kingfisher *Ceyx pusillus*, Mangrove Golden Whistler *Pachycephala melanura* and Broad-billed Flycatcher *Myiagra ruficollis*), whereas the other two (Buff-breasted Paradise-Kingfisher *Tanysiptera sylvia* and Bar-breasted Honeyeater *Ramsayornis fasciatus*) are associated with rainforest and paperbark swamps, respectively. Reports of the Broad-billed Flycatcher as far south as the Sunshine Coast (Menkhorst *et al.* 2017) suggested that this species may still be expanding its range southwards. As McAllan *et al.* (2007) pointed out, the southward expansion of mangrove birds, including the Mangrove Honeyeater *Gavicalis fasciogularis*, has undoubtedly been facilitated by the southward expansion of mangroves (e.g. Fazlioglu *et al.* 2020), probably at least partly because of increased sedimentation of estuaries caused by erosion from agricultural clearing, as well as an increase in rainfall. In addition, mangroves have been extending inland, invading saltmarshes, because of a slight rise in sea level because of global warming (Saintilan & Williams 1999).

The southern limit of the migratory Buff-breasted Paradise-Kingfisher was thought to be Paluma Range (19.2°S) until the early 1980s when it was found west of Mackay (21.1°S: Nix 1984), then Byfield (22.8°S), where ~20 pairs are now known to breed (Briggs & Noske 2021). The Bar-breasted Honeyeater was first recorded in the Rockhampton region in 1975 (Longmore 1978), yet by 1999 was present at five sites, and by 2019, at >30 sites, including some in the city of Rockhampton itself (Briggs & Noske 2021). Although it is possible that the absence of early records of these species from the region may be because of the small number of birdwatchers, it is unlikely that so many species would have been overlooked in previous surveys and studies.

Finally, in 2012 a resident breeding population of the Large-tailed Nightjar *Caprimulgus macrurus*, a widespread but largely tropical species, was discovered in the estuarine wetlands of the Maroochy River, Sunshine Coast, >60 km south of its previously published distributional limit (Gynther 2015). Since then, this species has been recorded numerous times in the region and, in 2022, was recorded at Donnybrook, a further 43 km south (eBird 2023). Gynther (2015) argued that it was unlikely to have been overlooked by observers before its recent discovery because of its distinctive and loud incessant call, and the relatively large human population in the Sunshine Coast, including many bird observers. This argument also applies to the Fairy Gerygone, especially given the greater number of birdwatchers in the Brisbane region.

Habitat considerations and conclusions

Unlike most of the above species, the Fairy Gerygone has relatively broad habitat requirements, which Higgins & Peter (2002) summarised as mainly rainforest edges and ecotones between rainforest and other habitats, as well as gallery rainforest. This predilection for habitat edges and riparian corridors (which by their nature are narrow and linear) undoubtedly facilitates this species' capacity for dispersal and the colonisation of new sites. Near Cooktown, North Queensland, Johnson & Mighell (1999) found it in tall riverine rainforest, wet and dry sclerophyll (open) forest, and rainforest edge, but not inside rainforest. Indeed, Ford (1978) considered extensive blocks of rainforest as an ecological barrier to its dispersal. Although 21 (70%) of the 30 selected sites in South-east Queensland in the present study were classified as notophyll or microphyll vine forest (or rainforest) (Table 2), it is possible that the Fairy Gerygones mostly occupied the edges.

Only one of the selected sites was classified as Open Eucalypt Forest, but this habitat may be under-represented because of my bias in selecting closed forest if it was close to the site's grid coordinates. Around Tin Can Bay, Nix (1985) mostly encountered the species in coastal vine thickets, but he also found it in open forest dominated by Forest Red Gum, Pink Bloodwood *Corymbia intermedia*, cypress pine *Callitris* sp. and *Lophostemon* sp. The habitat at Freshwater Creek and Tinchi Tamba near Hays Inlet (see Results above) was also open forest dominated by Forest Red Gum and Swamp She-oak *Casuarina glauca* with an understorey of rainforest plants, but was also adjacent to paperbark forest (pers. obs.). Other habitats not mentioned by Higgins & Peter (2002) were Paperbark Open Forest (n = 3) and Strand and Fore Dune Low Open Forest (n = 2). However, Hall (1974, p. 170) recorded the species in "tea-tree forest" at Cape Gloucester, north of Proserpine, and this probably refers to paperbark forest. At Shoalwater Bay Training Area, two of the 12 habitats occupied by Fairy Gerygones were classified as Dune Mesophyll Scrub and Dune Sclerophyll Scrub (Schodde *et al.* 1992), but they were dominated by tea-trees, eucalypts and acacias, rather than vine-thicket species. Thus, Strand and Fore Dune Low Open Forest may well represent a novel habitat for the species, possibly indicating habitat lability at the colonisation front.

Lack of interspecific competition in its preferred habitats may have played an important role in enabling range expansion of the Fairy Gerygone. The most likely

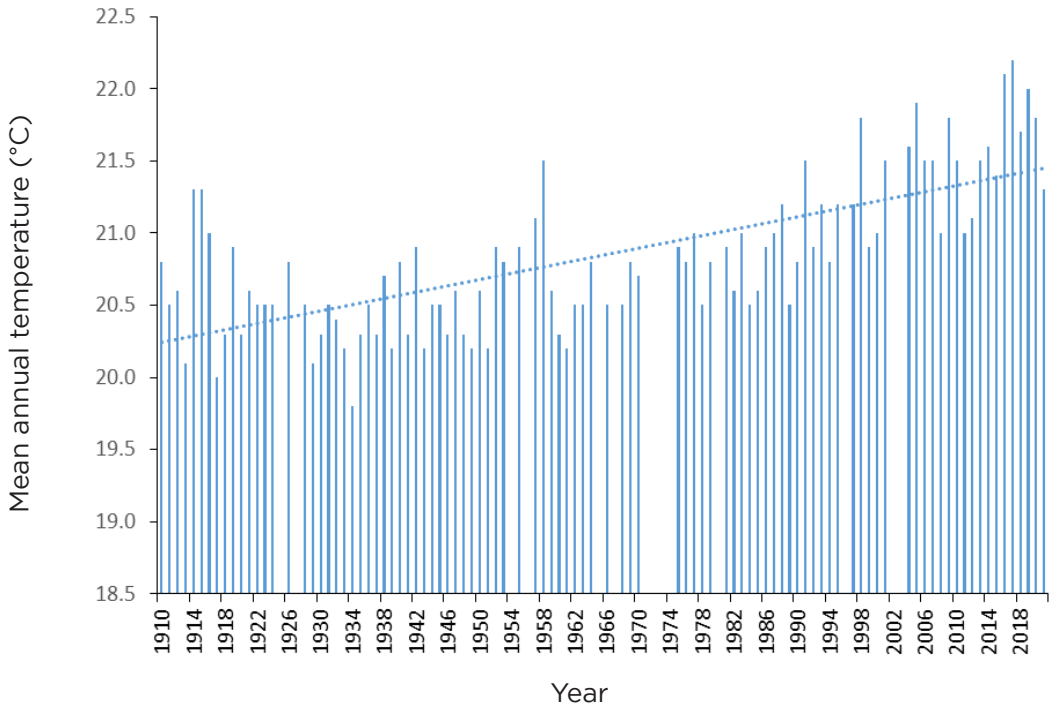

Figure 6. Mean annual temperature from 1910 to 2021 at Cape Moreton, near Brisbane, Queensland.

candidates for such competition are the broadly sympatric, congeneric Brown Gerygone, White-throated Gerygone and Mangrove Gerygone, yet as these species are mainly associated with different habitats (rainforest, eucalypt forests and mangroves, respectively) from those preferred by the Fairy Gerygone, competition would probably be rare. Moreover, apart from the strictly tropical Large-billed Gerygone *G. magnirostris*, the Fairy Gerygone has the longest bill of the eight species of gerygones in Australia, as well as the longest rictal bristles, apart from the Brown Gerygone (Keast & Recher 1997). These features suggest that the Fairy Gerygone can exploit a broader range of prey types and sizes than its congeners, further reducing potential interspecific competition.

As mentioned previously, the reporting rate for this species almost doubled during the 20 years between the two Australian bird atlases. The 'change map' for the species (Appendix 4 in Barrett *et al.* 2003) indicates an increase of >20% in the Cape York, Central Mackay Coast, Brigalow Belt North and South Brigalow bioregions, but a decrease of >20% in the Einasleigh Uplands, and no change in the Wet Tropics. Perhaps not coincidentally, bioregions where the species increased have also experienced some of the highest vegetation clearing rates in Queensland. The Brigalow Belt, in particular, has lost two-thirds of its original vegetation cover, primarily from the dominant eucalypt woodlands and open forests, but also from Brigalow *Acacia harpophylla* forest and rainforest (Noske & Briggs 2021; Accad *et al.* 2023). Within this bioregion, the Rockhampton region has suffered the local extinction or decline of 22 bird species, 11 of them associated with eucalypt forest or woodland, and six with rainforests (Noske & Briggs 2021). Although deforestation has almost certainly played a major role in the regional loss and decline of these species, it might have (ironically) favoured the Fairy Gerygone with its preference for forest edges, which would have increased substantially as forest remnants decreased in size.

Although the number of bird observers and reporting rates in Queensland have risen in the last two decades, especially in South-east Queensland (e.g. Noske & Niland 2022), it is doubtful that this factor alone could have been responsible for the relatively recent discovery of Fairy Gerygones in the Brisbane region. Instead, it seems likely that this species has gradually expanded its range southward because of an increase in areas with a suitable climatic regime, resulting from a rise in temperatures, both regionally and globally. Australia's climate has warmed by an average of 1.47 ± 0.24 °C since national records began in 1910 (Bureau of Meteorology 2023). The climate change network site at Cape Moreton, 66 km north-east of Brisbane city, shows a highly significant trend of increasing annual mean temperatures from 1910 to 2021 (Figure 6). With ongoing global warming predicted, the Fairy Gerygone may be expected to continue expanding its range southwards towards the New South Wales border, and eventually into northern New South Wales, where there appears to be ample suitable habitat. Monitoring of populations in northern Queensland, especially on Cape York Peninsula, is also desirable in view of the predicted decline in that region (Reside *et al.* 2016) and the possibility that their southward expansion is concomitant with a retraction in the north.

Acknowledgments

I am very grateful to Rob Kernot and Sue Lee for showing me locations of Fairy Gerygones in the Sunshine Coast hinterland, and to Greg Roberts for the initial information on the bird's status on the Sunshine Coast. Many thanks go also to Greg Nye, Niven McCrie, Sarah Beavis and Phil Robson for assisting with nine 'Fairy Hunts' in that region between August 2015 and January 2018. Thanks go also to Rod Gardner, Peter Storer, Andy Jensen and Ged Tranter for showing me the sites of their recent Fairy Gerygone sightings in the Brisbane region. Fauna Watch data were supplied by Rob Kernot. Mat Gilfedder provided initial advice on eBird records, and Dan Kelman, Queensland Herbarium, was

very helpful on the use of the Queensland Globe. The map was kindly drawn by Ofalia Ho. Don Franklin provided information on predictions from the modelled climatic envelope of the species. Finally, I thank Stephen Garnett and George Appleby for their comments on an earlier version of this paper.

References

Accad, A., Kelley, J.A.R., Richter, D., Li, J., Neldner, V.J. & Ryan T.S. (2023). *Remnant Regional Ecosystem Vegetation in Queensland (Version 13.0), Analysis 1997-2021*. Queensland Department of Environment & Science, Brisbane.

ALA (Atlas of Living Australia) (2021). Open access to Australia's biodiversity data. Available at https://www.ala.org.au (accessed 15 December 2021).

Appleby, G. & O'Brien, M. (2015). An expansion of the range of the Brown Gerygone in Victoria, 1977–2009. *Australian Field Ornithology* **32**, 26–37.

Barrett, G., Silcocks, A., Barry, S., Cunningham, R. & Poulter, R. (2003). *The New Atlas of Australian Birds*. Royal Australasian Ornithologists Union, Melbourne.

Blakers, M., Davies, S.J.J.F. & Reilly, P.N. (1984). *The Atlas of Australian Birds*. Melbourne University Press, Melbourne.

Briggs, A. & Noske, R.A. (2021). The avifauna of Rockhampton revisited after 45 years: Additions, deletions and a checklist covering 135 years. *Sunbird* **49**, 1–39.

Britton, P.L. (1992). The Queensland Ornithological Society Bird Report, 1991. *Sunbird* **22**, 51–83.

Broadbent, K. (1888). Birds of the central part of Queensland. *Proceedings of the Royal Society of Queensland* **5**, 14–31.

Brooker, M.G. & Brooker, L.C. (1989). Cuckoo hosts in Australia. *Australian Zoological Reviews* **2**, 1–67.

Bureau of Meteorology (2023). Climate data. Available at: http://www.bom.gov.au/climate/data (accessed 20 November 2023).

Chambers, L.E, Hughes, L. & Weston, M.A. (2005). Climate change and its impact on Australia's avifauna. *Emu* **105**, 1–20.

Chen, I-C., Hill, J.K., Ohlemüller, R., Roy, D.B. & Thomas, C.D. (2011). Rapid range shifts of species associated with high levels of climate warming. *Science* **333**, 1024–1026.

Chisholm, A.H. (1925). The Fairy Warbler: A re-discovery. *Emu* **24**, 161–165.

Cooper, R.M., McAllan, I.A.W., Brandis, C.C.P. & Curtis, B.R. (2016). *An Atlas of the Birds of New South Wales and the Australian Capital Territory*, *Volume 2 – Comb-crested Jacana to Striated Pardalote*. NSW Bird Atlassers Inc., Sydney.

Coristine, L.E. & Kerr, J.T. (2015). Temperature-related geographical shifts among passerines: Contrasting processes along poleward and equatorward range margins. *Ecology and Evolution* **5,** 5162–5176.

Crossley, G. (2004). Outing and campout reports: Numabulla. *Birds Queensland Newsletter* **35** (2), 6.

eBird (2021). eBird: An online database of bird distribution and abundance. Cornell Lab of Ornithology, Ithaca, New York, USA. Available at: http://www.ebird.org (accessed 15 December 2021).

eBird (2023). eBird: An online database of bird distribution and abundance. Cornell Lab of Ornithology, Ithaca, New York, USA. Available at: http://www.ebird.org (accessed 20 November 2023).

Fazlioglu, F., Wan, J.S.H. & Chen, L. (2020). Latitudinal shifts in mangrove species worldwide: Evidence from historical occurrence records. *Hydrobiologia* **847**, 4111–4123.

Ford, J. (1978). Conspecificity of the Black-throated and Fairy Warblers. *Emu* **78**, 75–79.

Garnett, S. & Franklin, D. (Eds) (2014). *Climate Change Adaptation Plan for Australian Birds*. CSIRO Publishing, Melbourne.

Glushenkov, O. (2017). The extending of ranges of some bird species at the north-eastern border of their distribution due to intra-century climate changes. *Nature Conservation Research* **2** (3), 23–39.

Gynther, I. (2015). Large-tailed Nightjar *Caprimulgus macrurus* on the Maroochy River of Queensland's Sunshine Coast: A probable recent expansion of range. *Sunbird* **45**, 28–47.

Hall, B.P. (1974). *Birds of the Harold Hall Australian Expeditions, 1962-70*. Trustees of the British Museum (Natural History), London.

Hickling, R., Roy, D.B., Hill, J.K., Fox, R. & Thomas, C.D. (2006). The distributions of a wide range of taxonomic groups are expanding polewards. *Global Change Biol*ogy **12**, 450–455.

Higgins P.J. & Peter, J.M. (Eds) (2002). *Handbook of Australian, New Zealand & Antarctic Birds, Volume 6: Pardalotes to Shrike-thrushes*. Oxford University Press, Melbourne.

Hindwood, K.A. & McGill, A.R. (1956). The Mangrove Warbler - extension in range. *Emu* **56**, 145–146.

Hitch, A.T. & Leberg, P.L. (2007). Breeding distributions of North American bird species moving north as a result of climate change. *Conservation Biology* **21**, 534–539.

Johnson, D.D.P. & Mighell, J.S. (1999). Dry-season bird diversity in tropical rainforest and surrounding habitats in north-east Australia. *Emu - Austral Ornithology* **99**, 108–120.

Jones, M.V. (1981). Birds of the Maryborough District, Queensland, 1972-1980. *Australian Bird Watcher* **9**, 1–13.

Keast, A. & Recher, H.F. (1997) The adaptive zone of the genus *Gerygone* (Acanthizidae) as shown by morphology and feeding habits. *Emu* **97**, 1–17.

Longmore, N.W. (1978). Avifauna of the Rockhampton area, Queensland. *Sunbird* **9**, 25–53.

Massimino, D., Johnston, A. & Pearce-Higgins, J.W. (2015). The geographical range of British birds expands during 15 years of warming. *Bird Study* **62**, 523–534.

McAllan, I., Cooper, D. & Curtis, B. (2007). Changes in ranges: An historical perspective. In: Olsen, P. (Ed.) (2007). *The State of Australia's Birds 2007: Birds in a Changing Climate*, pp. 12–13. *Wingspan* Supplement **14** (4).

McGill, A.R. (1970). *Australian Warblers*. Bird Observers Club, Melbourne.

McGill, A.R. (1984). The southward extension of range in the Mangrove Warbler. *Australian Birds* **18**, 33–35.

Menkhorst, P., Rogers, D., Clarke, R., Davies, J. & Franklin, K. (2017). *The Australian Bird Guide*. CSIRO Publishing, Melbourne.

Muir, D. (1993). Members' sightings. *Birds Queensland Newsletter* **23** (10), 8.

Nix, H.A. (1972). Fauna of the Shoalwater Bay area Part 7. In: Gunn, R.H., Galloway, R.W., Walker, J., Nix, H.A., McAlpine, J.R. & Richardson, D.P. (Eds). *Shoalwater Bay Area, Queensland.* Technical Memorandum 72/10. Division of Land Research, CSIRO, Australia.

Nix, H.A. (1984). The Buff-breasted Paradise Kingfisher in central Queensland. *Sunbird* **14**, 77–79.

Nix, H.A. (1985). The Fairy Gerygone at Tin Can Bay. *Sunbird* **15**, 4–5.

Noske, R.A. & Briggs, A. (2021). Species loss and decline among birds of coastal Central Queensland over 130 years. *Pacific Conservation Biology* **28**, 427–443.

Noske, R.A. & Niland, D. (2022). Queensland annual bird report, 2018-2019: Introduction. *Sunbird* **49**, 1–7.

Nyári, Á.S. & Joseph, L. (2012). Evolution in Australasian mangrove forests: Multilocus phylogenetic analysis of the gerygone warblers (Aves: Acanthizidae). *PLoS ONE* **7**, e31840.

Olsen, P. (2007). *The State of Australia's Birds 2007: Birds in a Changing Climate*. *Wingspan* Supplement **14** (4), 1–32.

Queensland Government (2022). Regional Ecosystem descriptions. Available at: https://apps.des.qld.gov.au/regional-ecosystems/list/ (accessed 7 July 2022).

Queensland Government Department of Resources (2022). Queensland Globe. Available at: https://qldglobe.information.qld.gov.au/ (accessed 7 July 2022).

Redhead, D.I. (1988). The Queensland Ornithological Society Bird Report, 1986. *Sunbird* **18**, 28–51.
Reside, A.E., VanDerWal, J., Garnett, S.T. & Kutt, A.S. (2016). Vulnerability of Australian tropical savanna birds to climate change. *Austral Ecology* **41**, 106–116.
Roberts, G.J. (1976). Fairy Warbler. *Queensland Ornithological Society Newsletter* **7** (12), 1.
Roberts, G. (2012). Fairy Gerygone and Spotted Harrier on the Sunshine Coast. 29 January 2012. Available at: http://sunshinecoastbirds.blogspot.com/2012/01/fairy-gerygone-spotted-harrier-on.html
Saintilan, N. & Williams, R.J. (1999). Mangrove transgression into saltmarsh in south-east Australia. *Global Ecology and Biogeography* **8**, 117–124.
Schodde, R., Catling, P.C., Mason, I.J., Richards, G.C. & Wombey, J.C. (1992). *Land Vertebrate Survey of Shoalwater Bay Training Area, Queensland*. CSIRO Division of Wildlife & Ecology for Australian Department of Defence, Canberra.
Silcocks, A. & Sanderson, C. (2007). Volunteers monitoring change: The Atlas of Australian Birds. In: Olsen, P. (Ed.) (2007). *The State of Australia's Birds 2007: Birds in a Changing Climate*, pp. 10–11. *Wingspan* Supplement **14** (4).
Storr, G.M. (1973). *List of Queensland Birds.* Special Publication of the Western Australian Museum, Number 5. Western Australian Museum, Perth.
Storr, G.M. (1984). Revised List of Queensland Birds. *Records of the Western Australian Museum, Supplemen*t **19**, 1–189.
VanDerWal, J., Murphy, H.T., Kutt, A.S., Perkins, G.C., Bateman, B.L., Perry J.J. & Reside, A.E. (2013). Focus on poleward shifts in species' distribution underestimates the fingerprint of climate change. *Nature Climate Change* **3**, 239–243.
Wildlife Queensland Sunshine Coast & Hinterland Inc. (2021). Fauna Watch. Available at: https://wildlife.org.au/our-work/conservation-programs/faunawatch/ (accessed 15 December 2021).
WildNet (2021). WildNet database. Available at https://apps.des.qld.gov.au/species-search (accessed 15 December 2021).
Wolstenholme, H. (1925). Notes on the birds observed during the Queensland congress and campout, 1924. Part 2. *Emu* **24**, 243–251.

Received 4 August 2023, accepted 20 December 2023, published online 3 April 2024

Appendix 1. Names of plant species typical of Regional Ecosystems used by Fairy Gerygones in South-east Queensland with abbreviations as listed in Table 2.

Abbreviation	*Scientific name*	*Common name*
Act	*Acacia disparrima*	Hickory Wattle
Aci	*Acronychia imperforata*	Logan Apple
App	*Aphananthe philippinensis*	Rough-leaved Elm
Arc	*Araucaria cunninghamii*	Hoop Pine
Art	*Argyrodendron trifoliolatum*	White Booyong
Beo	*Beilschmiedia obtusifolia*	Blush Walnut
Brd	*Brachychiton discolor*	Lacebark
Caa	*Castanospermum australe*	Black Bean
Cac	*Casuarina cunninghamiana*	River She-oak
Cae	*Casuarina equisetifolia*	Coastal She-oak
Coc	*Corymbia citriodora*	Spotted Gum
Cro	*Cryptocarya obovata*	Pepperberry
Cua	*Cupaniopsis anacardioides*	Tuckeroo
Cup	*Cupaniopsis parvifolia*	Small-leaved Tuckeroo
Dep	*Dendrocnide photiniphylla*	Shiny-leaved Stinging Tree
Dib	*Dissiliaria baloghioides*	Lancewood
Dif	*Diospyros fasciculosa*	Grey Ebony
Dig	*Diospyros geminata*	Queensland Ebony
Dip	*Diospyros pentamera*	Myrtle Ebony
Drd	*Drypetes deplanchei*	Yellow Tulip
Dym	*Dysoxylum mollissimum*	Red Bean
Elg	*Elaeocarpus grandis*	Blue Quandong
Euc	*Eucalyptus crebra*	Narrow-leaved Ironbark
Eut	*Eucalyptus tereticornis*	Forest Red Gum
Exd	*Excoecaria dallachyana*	Scrub Blind-your-eye
Fim	*Ficus macrophylla*	Moreton Bay Fig
Fiw	*Ficus watkinsiana*	Watkin's Fig
Fla	*Flindersia australis*	Crows Ash
Gml	*Gmelina leichhardtii*	White Beech
Gob	*Gossia bidwillii*	Python Tree
Grr	*Grevillea robusta*	Silky Oak
Hit	*Hibiscus tiliaceus*	Cotton Tree
Jap	*Jagera pseudorhus*	Foam Bark Tree
Mad	*Mallotus discolor*	Yellow Kamala
Mea	*Melia azedarach*	White Cedar
Meq	*Melaleuca quinquenervia*	Broad-leaved Paperbark
Olp	*Olea paniculata*	Native Olive
Plp	*Planchonella pohlmaniana*	Yellow Boxwood
Rhr	*Rhodosphaera rhodanthema*	Deep Yellowwood
Syf	*Syzygium francisii*	Giant Water Gum
Toc	*Toona ciliata*	Red Cedar
Vil	*Vitex lignum-vitae*	Lignum Vitae
Waf	*Waterhousea floribunda*	Weeping Lilly-pilly