

DENSITY OF THREE SKINK SPECIES ON A SUB-TROPICAL PACIFIC ISLAND ESTIMATED WITH HIERARCHICAL DISTANCE SAMPLING

SARAH HAVERY^{1,3}, STEFFEN OPPEL¹, NIK COLE², AND NEIL DUFFIELD¹

¹Centre for Conservation Science, Royal Society for the Protection of Birds, The Lodge, Sandy, Bedfordshire SG19 2DL, UK

²Durrell Wildlife Conservation Trust, Les Augrès Manor, Trinity, Jersey JE3 5BP, Channel Islands, UK

³Corresponding author; e-mail: sarah.havery@rspb.org.uk

Abstract.—Henderson Island is an uninhabited island in the South Pacific Ocean with many native vertebrate and invertebrate species, but reptile populations are very poorly known. Reptile populations are typically quantified using simple count statistics, which may not allow robust population comparisons in time or space if detection probability changes. Here, we provide density estimates for three skink species on Henderson Island using repeated point counts and hierarchical distance sampling to estimate skink density while accounting for habitat associations and variation in detectability. *Emoia cyanura* had the highest density (Mean \pm SE, $1,286 \pm 225.3$ individuals/ha; 95% confidence interval = 912.1 – $1,812.6$), followed by *Cryptoblepharus poecilopleurus* (762.7 ± 108.3 individuals/ha; 95% CI = 577.5 – $1,007.5$) and *Lipinia noctua* (375.7 ± 125.4 individuals/ha; 95% CI = 195.4 – 722.6). The density of *C. poecilopleurus* varied by substrate and was higher on rock and gravel, and *L. noctua* density was higher in areas with larger trees or with less litter cover. We also recorded two gecko species that had not previously been recorded on Henderson Island. While this single-year survey does not capture environmental variability in population density over time, it provides a useful starting point for future assessments.

Key Words.—detectability; island; lizard; Henderson; Pitcairn; reptile

INTRODUCTION

Henderson Island, an island in the United Kingdom Overseas Territory of the Pitcairn Islands, is an uninhabited oceanic raised coral atoll with four endemic land birds, nine endemic flowering plants, and at least 18 endemic invertebrate species (Graves 1992; Benton 1995; Benton and Lehtinen 1995; Florence et al. 1995). Despite a wealth of knowledge about most native biodiversity, very little is known about the reptile species that are present on the island. Because previous reptile surveys on Henderson Island have been brief and opportunistic (Gill 1993), there is no information on the relative abundance and density of the herpetofauna on this World Heritage island.

Reptile populations are typically enumerated using simple count statistics believed to reflect population size, species occurrence or species richness, assuming perfect or constant detectability (Mazerolle et al. 2007). Simple indices may not facilitate comparisons between islands or over time, as differences in detection probability may occur in different habitats, and may not remain constant over time, which may bias conclusions drawn from simple abundance indices (Kéry et al. 2009; Lardner et al. 2015; Oppel et al. 2014). Besides cryptic behavior and camouflage, which affect detectability, reptile activity is highly variable and dependent on environmental conditions, which results in non-constant

availability for detection (Rodda et al. 2015). Reptile density may also depend on microhabitat and may vary spatially depending on microhabitat composition (Amo et al. 2006; Michael et al. 2010). Abundance estimation should therefore take microhabitat at sampling sites into account, which is possible with recent advances in statistical methods such as hierarchical distance sampling (Mazerolle 2015).

Hierarchical distance sampling models use repeated surveys at randomly selected points and can account for density variation among habitats, varying probability of detection, and varying availability for detection (Chandler et al. 2011; Dénes et al. 2015; Sillett et al. 2012). These models have been used successfully for several bird species and have the potential to allow an unbiased comparison of reptile densities over space or time (Mazerolle 2015). The main advantage of these models is that they do not require the intrusive marking of a large number of individuals as would be required for mark-recapture studies (Dénes et al. 2015). However, counting unmarked individuals imposes some limitations that require that both design- and model-based assumptions are satisfied.

A key assumption of hierarchical distance sampling models is that over the period of the repeated surveys, the population around each point was closed, i.e., no individuals were born, died, immigrated, or emigrated (Chandler et al. 2011; Sollmann et al. 2016). During



FIGURE 1. Skink species on Henderson Island: (A) Brown-Tailed Copper Striped Skink, *Emoia cyanura* (Photographed by Tara Proud); (B) Oceanic Snake-Eyed Skink, *Cryptoblepharus poecilopleurus* (Photographed by Neil Duffield); (C) Moth Skink, *Lipinia noctua* (Photographed by Sarah Havery); and (D) a skink that closely resembles *Cryptoblepharus poecilopleurus*, but with distinctively different markings (Photographed by Andrew Skinner).

each survey the distance from the observer to each detected animal is measured to account for the problem that individuals farther from the observer are more difficult to detect, and a further critical assumption is that the distances are measured accurately (Buckland et al. 2001; Thomas et al. 2010). Hierarchical distance sampling models combine the information from repeated counts and from estimated distances to detected individuals to independently estimate density, availability for detection, and detection probability (Dénes et al. 2015). These density estimates can then be compared over time to allow an unbiased assessment of population changes (Kéry et al. 2009).

Here, we provide an estimate of density for three species of skinks, the most common reptile species on Henderson Island. We conducted repeated point counts in 2015, recorded environmental variables, and estimated densities while accounting for imperfect detection. Although based on a single year and thus not suitable to quantify natural temporal variation in density, this work provides a first estimate of skink density that will contribute to an improved understanding of the relative abundance of three common reptile species of Pacific islands.

MATERIALS AND METHODS

Study site.—Henderson Island is a sub-tropical uninhabited raised coral atoll in the South Pacific Ocean (24°20'S, 128°19'W), which consists mainly of a flat limestone plateau about 30 m above sea level covered in shrubby forest up to 5 m tall. The plateau is fringed by a narrow strip of beach embayment forest, which is dominated by *Pandanus tectorius* and introduced *Cocos nucifera* with a fern or grass dominated ground layer (Benton and Spencer 1995). Total rainfall during the austral spring (September to November) was 2,302 mm in 2015, varying little from 2013 (2,226 mm) and 2014 (2,303 mm) over the same time period (Lavers et al. 2016), despite a strong El Niño during 2015 (Stramma et al. 2016). The mean monthly air temperatures were around 23° C in October and November 2015, with daily minimum temperatures exceeding 17.5° C in November 2015 (Lavers et al. 2016). Satellite-derived measures of the vegetation of the island suggest that conditions in 2015 were not atypical and very similar to conditions between 2000–2017 (Fig. S1).

Reptile species diversity.—Oceanic Snake-Eyed Skinks (*Cryptoblepharus poecilopleurus*; Fig. 1),

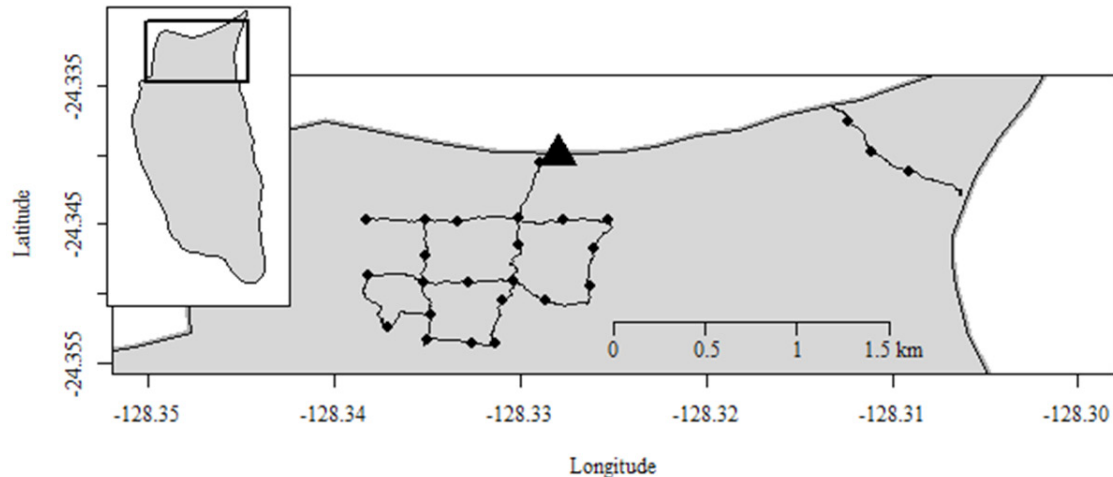


FIGURE 2. Track network across the plateau habitat of the northern area of Henderson Island (inset) and point count locations (black dots) used to survey skink density in 2015. The black triangle indicates the location of the research camp.

Brown-Tailed Copper Striped Skinks (*Emoia cyanura*; Fig. 1), Moth Skinks (*Lipinia noctua*; Fig. 1), and Mourning Geckos (*Lepidodactylus lugubris*) can be found on Henderson Island (Gill 1993; Brooke, M. de L., I. Hepburn, and R.J. Trevelyan. 2004. Henderson Island, World Heritage Site: Management Plan, 2004–2009. Foreign and Commonwealth Office, in conjunction with the Pitcairn Islands Administration and the Royal Society for the Protection of Birds. Available from <https://www.ukotcf.org/pdf/Henderson.pdf> [Accessed 12 August 2018]). These lizard species have a wide distribution across the Pacific (Ineich and Blanc 1989). *Emoia cyanura* and *L. noctua* may have been introduced to Henderson Island by Polynesian settlers (Austin and Zug 1999; Klein et al. 2016; Gill 1993; Kraus 2007), but for *C. poecilopleurus* (Gill 1993; Horner 2007; Blom 2015) and *L. lugubris*, it is unclear whether they are native or have been introduced to Henderson (Zug 1991; Moritz et al. 1993; Radtkey et al. 1995). There is a shortage of reptile studies from this island and it is plausible that other species may be present that have not been officially recorded to date. We studied the reptile species diversity from 27 September to 17 November 2015 by capturing individuals using hand-capture and pit-fall traps, and we created a photographic database of all individuals caught. The gecko species were only caught by hand, mostly at night.

Point counts of reptiles.—To estimate densities of *C. poecilopleurus*, *E. cyanura*, and *L. noctua*, and to record the presence of any other reptile species, we conducted standardized point counts at 25 random locations across the plateau habitat. The point count locations were along a network of partially cleared paths leading 1.5 km into the interior of the island from North Beach, and all points were at least 200 m apart to minimize

the chance of counting the same individuals at different point locations (Fig. 2). Our trails were characterized by a reduction of vegetation between 30–250 cm above ground under unmodified canopy, and thus did not materially affect the movement ability or behavior of skinks.

Between 11 October and 17 November, we conducted six repeat point-count surveys at each point, with a randomized approach to avoid points being surveyed more than once per day. Because the models we employed to estimate density assume that the population at each survey location was closed over the period of repeat counts, we conducted all repeat counts at a given point within one month to minimize changes to the local population inhabiting the area around each survey point. To maximize detectability, we conducted surveys during periods of the day when skink activity was considered to be high (i.e., warm enough for basking, avoiding midday heat), with three surveys at each point during the morning period (0830–1130, UTC-8) and three surveys during the afternoon period (1430–1630) to capture diurnal variation in skink activity. The skinks displayed evasive behavior to a moving observer but returned to normal behavior once the observer remained motionless for > 4 min, which was established through trials prior to surveys. Therefore, at each point we first waited 5 min after arriving at a point to allow skink activity to return to normal after disturbance by the approaching observer, which minimized the impact of observers on detection but did not result in skinks permanently vacating the area.

Each point count consisted of a 10-min count period during which we recorded all observed individuals. To prevent double counting during a given point count, we identified skinks individually based on size, coloration, tail length and location, which was feasible given the

generally low number of skinks at observation points (Table S3). We only counted individuals that could be accurately identified to species level and could be discerned from already counted individuals of the same species. The number of individuals that could not be identified to species level was negligible (fewer than five individuals) and was therefore unlikely to have affected our density estimates.

We recorded each observed individual skink in one of two distance bands to estimate the decreasing probability of detection with increasing distance from the observer. We recorded the location where skinks were first detected in the bands 0–2 m and > 2–6 m, which was considered to be the greatest distance at which skinks could still be identified to species level. We used a tape measure to measure the distance between the observer and points (wooden debris, rocks, fossilized corals, etc.) where skinks were first detected after the count was completed to prevent disturbance during the count. We expected that there would be variation in detection as a result of variable weather conditions, in particular that detection would be higher during warmer conditions in the late morning or afternoon on sunny days compared to early mornings and/or cloudy conditions. We also expected higher detection probability on still days compared to moderate wind speeds when natural rustling of leaves obscured the rustling of skink movement. We recorded a visual estimate of cloud cover (%), wind speed (still, light, moderate), as well as a categorical variable for the time of day, at each point count to account for variation in detection probability and activity of the lizards. Only two observers participated in the counts, and we standardized their visual estimation of conditions through practicing together; observer identity was included as a covariate to minimize any impacts of subjectivity in data collection.

Lizard density may vary across the island depending on substrate or vegetation structure, and we therefore surveyed relevant microhabitat variables at each point. The variables were measured at all points by a single expert botanist to minimize observer differences in estimation (Lavers et al. 2016). We recorded a visual estimate of canopy cover (%) because this affects the sunlight reaching the forest floor. We further recorded qualitative understory density based on ease of passage for a human observer (open, moderate, closed) and mean diameter at breast height (DBH; in cm) of the four trees closest to the point corresponding to each compass quadrant, measured with a tape measure, because these two metrics reflect the amount of vegetation available for skinks to use as perches and the amount of vegetation that blocked the view of an observer and therefore affected detectability. Lastly, we recorded substrate composition (rock, gravel, sandy soil) and a visual estimate of ground cover of leaf litter (%), because these two characteristics

may affect movement ability and availability of hiding places for skinks.

Estimating skink density.—We estimated density of skink species using hierarchical distance sampling models implemented in the function `gdistsamp` in R package `Unmarked` (Fiske and Chandler 2011) in R 3.2.5 (R Development Core Team 2016). We expected that detection probability would decrease with increasing distance from the observation point and used a half-normal detection function to describe this process (Silleet et al. 2012). For the abundance component of the model, we assumed that the number of skinks at each point was described by a Poisson random variable, because a negative binomial distribution resulted in implausible abundances in similar modeling studies of birds (Kéry et al. 2005; Hunt et al. 2012). We included the observer and wind condition as additive effects to account for different detection probabilities between observers and wind conditions, and we considered that the availability of skinks for detection may be either constant, or depend on the time of day, the day of the year (to reflect seasonal phenology), or cloud cover. For each species, we first constructed 15 candidate models accounting for plausible scenarios of availability and detection processes (Table S1), and we used an information-theoretic approach to select the most parsimonious model based on Akaike's Information Criteria corrected for small sample size (Burnham and Anderson 2004; Mazerolle 2006). We subsequently used the best detection covariates for each species in five candidate models exploring whether density varied by habitat across the points. These five models analyzed whether skink density was influenced by: (1) canopy cover; (2) understory density; (3) substrate; (4) leaf litter ground cover; and (5) tree diameter at breast height. We present density estimates and 95% confidence intervals from the most parsimonious model.

To test whether the most parsimonious model fit the observed count data, we used parametric bootstrapping to evaluate the goodness-of-fit (Silleet et al. 2012). We simulated 200 artificial datasets based on the parameter estimates of the most parsimonious model and refit the model to these artificial datasets to compute a fit statistic. We used the Freeman-Tukey fit statistic to quantify the fit of a model to a data set and compared the value of the fit statistic for the observed data set to the reference distribution obtained from the 200 artificial datasets (Silleet et al. 2012). We concluded that the most parsimonious model fit the data if the fit statistic of the observed data was within the 95% quantile of the reference distribution obtained from the artificial data sets, and we report the *P*-value of the fit statistic. We present mean (\pm standard error and 95% confidence interval) estimates for density and availability for all

TABLE 1. Model selection table showing the five hierarchical distance sampling models for estimating the density of three skink species on Henderson Island in 2015 (*Cp* = *Cryptoblepharus poecilopleurus*, *Ec* = *Emoia cyanura*, *Ln* = *Lipinia noctua*). Models have three components accounting for variation in density, availability for detection, and detection probability. Abbreviations are *k* = number of estimable parameters, Δ AIC = difference in AIC units to the most parsimonious model, ω AIC = relative weight of evidence for each model, R^2 = Nagelkerke's R^2 -index.

Species	density	Availability	detection	k	Δ AIC	ω AIC	R^2
<i>Ec</i>	constant	Day	constant	4	0.00	0.24	0.195
	canopy	Day	constant	5	0.85	0.16	0.232
	constant	Day	observer	5	1.57	0.11	0.209
	tree size	Day	constant	5	1.59	0.11	0.208
	litter cover	Day	constant	5	1.92	0.09	0.198
<i>Cp</i>	substrate	cloud cover	constant	8	0.00	0.78	0.551
	constant	cloud cover	constant	4	5.01	0.06	0.244
	litter cover	cloud cover	constant	5	5.68	0.05	0.283
	tree size	cloud cover	constant	5	6.64	0.03	0.255
	canopy	cloud cover	constant	5	7.00	0.02	0.244
<i>Ln</i>	tree size	time of day	constant	5	0.00	0.27	0.439
	constant	time of day	constant	4	0.18	0.25	0.388
	litter cover	time of day	constant	5	0.26	0.24	0.433
	canopy	time of day	constant	5	2.16	0.09	0.388
	constant	time of day	observer	5	2.18	0.09	0.388

levels of a categorical covariate, or for the mean values of a continuous covariate. We estimated detection probability using the scale parameter from the half-normal detection function and present mean (\pm standard error and 95% confidence interval) detection probability at a distance of 2 m from the observer.

RESULTS

Besides the four species known to occur on Henderson Island, we also recorded Stump-Toed Gecko (*Gehyra mutilata*) and Indopacific Tree Gecko (*Hemiphyllodactylus typus*) for the first time on Henderson Island (Appendix 1). We observed all three gecko species in the beach embayment forest habitat, but observed *G. mutilata* only in the plateau habitat; however, night-time surveys on the plateau were too limited to infer that *L. lugubris* and *H. typus* are absent from the plateau. We observed all three known skink species in both beach embayment and plateau habitats. Additionally, we observed another form of skink that closely resembles *Cryptoblepharus poecilopleurus*, but with distinctively different markings (Fig. 1; Appendix 2).

We recorded 255 detections of *E. cyanura*, 166 detections of *C. poecilopleurus*, and 125 detections of *L. noctua* during the 150-point counts, with an average encounter rate of 1.70 ± 1.63 (SD), 1.11 ± 1.18 , and 0.88 ± 0.97 individuals per 10-min count, respectively. The estimated density of *E. cyanura* was the highest of the three skink species with 1,285.8 individuals/ha (Table 2).

The density of *E. cyanura* was not related to any of our measured habitat variables, and the most parsimonious model included only day as availability covariate (Tables 1 and S1), assuming that the availability of this species for detection increased later in the season ($\beta = 0.29$, SE = 0.139; Table 2). Detection probability of this species at a distance of 2 m from the observer was 0.345 (SE = 0.056; 95% confidence interval: 0.244–0.464). The Freeman-Tukey goodness-of-fit statistic for the most parsimonious model suggested that the model provided an adequate fit to observed data ($P = 0.388$, indicating no significant difference between observed and simulated data under the model).

The density of *C. poecilopleurus* was best explained by substrate (Tables 1 and S1) and indicated a much higher density in areas without sandy soil than in areas with sandy soil (Table 2). The availability for detection of *C. poecilopleurus* was best explained by cloud cover, with decreasing availability with increasing cloud cover ($\beta = -0.45$, SE = 0.28, Table S2). Detection probability of this species at a distance of 2 m from the observer was 0.679 (SE = 0.053; 95% confidence interval: 0.554–0.798). The most parsimonious model provided an adequate fit to observed data (Freeman-Tukey goodness-of-fit statistic $P = 0.985$).

For *Lipinia noctua*, there was considerable model selection uncertainty, with the density being explained equally well by the average DBH of trees and by the proportion of litter cover (Tables 1 and S1). *Lipinia noctua* density either increased with the mean diameter of trees ($\beta = 0.183$, SE = 0.12), or decreased with

TABLE 2. Mean densities (individuals/ha), standard errors, and 95% confidence limits (CI) of three skink species on Henderson Island in 2015 (*Cp* = *Cryptoblepharus poecilopleurus*; *Ec* = *Emoia cyanura*; *Ln* = *Lipinia noctua*), estimated using repeated distance sampling point counts and hierarchical mixture models; estimates for each species are derived from the most parsimonious model (Table 1). Note that for *L. noctua* three models received similar support from the data including environmental covariates, and density estimates are reported for two models.

Species	Habitat	mean density	standard error	lower 95% CI	upper 95% CI
<i>Cp</i>	gravel and rock	1337.2	363.0	785.5	2276.5
	gravel	1315.1	311.3	826.9	2091.4
	gravel, rock and sandy soil	341.3	219.8	96.6	1206.1
	gravel and sandy soil	837.5	295.0	420.0	1670.3
	sandy soil	430.2	238.3	145.2	1274.1
<i>Ec</i>	all habitats	1285.8	225.2	912.1	1812.6
<i>Ln</i>	treecsize 23.2 cm DBH	290.0	67.5	183.7	457.8
	treecsize 35.9 cm DBH	348.1	64.7	241.8	501.1
	treecsize 48.6 cm DBH	417.9	86.2	279.0	626.0
	55% litter cover	421.3	89.6	277.7	639.1
	77% litter cover	353.9	64.9	247.0	507.0
	99% litter cover	297.3	67.5	190.5	463.9

increasing litter cover ($\beta = -0.174$, SE = 0.12). The availability for detection of *L. noctua* increased during the course of the day ($\beta = 3.85$, SE = 1.98, Table S2). Detection probability of this species at a distance of 2 m from the observer was 0.318 (SE = 0.074; 95% confidence interval: 0.210–0.481). The most parsimonious model provided an adequate fit to observed data (Freeman-Tukey goodness-of-fit statistic $P = 0.771$).

DISCUSSION

We provide the first estimates of density and habitat associations of skinks for any sub-tropical island in the Pacific Ocean and adopt hierarchical distance sampling as a feasible method for monitoring of small skink species (Mazerolle 2015). We also recorded two gecko species for the first time on Henderson Island, which were previously only known to occur on Pitcairn Island within this archipelago (Gill 1993). Our study is of a basic descriptive nature and was conducted in a single year, hence we can neither quantify temporal variability in densities nor extrapolate our findings to other sites based on the apparent microhabitat relationships we describe for our sampling locations.

In our study year, *Emoia cyanura* was the most abundant skink species on Henderson Island, followed by *C. poecilopleurus* and *L. noctua*. Our data suggested that the two less abundant species exhibited density variation among microhabitats, with *C. poecilopleurus* density being highest on rock and gravel substrates, and *L. noctua* density influenced either by tree size or litter cover. These data provide a first estimate for the three skink species on Henderson Island, to which future estimates can be compared, but we caution that such comparisons may be confounded by natural temporal variability. In addition, many of our environmental variables were estimated subjectively, and more objective measurements using densiometers to assess vegetation density and litter cover may be useful to ensure a high degree of repeatability in these measurements over time.

Previous studies of *E. cyanura* on other islands have described this species as common (Baker 1947; Ineich and Zug 1991; Fisher 2011; Morley and Winder 2015; Klein et al. 2016) with density estimates in Fiji of 1,390 individuals/ha (Zug 1991), similar to the density estimated here for Henderson Island (1,285 individuals/ha). The density of *E. cyanura* on Henderson Island was not related to any of our measured microhabitat variables. Previous habitat associations for *E. cyanura* in relation to the sympatric species *Emoia impar* have shown that *E. cyanura* prefer open habitats and *E. impar* prefer forested habitat (Zug 1991; Bruna et al. 1996; Schwaner and Ineich 1998). In the absence of *E. impar* on Henderson Island, it is possible that the lack of inter-specific competition allows *E. cyanura* to use a broader suite of habitats. Alternatively, given the relative uniformity of habitat within the survey area on Henderson Island, the previously documented association with open habitats may not be evident in the Henderson Island population because no stark habitat contrasts exist on the plateau.

Cryptoblepharus poecilopleurus has been described as uncommon or restricted on other Pacific islands and has been described as restricted to rocky or coralline shorelines, typically inhabiting coastal vegetation (Wiles et al. 1990; Pregill 1993; Wiles and Guerrero 1996; Perry et al. 1998; Fisher and Ineich 2012). Our study is consistent with such an affinity to rocky substrates, as we found higher *C. poecilopleurus* density on rock and gravel substrates than on sandy soils on Henderson Island. However, unlike the cited studies above, we found *C. poecilopleurus* throughout the interior of Henderson Island. The terrain on Henderson Island is rocky and coralline throughout with very little soil present, therefore this species does not appear to be restricted to coastal shorelines within rocky terrain.

Previous studies on *L. noctua* are limited to those that incidentally reported the species as being widespread,

localized and less numerous than other skink species (Fritts and Rodda 1998; Austin 2006). *Lipinia noctua* has been described as semi-burrowing and associated with trees on other Pacific Islands (Fisher and Ineich 2012; Blom 2015), which is consistent with our result indicating higher *L. noctua* density with increasing tree size on Henderson Island. However, limited litter cover (i.e., decreasing proportion of litter cover) may be an equally plausible explanation of *L. noctua* density variation as increasing tree size. Higher litter coverage may provide suboptimal thermal microhabitat for *L. noctua* or may be avoided due to competitive interactions with other skink species (Bruna et al. 1996; Downes and Bauwens 2002), but a larger sample size of broader habitat gradients would be necessary to confirm the habitat associations of this species.

The herpetofauna of most islands in the tropical and sub-tropical Pacific Ocean is poorly understood, and the native distribution and origin of many species is unclear. The reptile diversity in the region has been highly influenced by human-mediated dispersal across the Pacific Ocean, and there are virtually no historical records of the native herpetofauna of Pacific islands that pre-date the arrival of people to such islands (Austin and Zug 1999; Kraus 2007). During this study, we also found two gecko species that had not been recorded previously on Henderson Island (*Gehyra mutilata* and *Hemiphyllodactylus typus*). Due to limited previous reptile surveys on Henderson Island, it is unknown if these newly recorded species are recent introductions or if they have been missed in previous surveys due to their cryptic and nocturnal nature. Of the three gecko species now known to occur on Henderson Island, it is highly likely that the newly recorded *G. mutilata* and *H. typus* arrived via human-aided transport, due to the known dispersal of these species across the Pacific (Fisher 1997; Rocha et al. 2009). Further study is required to better understand the potential impacts (positive or negative) of non-native reptile species on the native flora and fauna. This study provides first quantitative skink data and density estimates that can be used in the future to monitor changes, but we emphasize that reptile populations undergo many natural fluctuations and our single-year study cannot provide an assessment of how variable reptile populations on Henderson Island may be over time.

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SARAH HAVERY works as a Species Recovery Officer for the Royal Society for the Protection of Birds, Sandy, UK. She received her B.Sc. (Hons) in Biology from the University of Bristol, UK, and her M.Sc. in Conservation and Biodiversity from the University of Exeter, UK. Her research interests lie in island ecology, and she has been involved in conservation projects in Mauritius, Isles of Scilly (UK), Antigua (West Indies), Henderson Island, and Turks and Caicos Islands. (Photographed by Neil Duffield).



STEFFEN OPPEL is a Senior Conservation Scientist at the Royal Society for the Protection of Birds Centre for Conservation Science in Cambridge, UK. He uses quantitative evidence to achieve effective conservation of threatened species and their habitats in a wide variety of ecosystems around the world and has been directly involved in habitat and species recovery work on islands in the Caribbean, Mediterranean, North and South Atlantic, and South Pacific. (Photographed by Laura Bambini).



NIK COLE is a Conservation Biologist for the Durrell Wildlife Conservation Trust, Jersey, UK, and Islands Restoration Manager with the Mauritian Wildlife Foundation, Vacoas, Mauritius. His work focuses upon the restoration of island ecosystems, through the management and removal of invasive species and the reintroduction of threatened fauna and flora to rebuild native communities. Located primarily in Mauritius, Nik is involved with research and restoration projects within the Indian Ocean and Caribbean. (Photographed by Rouben Mootoocurpen).



NEIL DUFFIELD is a Conservation Adviser for The Royal Society for the Protection of Birds, Sandy, UK. His work focuses on habitat restoration targeted by the requirements of species in the UK but has also undertaken field research including on Henderson Island, UK seabirds, and in the Amazon rainforest. Neil has a B.Sc. (Hons) in Environmental Management from the University of Birmingham, UK, and an M.Sc. in Conservation and Biodiversity from the University of Exeter, UK. (Photographed by Sarah Havery).

Havery et al.—Erratum: Density of skinks on Henderson Island in the South Pacific.

ERRATUM: DENSITY OF THREE SKINK SPECIES ON A SUB-TROPICAL PACIFIC ISLAND ESTIMATED WITH HIERARCHICAL DISTANCE SAMPLING

SARAH HAVERY^{1,3}, STEFFEN OPPEL¹, NIK COLE², AND NEIL DUFFIELD¹

¹ *RSPB Centre for Conservation Science, Royal Society for the Protection of Birds, The Lodge, Sandy, Bedfordshire, SG19 2DL, UK*

² *Durrell Wildlife Conservation Trust, Les Augrès Manor, Trinity, Jersey, JE3 5BP, Channel Islands, UK*

³ *Corresponding author. e-mail: sarah.havery@rspb.org.uk*

One species in “Density of three skink species on a sub-tropical Pacific island estimated with hierarchical distance sampling” was misidentified due to distinct color morphs being present in another species. Melanism is common in peripheral populations of *E. cyanura* (I. Ineich pers. comm. 2018), the most commonly observed species in our study. Instances of melanism in *E. cyanura* are relatively high on Henderson Island, but melanistic individuals were erroneously reported as *Lipinia noctua*. The density and habitat relationships we reported for *Lipinia noctua* are therefore in fact for a melanistic morph of *Emoia cyanura*. The misidentification does not affect any of the density estimates and habitat associations provided in this paper. However, our density estimates apply only to two (and not three) species, with two separate estimates for the two distinct colour morphs of *Emoia cyanura*.

Throughout the paper all references to density estimates and habitat relationships of *Lipinia noctua* are in fact for the melanistic morph of *Emoia cyanura*. References to *Emoia cyanura* are only for the copper colored morph of *Emoia cyanura*. In Figure 1, panels (a) and (b) are correct, but panel (c) shows the Melanistic Brown Tailed Copper Striped Skink, *Emoia cyanura* and panel (d) shows the Moth Skink, *Lipinia noctua*. *Lipinia noctua* was therefore positively identified on Henderson Island, but occurred with too few individuals to allow a quantitative assessment of density and habitat relationships.