1 **Using anecdotal reports to clarify the distribution and status of a near mythical species:**

2 **Australia's Night Parrot (*Pezoporus occidentalis*)**

3

4 Running Title: DISTRIBUTION AND STATUS OF THE NIGHT PARROT

5

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26 **Abstract**

27 Shortfalls in our knowledge of the most basic parameters, such as overall range and population

28 size, ensure evidence-based conservation of poorly known or 'missing' species is inherently

29 difficult. Often, the only source of such knowledge is anecdotal reports, which are usually

30 considered too unreliable to be of value. Methods that help conservation decision-makers use

31 anecdotal records of poorly known or 'missing' species to decide where conservation action

32 should occur, and how urgent that action might be, will support better conservation decisions

33 for those species. Here, we use a Delphi-style process based on expert opinion to assess the

34 largely anecdotal sightings record of the Night Parrot (*Pezoporus occidentalis*), an endangered

35 species from arid central Australia that underwent a significant decline following the arrival of

36 Europeans. Our results clarify the patterns and possible causes of this decline and subsequent

37 range contraction. We conclude that the species persists in only two broad regions, and is

38 probably extinct throughout much of its former range. Our method is applicable to other poorly

39 known species with a similarly sporadic and largely anecdotal sightings record. This method

40 could be used to clarify the historical and current distribution and status of such species, a

41 critical first step in understanding their conservation requirements.

42

43 **Additional Keywords**

44 anecdotal, conservation, uncertainty, sightings record, missing species, Night Parrot

45

46 **Introduction**

47 For poorly known or 'missing' species, anecdotal reports are often the only source of even the

48 most basic information such as distribution or abundance. Notoriously unreliable (McKelvey

49 *et al*. 2008), anecdotal reports may be the only data available on where a species can be found.

50 Nonetheless, conservation planners must use these reports when estimating a species' risk of

extinction (IUCN Standards and Petitions Committee 2019), or planning for a species'

conservation (Rondinini *et al*. 2006). This makes effective evidence-based conservation

difficult (Pullin and Knight 2001, Sutherland *et al*. 2004), particularly the accurate conservation

assessment of data-deficient species (Bland *et al*. 2017). Methods that overcome the

unreliability inherent in anecdotal occurrence data will improve the quality of decisions based

on those data (Boakes *et al*. 2010).

Anecdotal reports of rare species are either a legitimate record, a case of mistaken identity, or

very occasionally, a fabrication (Harrop *et al*. 2012). Wrongly accepting or rejecting

contemporary reports may obscure the true status of a species (Roberts *et al*. 2009, Pillay *et al*.

2014), while mishandling historical reports can obscure trends in the status of a species over

time (McKelvey *et al*. 2008, Roberts *et al*. 2009). Reliance on historical and contemporary

false positive data has led to real and significant errors regarding the presence, population

dynamics, and range of rare species (McKelvey *et al*. 2008). In such cases, field research is

often the only way to reveal such errors. However, for poorly known, extremely rare, or cryptic

species, meaningful field research may not be possible, so conservation assessments must rely

almost entirely on review of anecdotal reports. Techniques have been developed to overcome

the uncertainty associated with anecdotal reports, and are typically used to calculate the

probability that a species is extinct (Thompson *et al*. 2013, Lee *et al*. 2015). Although useful

when deciding whether to continue searching for a species or fund its conservation, these

techniques do not necessarily provide detail on a species' recent biogeographic history.

Particularly for poorly known species, this is important information that may provide valuable

insights into whether a species is threatened, what processes have driven changes in

distribution, and where it remains extant.

76   Emblematic of this problem is the Night Parrot (*Pezoporus occidentalis*), a species for which

77   there is little primary data, but numerous anecdotal reports. A nocturnal parrot endemic to arid

78   central Australia, the Night Parrot was typically found in association with dense, low vegetation

79   such as long unburnt *Triodia* grasslands or samphire flats (Andrews 1883, Wilson 1937). It

80   was first seen by Europeans in 1845 (Davis 2002), and specimens were collected occasionally

81   from inland Australia until the late-19th century (Higgins 1999). For most of the 20th century,

82   the only evidence of the parrot's existence was a trickle of rumours and unconfirmed reports

83   (see e.g., Wilson 1937, Parker 1980). Irrefutable proof of its continued survival only arrived in

84   1990 when a dead Night Parrot was found in western Queensland (Boles *et al*. 1994). Finally,

85   in 2013 an extant population was discovered in Queensland (Koch 2013), and several further

86   populations have since been found in Western Australia (Jackett *et al*. 2017).

87

88   Although it was accepted that the Night Parrot underwent a severe decline, this sporadic and

89   primarily anecdotal history of its detection has not supported a clear narrative describing

90   changes in its likely status and distribution. In the period where only anecdotal records were

91   being made, some ornithologists wondered whether the species was actually extinct (Lendon

92   1968), while others thought it might not even be rare, simply very difficult to detect (Schodde

93   and Mason 1980). Adding to the confusion, some historical reports are widely accepted (e.g.

94   Wilson 1937, Parker 1980), while others meeting apparently similar evidentiary standards were

95   less readily accepted (e.g. Menkhorst and Ryan 2015, Hamilton *et al*. 2017). This confusion

96   has been perpetuated by sensationalism of recent media reports claiming the Night Parrot was

97   thought extinct, a spate of new discoveries including several that remain unconfirmed (e.g.

98   Beavan 2017), and findings that some claimed detections were fraudulent (Menkhorst *et al*.

99   2020).

100

For regulators assessing the potential impact of development on the Night Parrot, or agencies responsible for improving the species' population trajectory, knowing where it may occur, and its status, are fundamental requirements. In the absence of such data, we detail a method using the historical record of Night Parrot sightings to describe both changes in the species' distribution over time, and its likely current status and distribution. After compiling a database of all known and purported Night Parrot encounters, we use a method for reviewing anecdotal reports to assess the degree of certainty for each encounter. We use the results to map the distribution of the Night Parrot over time, including its likely current distribution. Lastly, we combine these results with a review of historical reports describing the Night Parrot's status to draw conclusions around historical changes in status. Beyond establishing these parameters for the Night Parrot, the method we propose is non-specific. It could be applied to other poorly-known or 'missing' species, improving the quality of formal conservation assessments such as extinction risk, and the resulting decisions by environmental regulators.

Materials and Methods

Our basic process was to (1) compile reports of the Night Parrot, (2) assess the degree of certainty of each record, then (3) examine the resulting sight record and determine whether it revealed any patterns of occurrence that could provide insight into the species' historical distribution, and any changes in that distribution.

Compilation of Night Parrot record database

As a 'missing' species, the Night Parrot has always enjoyed a high public profile, and there is an extensive catalogue of alleged encounters. Commencing in the 1970s, SAP began compiling these encounters into a single database, a process continued by IAWM, with recent additions by AHB, SAM and NPL. The database contains all known reports the authors are aware of,

from multiple sources, including but not limited to scientific journals, government reports, birding magazines, the general media, personal communications, and government-led campaigns that aimed to solicit information from the public. A 'report' included any reference to a possible encounter with a Night Parrot, such as sightings (first and second hand), specimen locations, photographs, and more recently, recorded calls. The database is comprehensive; searches for published reports have been exhaustive over several decades, and given the public profile of the Night Parrot, it is probable that most encounters have been either published, or reported directly or indirectly to the authors.

Details of the location, date, observer, and any relevant notes for each report were recorded in the database. The location information for some records was vague, only permitting assignment to a general locality, often the centroid of a named property. As the aim of this study was to recognise trends at a continental scale, these records were retained. Only one report could not be assigned to a locality, so was removed for this analysis. The year of each sighting was noted. The median year was assigned to reports that included a possible date range. The latest year in a range of years was assigned to reports that included several encounters at a single site over time, as this reflected the last time the species was known to occur at the site.

Report assessment

We used expert opinion to assess the certainty that each of the 238 reports was of a Night Parrot. Expert opinion is commonly used in conservation science to resolve questions not easily answered empirically (Burgman *et al*. 2011a, Martin *et al*. 2012). However, because expert opinion varies, sometimes greatly due to inherent bias or differences in expertise, methods have been developed that account for this variation when deriving an accurate estimate of a specified parameter (Burgman *et al*. 2011b, McBride *et al*. 2012). These methods are extensions of the

Delphi-style 'estimate-feedback-estimate' process, requiring experts to provide an initial independent opinion based on available information. Anonymised results of that initial elicitation are presented to the experts, and the opportunity provided to discuss them. Each expert may then revise his or her estimate, with the final result a combination of these final estimates.

For this assessment, AHB, SAM, NAJ and NPL were selected as experts. Each is an ornithologist with extensive field experience, and importantly, all four have direct field experience with the Night Parrot and are familiar with the Night Parrot literature. Although four seems a small number of experts, even small numbers of experts produce accurate estimates (Clemen and Winkler 1985) and extending the group to include additional experts with less experience of the species seemed unlikely to improve the result.

Before commencing their assessment, each expert was provided with the following list of factors to consider, where possible, when assessing each report: the physical description of the bird/s; observer experience (including previous experience with Night Parrots); observer pre-disposition to wanting to see a Night Parrot; light conditions; distance from observer to bird; duration of observation; habitat; range; behaviour; and, number of observers in the party (if more than a single observer). A scoring rubric was also provided, containing uncontentious examples of each of the six score categories (Appendix S1). Experts were then asked to consider each report, and estimate how *certain* they were each report was actually a Night Parrot by assigning a score of zero to five: zero for a report that was certainly not a Night Parrot, five for a report that certainly was a Night Parrot. Although research supports the separate assessment then pooling of some factors (Lee *et al*. 2015), it would have been difficult to assign an appropriate and consistent weighting across so many factors without artificially

176   distorting the final score of some reports. Using an overall assessment allowed the experts to

177   exercise their judgement in assessing the importance of each factor for any given sighting.

178   Finally, it is important to note that the score expresses the *degree of certainty* that a particular

179   report was of a Night Parrot. It is likely some low scoring records were in fact Night Parrots;

180   however, the report did not include enough detail to be certain.

181

182   After each expert provided their initial independent assessment of each report, the results were

183   collated, anonymised, and distributed to all experts for consideration. While there was

184   consistency on many assessments, there were several where estimates varied. A discussion was

185   held among the experts that focused on the assessment process, and particularly those records

186   where there were clear differences in opinion. Following this discussion, each expert was

187   invited to revise their estimates. These revised estimates were then averaged to determine a

188   final score representing the certainty that each report was of a Night Parrot. The estimates of

189   all experts were weighted evenly.

190

191   In addition to specific records, we collated any statements found in the literature that directly

192   or indirectly referred to the status of the Night Parrot. Our aim was to determine whether any

193   patterns of decline could be established from this commentary that might support patterns of

194   decline established through the analysis of specific records.

195

196   *Analysis of records*

197   Inferring changes in status and distribution based on changes in the number of records meeting

198   the certainty thresholds required variation in the number of records meeting the threshold to be

199   spatially and temporally random. We confirmed that mean certainty scores for all records that

200   involved some subjective assessment (i.e. those records not supported by definitive proof such

as a skin or audio recording) were not correlated temporally (r = -0.08, p = 0.25), or spatially, using state as a proxy for spatial location (ANOVA, $F_{5,197}$ = 0.50, p = 0.77). Because temporal changes in survey effort could influence interpretation of the results, we also examined changes in the rate of reporting over time (see Results).

We then extracted all reports of the Night Parrot that achieved an overall certainty score > 2.5. Reports that surpassed this threshold were termed 'probable' records. While this threshold is arbitrary, it achieves the requirement of applying a consistent standard to each report across the entire reporting period.

Research in Queensland (Murphy *et al*. 2017) and emerging evidence from Western Australia (Borrello 2018, N. Leseberg unpub. data) suggests that Night Parrots are largely sedentary, not nomadic as proposed by some authors (Andrews 1883, Higgins 1999). If this is true, the detection of Night Parrots in an area at a particular time could reasonably suggest a history of occupancy in that area up to that time. Therefore, we plotted all probable records of the Night Parrot since 1845 to represent a minimum estimate of the pre-European range of the Night Parrot. To detect changes in distribution over time we repeated this, plotting all probable records post 1920, post 1960, and post 2000. We reasoned that if birds were not recorded in a region since these particular years, it was likely they had ceased to occur in that region sometime before that year. The year 1920 was chosen as by this time the decline of the Night Parrot was being reported widely (White 1913, Whitlock 1924). The year 1960 was chosen because it represents the time by which all likely threats to the Night Parrot had reached their current extent within the species' range, and enough time had elapsed for their impact to be realised (Burbidge *et al*. 1988). The year 2000 was chosen to approximate the current distribution of the bird.

226

227   To determine whether raising the certainty threshold could lead to different conclusions, we

228   repeated this analysis, using only reports scoring ≥ 3, and again using only reports scoring ≥ 4.

229   These were classified respectively as 'likely' and 'very likely' records.

230

231   Finally, we reviewed all statements extracted from the literature that referred to the status of

232   the Night Parrot. Statements were attributed a period, geographic location, and inferred status

233   of the Night Parrot at the assigned location and time. The statements were placed in

234   chronological order, and examined for trends at different spatial scales (Appendix S2).

235

236   **Results**

237   We collected 238 reports of Night Parrot, spanning the period 1845 to 2020. Seventy of these

238   reports were classified as 'probable' records. Of these 'probable' records, 54 were classified as

239   'likely', and 34 as 'very likely'. There were probable records from all mainland states and

240   territories except New South Wales and the Australian Capital Territory. Except for the 1870s,

241   rates of reporting were consistent from 1845 until around 1960 (Fig. 1). From 1960 onwards

242   there was an increase in the rate of reporting, which continues to the present day. The 1870s

243   spike in reports is associated with the work of F.W. Andrews, who collected most of the known

244   Night Parrot specimens around this time (Black 2012). Increased reporting rates from the 1960s

245   onwards probably reflects greater awareness of the species' plight, particularly following the

246   widely publicised discovery of a dead Night Parrot in 1990. This discovery resulted in several

247   campaigns for information relating to Night Parrot sightings, particularly by the Western

248   Australian government. The increased number of probable reports in the decade 2010-2019 is

249   associated with the 2013 discovery of birds in western Queensland, and subsequent

250   development of effective detection methods which has led to the discovery of Night Parrots at

251   several locations in central northern Western Australia.

252

253   [Fig. 1.]

254

255   *Pre-European distribution*

256   The plot of all probable Night Parrot records since 1845 is consistent with Night Parrots being

257   found throughout central Australia prior to European settlement (Fig. 2). Given the species can

258   apparently persist in the driest parts of the continent, the absence of records from the Simpson,

259   Gibson, Great Victoria and Tanami Deserts may reflect a lack of search effort rather than

260   genuine absence. Several records obtained from these areas did not contain enough detail for

261   acceptance, but it seems likely the bird occurred in suitable habitat throughout Australia's

262   interior. Given the species' occurrence in north-western Victoria, it is also probable the species

263   once occurred in far south-western, and possibly western New South Wales. With few

264   exceptions, most reports that did not reach the threshold to be considered probable records were

265   from areas where it was possible the Night Parrot did occur. Therefore, it is important to

266   recognise that the absence of probable records does not necessarily indicate the historical

267   absence of Night Parrots.

268

269   Using these results we constructed an approximate historical range using a smoothed convex

270   polygon incorporating all probable records, and regions where, despite no probable records,

271   the Night Parrot could have occurred. This was not meant to represent a definitive historical

272   range, but a visual baseline against which potential changes in range could be compared.

273

274   [Fig. 2.]

275

Post-European changes in distribution

Since 1920 there have been probable records from throughout the Night Parrot's historical range. Although there were no apparent changes in distribution, there were few records from the southeast of the bird's range, and only two records from the southern Northern Territory, despite several records prior to 1920.

Since 1960, there have been continuing records from the northern part of the bird's historical range, but no records from northwest Victoria, and only two records from southern South Australia, suggesting a contraction from the southeast. There are also no probable records from the southern Northern Territory since 1960.

Since 2000, there have been probable records from only two regions of the Night Parrot's historical distribution: western Queensland, and central northern Western Australia. The lack of probable records from the southeast of the bird's historical range suggest the Night Parrot is locally extinct in southern South Australia and northwest Victoria. Likewise, the absence of probable records from the southern Northern Territory since before 1960 suggest local extinction. Importantly, increased rates of both unconfirmed reports and probable records from elsewhere as the range contraction progresses, point to the range contraction being genuine rather than an artefact of survey effort.

Effect of raising stringency for required certainty

Raising the stringency required for certainty of sightings did not change the estimated pre-European distribution substantially (Fig. 3), although no records from northwest Victoria received a certainty score ≥ 4. Applying the higher certainty scores across the different periods

produced similar results for each period, but suggests an acceleration in the decline, with Night

Parrots not recorded in southern South Australia or the southern Northern Territory after 1920.

The overall outcomes of this decline are similar, with the species retreating to western

Queensland and central northern Western Australia.

[Fig. 3.]

Pre-European status and subsequent decline

Consideration of all statements relating to the Night Parrot's pre-European status suggest the

species was at times relatively common, or at least regularly encountered, throughout most of

its range. The species was reported sporadically from northwest Victoria and from central and

northeast South Australia in the 1870s and early 1880s (Andrews 1883, Menkhorst and Ryan

2015). Its decline in Victoria had certainly been noted by the turn of the century, and likely

earlier (Menkhorst and Ryan 2015), and by 1885, declines had been noted in the Gawler Ranges

and the Lake Eyre Basin. It is probable no skins were received by the South Australian Museum

after 1872, despite searches by the prolific collector of Night Parrots, F.W. Andrews (Black

2012, Olsen 2018). This abrupt disappearance within a decade indicates a rapid disappearance

from the southeast of the species' range.

Declines in central Australia apparently commenced about 20 years after declines in the

southeast, and were possibly more gradual. The Night Parrot was seen regularly in the southern

Northern Territory until at least the early 1890s (North and Keartland 1896). In 1923, F.L.

Whitlock spoke to several informants in the region who claimed first-hand knowledge of the

species, including Indigenous Traditional Owners. They reported seeing the bird occasionally

until around 1905, but rarely thereafter (Whitlock 1924).

325

326 Few reports indicate when the Night Parrot began to decline in Western Australia. It was

327 encountered occasionally throughout central Western Australia until around 1900, with some

328 observers reporting it as 'plentiful' at locations in the state's northwest (North and Keartland

329 1898, Wilson 1937). M. Bourgoin, who knew the bird well, claimed five encounters between

330 1912 and 1935 in central Western Australia (Wilson 1937), suggesting the species was

331 persisting, perhaps at low densities. The bird's apparent disappearance from this part of its

332 range was being reported by the mid-1920s (Olsen 2018). Although the evidence is not

333 conclusive, this decline apparently came later, and was not as severe as the initial declines in

334 southeast and central Australia.

335

336 **Discussion**

337 This analysis explored whether the record of largely anecdotal sightings of the Night Parrot

338 could be used to infer spatial and temporal changes in its geographical range. Because there

339 are only 28 specimens known (Black 2012), and few definitive sight records since the bird was

340 first seen by Europeans in 1845, there is little evidence to sustain robust conclusions about the

341 bird's distribution and status. Given how difficult the species is to detect, coupled with the vast

342 and remote landscapes it inhabits, it will be some time before the Night Parrot's true status can

343 be determined through field research. In these circumstances, methods that harness the

344 anecdotal record fill a critical gap and support decisions around management priorities and

345 required research.

346

347 *Application to other species and associated risks*

348 This method ultimately relies on anecdotal reports, which are notoriously unreliable

349 (McKelvey *et al*. 2008). The risks of using anecdotal data to draw conclusions about a species'

350   status and distribution are well known (Leseberg *et al*. 2020). If a higher standard of proof is

351   applied, valid sightings may be rejected, while a lower standard of proof may see false claims

352   accepted. These errors could result in mistaken claims of presence or absence. The risks of

353   either approach must be considered when setting certainty thresholds, and making conclusions

354   based on the results of this method. Importantly, results should not be treated as a definitive

355   biogeographical history, but as a starting point to inform conservation assessment and further

356   research priorities.

357

358   Because the Night Parrot is a high profile species, and was likely to be encountered, at least

359   sometimes, in circumstances permitting a detailed and accurate description, it is particularly

360   suited to this analysis. Furthermore, this assessment could incorporate significant recent

361   advances in our knowledge of the species. These factors allowed collation of a substantial

362   catalogue of probable sightings. However, if a species is not well-known, there is little

363   knowledge of its ecology and behaviour, or if that species is easily misidentified, it will be

364   more difficult to accurately assess sightings and generate a useful corpus of probable records.

365   Consequently, patterns of distribution are likely to be more obscure. Here, applying the higher

366   certainty scores to the Night Parrot data simulated performing the analysis when levels of

367   knowledge are lower. Although some temporal and spatial detail was lost, the number of

368   sightings reaching the higher thresholds supported the same broad conclusions. The threshold

369   of valid sightings required to support robust conclusions will vary between species, and may

370   be unachievable. Identifying this threshold requires a species-specific assessment of the risk

371   associated with any conclusions based on this approach.

372

373   *Support for conclusions around Night Parrot distribution and status*

The pattern of the Night Parrot's decline revealed here is familiar, matching that of many ecologically similar small-to-medium sized mammals from Australia's arid zone. These mammal declines also began in southeast Australia in the mid to late 19th century, before continuing throughout central and western Australia during the early and mid-20th century (Woinarski *et al*. 2015). This supports the view that the Night Parrot declined due to many of the same factors. Research suggests several interacting factors triggered these mammal declines, including habitat degradation, competition associated with the spread of pastoralism and the accompanying large numbers of introduced and native herbivores (McKenzie *et al*. 2007, Morton *et al*. 2011). Concurrently, changed fire regimes homogenised the landscape, reducing the amount of cover available. The subsequent spread of cats (*Felis catus*) and foxes (*Vulpes vulpes*), sustained by high numbers of rabbits (*Oryctolagus cuniculus*), and possibly aided by the persecution of dingoes (*Canis dingo*), compounded these problems and forced the local extinction of many small-to-medium sized mammals. Local extinctions further fragmented populations in an already patchy landscape, subjecting remaining populations to increased extinction pressure to which most eventually succumbed.

Our conclusions also fit with predictions from theory about causes of species' declines. For example, extinction is a likely outcome if historical declines are sudden (Gotelli *et al*. 2011), especially if the decline is due to invasive species rather than habitat loss (Clavero *et al*. 2009). Our results suggest that declines in the south and southeast of the Night Parrot's range were sudden, and field research indicates these were probably linked to both introduced species and habitat loss (Murphy *et al*. 2018). This supports our conclusion that the absence of recent records from the south and southeast of the Night Parrot's range means the species is probably extinct there. Similarly, this analysis confirms a sporadic detection history from western Queensland and central northern Western Australia, there being probable records from almost

399 every decade since 1845. This is also an expected pattern; threatened species are more likely

400 to persist at the edge of their range (Channell and Lomolino 2000, Fisher and Blomberg 2011),

401 particularly the edge most isolated from the origin and onward spread of threatening processes,

402 while a pattern of regular but infrequent records suggests a species probably occurs in isolated

403 pockets, and at extremely low densities (Fisher and Blomberg 2011). Accordingly, while the

404 Night Parrot persists along the northern and western edge of its likely historical range, it

405 probably does so very patchily, and at extremely low densities.

406

407 *Comparison with other methods of quantifying decline*

408 There is a growing body of research on methods to assess anecdotal reports and make

409 conclusions about the status of a species (Solow 2005, Boakes *et al*. 2015, Butchart *et al*. 2018).

410 Typically, these methods assess whether a potentially extinct species remains extant. Although

411 it is popularly reported that the Night Parrot was once thought extinct, the steady stream of

412 plausible, if not definitive reports, led most authors to believe the species remained extant but

413 extremely rare. Therefore, techniques that predict likelihood of extinction were not useful for

414 examining the Night Parrot's decline. The issue concerning the Night Parrot was, and still is,

415 knowledge of where it may persist. The method outlined here adapts similar procedures

416 developed for assessing anecdotal records of potentially extinct species (Lee *et al*. 2015), but

417 permits simple comparison between records at a larger scale, revealing patterns of decline more

418 specific methods may not. It will be appropriate for making general assessments around a

419 species' likely distribution and status, particularly when there is uncertainty. More focused

420 methods, such as those aimed at estimating probability of extinction, will be appropriate for

421 species when there is a clear trend toward potential extinction, even if only at a local scale.

422

423 *Future conservation implications for the Night Parrot*

424 The ongoing decline revealed by this analysis suggests the Night Parrot's current federal and

425 IUCN classification of endangered is justified under population size reduction criteria, but

426 supports a classification of critically endangered depending on estimated population size

427 (Threatened Species Scientific Committee 2015, BirdLife International 2019). Furthermore,

428 the results of this research and widespread searches for the species in western Queensland (N.

429 Leseberg unpub. data), and emerging data from searches in central and northern Western

430 Australia, point to the species occurring in very low numbers, at extremely low densities, and

431 in isolated, resident populations. The probable extreme fragmentation of the population poses

432 a significant extinction risk.

433

434 One probable record from near Innamincka in north-eastern South Australia in 1999, and

435 another tantalising report from this region in 2019 that scored 2.5, and therefore did not reach

436 the threshold to be considered probable, suggest the Night Parrot could still persist in far north-

437 eastern South Australia. However, the apparent strongholds for the species, western

438 Queensland and central northern Western Australia, should be the primary focus of

439 conservation funding and intervention, given the evidence of continuous occurrence in these

440 areas. Assessment by federal and state governments of development impacts on Night Parrots

441 in these strongholds should consider their demonstrated importance for the species'

442 persistence. Conversely, requirements for developers to consider the Night Parrot in regions

443 such as southern South Australia where it is likely the bird no longer occurs, but which are

444 currently mapped as potential Night Parrot habitat (Australian Government 2018), could be

445 reviewed.

446

447 In summary, this analysis demonstrates the value of a centralised, systematic, and critical

448 review of anecdotal records for poorly known species. This process has generated a clear ,

449 logical picture of the Night Parrot's distribution and status during the 175 years since its

450 discovery by Europeans, whereas the *ad hoc* collection and analysis of records for much of the

451 20th century contributed to continuing misperceptions around the bird's status, and perhaps

452 complicated efforts to find and conserve it. This method could clarify the status of other poorly

453 known species with primarily anecdotal detection histories, leading to more accurate estimation

454 of important metrics such as extent of occurrence and area of occupancy. In turn, this could

455 influence assessment of their conservation status, and the more effective prioritisation and

456 allocation of scarce conservation resources. Obvious Australian examples include the Buff-

457 breasted Button-quail (*Turnix olivii*) and Coxen's Fig-Parrot (*Cyclopsitta diophthalma coxeni*).

458 This analysis also shows the importance of reviewing sighting records as more sightings and

459 more knowledge become available. The systematic review of both historical and future reports

460 of a poorly known species using the most up-to-date knowledge will provide the best

461 foundation for evidence-based management for such inherently difficult-to-conserve species.

462

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618

Supporting Information

620 Appendix S1. The scoring rubric used to assist expert assessment of each Night Parrot report.

621 Appendix S2. A table of all statements extracted from the literature relating to the status of the

622 Night Parrot.

623 Appendix S3. The database of all known Night Parrot reports. Names of individual observers

624 and informants have been removed. To protect recently discovered populations, the locations

625 of these sites have been adjusted in this database, and in the figures so that they represent a

626 general area (within 100 km), but not the precise location of the report.
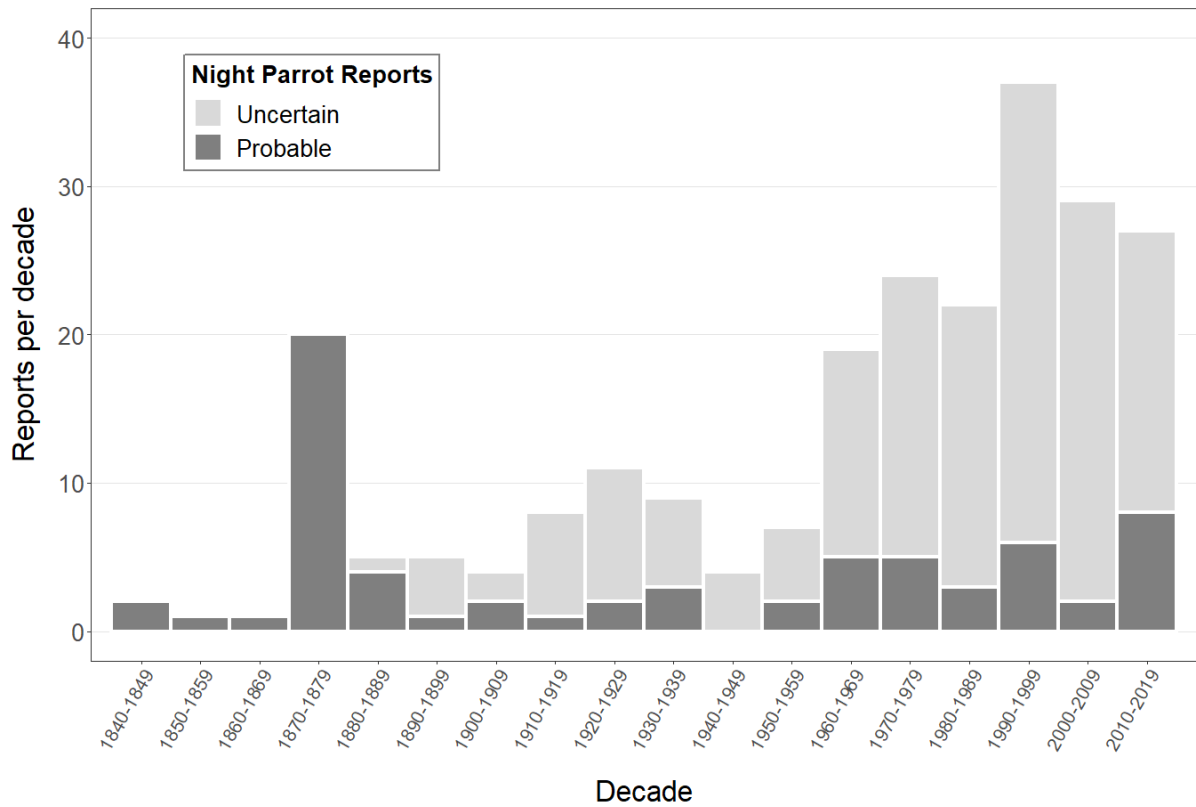
627

628   Fig. 1. Plot of both uncertain and probable Night Parrot reports per decade since the first

629   reported sighting in 1845, demonstrating a relatively consistent rate of confirmed sightings

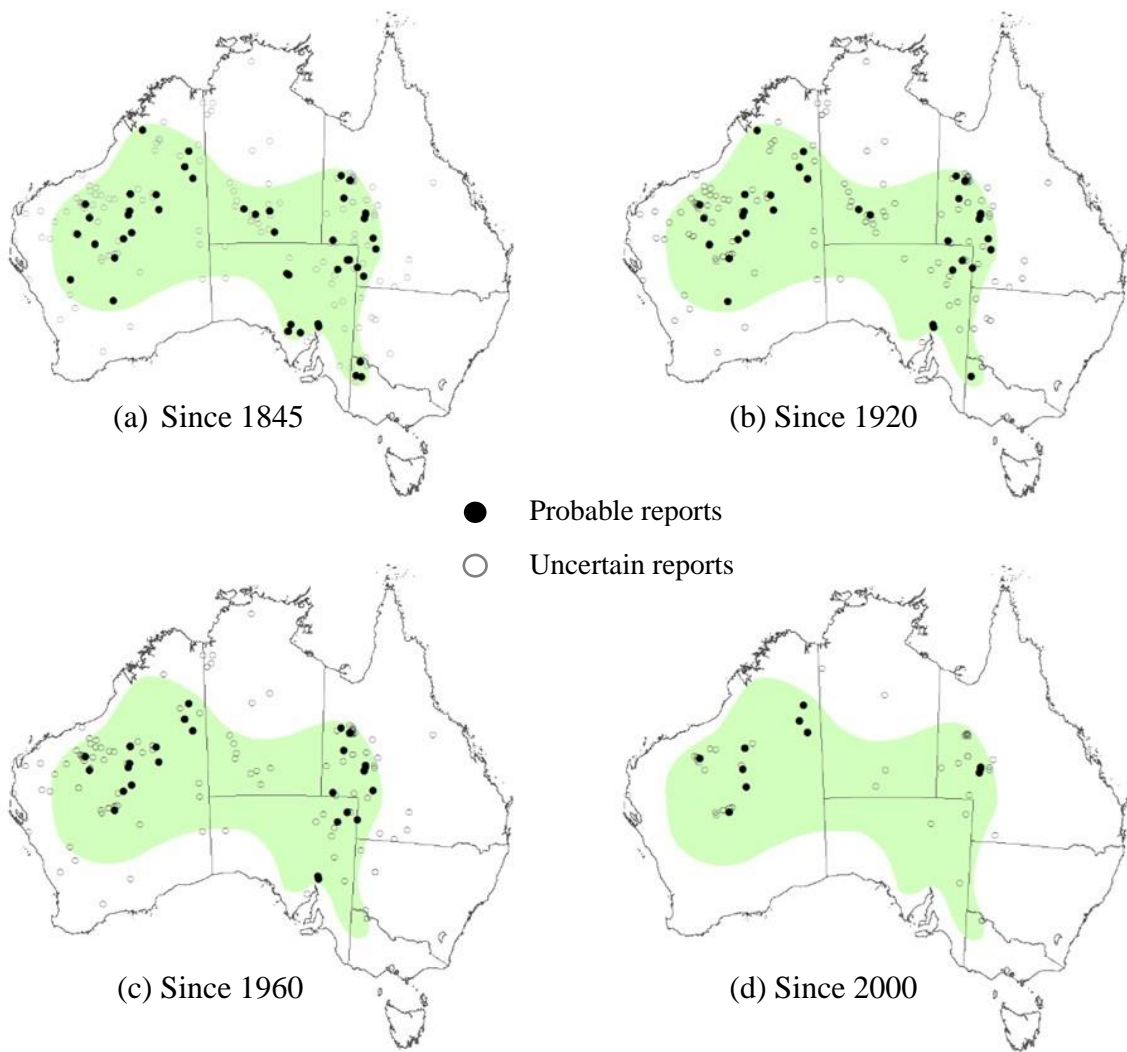630   against an increasing rate of unconfirmed reports.

Fig. 2. Probable and uncertain Night Parrot reports since (a) 1845, (b) 1920, (c) 1960 and (d) 2000. There is an apparent range retraction when compared against the approximate historical range (shaded green).
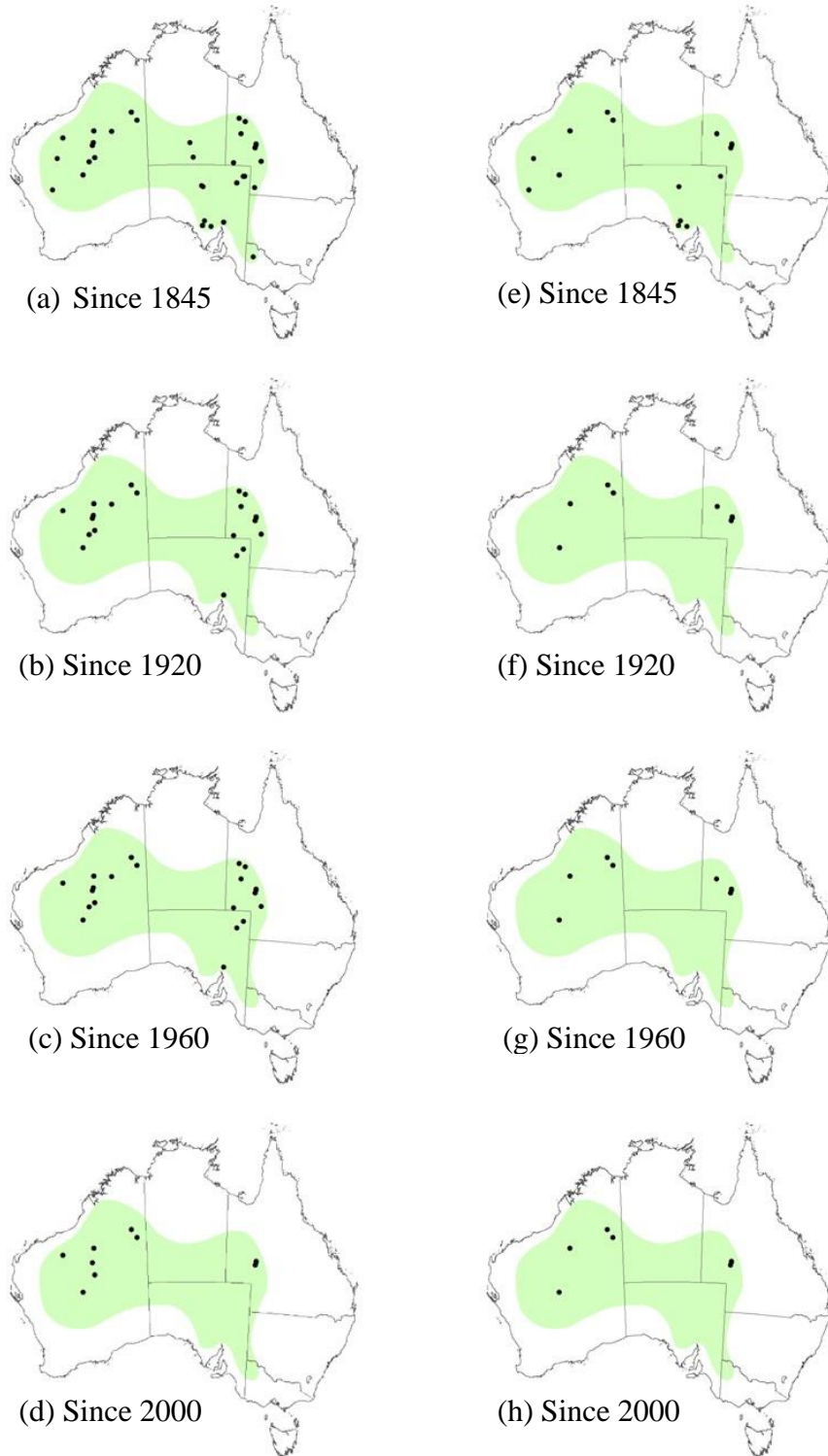
(a) Since 1845   (e) Since 1845

(b) Since 1920   (f) Since 1920

(c) Since 1960   (g) Since 1960

(d) Since 2000   (h) Since 2000

Fig. 3. Plot of likely Night Parrot records since (a) 1845, (b) 1920, (c) 1960 and (d) 2000, and very likely records since (e) 1845, (f) 1920, (g) 1960 and (h) 2000. Despite the increasing threshold, each demonstrates a similar pattern of contraction as the analysis using probable sightings.