



# Recent Estimates of Ring-Tailed Lemur (*Lemur catta*) Population Declines are Methodologically Flawed and Misleading

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Conserving and managing threatened species requires accurate population estimates. Recently, LaFleur *et al.* (2017) and Gould and Sauther (2016) attempted to estimate the size of the extant population of ring-tailed lemurs (*Lemur catta*) based on rapid field assessments and published counts from 32 and 34 sites, respectively, and estimated there to be fewer than 2500 ring-tailed lemurs remaining in the wild (Gould and Sauther 2016: 2000–2400 individuals; LaFleur *et al.* 2017: 2200 individuals). However, both studies have likely severely underestimated the size of the extant ring-tailed lemur population because of a range of methodological problems. Specifically, 1) the population status of several sites was misinterpreted from the literature, 2) population estimates for several important sites are incomplete or lacking, and 3) total population estimates are based on an incomplete sample of known populations.

## Misinterpretation of the Literature

Both studies depend primarily on published records; however, the data on presence and/or abundance of ring-tailed lemurs extracted from prior studies were misinterpreted or

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mischaracterized in several instances. For example, Gould and Sauther (2016) cite Gardner *et al.* (2009) to state that ring-tailed lemurs are likely extirpated from the Fiheranana–Manombo Complex (PK32 Ranobe). However, Gardner *et al.* (2009, p. 41) did record the species in both the Fiheranana and Manombo valleys and state: “Our failure to record [this] species elsewhere should therefore not be interpreted as implying their absence in other areas of the PA...” In addition, Gould and Sauther (2016) claim that there are three ring-tailed lemur groups in Nord–Ifotaka based on Semel and Ferguson (2013), although Semel and Ferguson (2013) was focused on characterizing the use of cliffs by lemurs, and not on surveying the ring-tailed lemur population. LaFleur *et al.* (2017) cite Irwin *et al.* (2005) for evidence that ring-tailed lemurs are extirpated from Pic d’Ivohibe and Kalambatritra, yet the latter paper reports a multisite census that 1) did not include Pic d’Ivohibe and 2) did not census the areas of Kalambatritra where ring-tailed lemurs are thought to occur. Finally, LaFleur *et al.* (2017) cite Moniac and Heitmann (2007) to estimate Andohahela’s ring-tailed lemur population at 82 individuals; however, this publication is merely an observation of two hunted lemurs within a pit near the National Park, and we were unable to determine the origin of the number 82.

### Incomplete Sampling within Survey Sites

Of the sites included in the papers, counts/population estimates are incomplete or lacking for many important areas. For example, Gould and Sauther (2016) include no data for several protected areas with well-known populations including Isalo and Zombitse-Vohibasia National Parks. In addition, both surveys consistently use count data from limited survey localities, but present these data as population estimates for entire protected areas. Thus, the figures likely represent severe underestimates of the population sizes at these sites. For example, Tsimanampetsotse National Park covers >200,000 ha, yet the population data presented are based on counts at two locations only and are not extrapolated for the whole National Park (LaFleur *et al.* 2017).

### Incomplete Geographic Coverage of Sites Considered

The two studies’ total population estimates were derived from 32 and 34 sites each, rather than systematic range-wide censuses or models, but these sites form an incomplete and potentially unrepresentative sample of known ring-tailed lemur populations. More than 100 ring-tailed lemur populations are known historically (Goodman *et al.* 2006), and we are aware of at least 45 localities at which the species has been observed since 2000, but that were not included in either of the recent studies or were erroneously included as extirpated (Table I; Electronic Supplementary Material [ESM] Fig. S1). Beyond these known populations, large areas of suitable habitat occur throughout southern Madagascar that have never been censused (ESM Fig. S1). While LaFleur *et al.* (2017) acknowledge their total population estimate as being limited to surveyed sites, Gould and Sauther (2016, p. 94) state that their research “represents all *known* populations,” and misleadingly present their estimate of 2000–2400 individuals as the total wild population of the species globally. Gould and Sauther (2016) also propose a new distribution map for the species, but omit vast areas of

**Table 1** Additional known locality records for ring-tailed lemur (*Lemur catta*) since 2000 that were not included in the population estimates published by Gould and Sauther (2016) and LaFleur et al. (2017). See Electronic Supplementary Material (ESM 1) for map of locations and references

No.	Locality	Source	Coordinates
1	Ankotapiky (Mikea)	Ganzhorn and Randriamanalina (2004)	21°52'09.3"S, 43°21'16.1"E
2	Abrahama-Jiloriaky (Mikea)	Ganzhorn and Randriamanalina (2004)	22°48'1"S, 43°25'6"E
3	Middle Mangoky 1	Ravoahangy et al. (2008)	21°41'14"S, 44°19'45"E
4	Middle Mangoky 2	Ravoahangy et al. (2008)	21°48'52"S, 44°08'24"E
5	Manombo	Gardner et al. (2009)	22°48'16"S, 43°45'38.7"E
6	Fiherenana	Gardner et al. (2009)	23°10'28.2"S, 43°57'42.2"E
7	Analavelona	Ravoahangy et al. (2008)	22°40'40"S, 44°11'30"E
8	Lavenombato	C. Gardner and L. Jasper pers. obs.	23°34'52.93"S, 43°49'57.24"E
9	Antafoky	Emmett et al. (2003)	23° 29'12.79"S, 44°4'26.52"E
10	Manderano	Emmett et al. (2003)	23° 31'46.15"S, 44°5'31.27"E
11	Sept Lacs	Emmett et al. (2003); C. Gardner and L. Jasper pers. obs.	23° 31'23.79"S, 44°9'38.34"E
12	Ranomay	C. Gardner and L. Jasper pers. obs.	23°34'28.73"S, 44°19'41.53"E
13	Vombositse	Ralison (2008)	24°11'3"S, 43°45'9"E
14	Antabore (Itampolo)	Ralison (2008); Raselimanana et al. (2005)	24°23'9"S, 43°50'8"E
15	Tongaenoro (Itampolo)	Ralison (2008); Raselimanana et al. (2005)	24°44'2"S, 44°01'8"E
16	Vohindefo	L. Jasper pers. obs.	25° 10'15.07"S, 44°32'8.32"E
17	Ankirkiriky Village (Marolinta)	B. Ferguson pers. obs.	25° 5'56.38"S, 44°37'3.07"E
18	Ankirkiriky Sacred Forest (Marolinta)	B. Ferguson pers. obs.	25° 5'11.88"S, 44°37'15.40"E
19	Main Road near Tsimilofo (Beloha)	B. Ferguson pers. obs.	24°57'7.18"S, 45°10'15.67"E
20	Vohipary (Andalatanosy)	B. Ferguson pers. obs. Sterman (2012)	24°36'8.14"S, 45°33'17.81"E
21	Vohitrosy, Elonty (Dadabe Matory)	B. Ferguson pers. obs.	24° 5'39.35"S, 46°10'20.54"E
22	Besakoa Ambany (Mahaly)	B. Ferguson pers. obs.	24°13'9.71"S, 46°14'16.52"E
23	Vohidava North (Anadabolava)	B. Ferguson pers. obs.	24°13'30.11"S, 46°16'18.63"E
24	Anadabolava 1	Ravoahangy et al. (2008)	24°12'38"S, 46°18'02"E
25	Anadabolava 2	Ravoahangy et al. (2008)	24°21'20"S, 46°10'51"E
26	Mitakeba Village (Imanombo)	B. Ferguson pers. obs.	24°34'52.07"S, 45°52'58.05"E
27	Vohitsiombe West (Kapila)	B. Ferguson pers. obs. Sass (2011)	24°25'22.18"S, 46° 6'9.87"E
28	Vohitsiombe East (Ebelo)	B. Ferguson pers. obs.	24°25'16.22"S, 46° 7'16.95"E
29	Betenina Andranobe (Tranomaro)	B. Ferguson pers. obs.	24°26'11.69"S, 46°24'42.26"E
30	Angavo East (Antanimora)	Rowland et al. (2011)	24°52'1.60"S, 45°49'50.23"E
31	Angavo South West 1 (Antanimora)	Rowland et al. (2011)	24°53'24.13"S, 45°48'38.93"E

**Table I** (continued)

No.	Locality	Source	Coordinates
32	Angavo South West 2 (Antanimora)	Rowland <i>et al.</i> (2011)	24°54'44.02"S, 45°47'41.96"E
33	Kobokara (Ifotaka)	B. Ferguson <i>pers. obs.</i> Scherz <i>et al.</i> (2012)	24°44'58.75"S, 46° 2'33.16"E
34	Ankazonampingaratsé (Mahabo)	B. Ferguson <i>pers. obs.</i>	24°41'9.10"S, 46° 8'29.33"E
35	Befinenetse (Ifotaka)	B. Ferguson <i>pers. obs.</i>	24°45'5.60"S, 46° 9'40.79"E
36	Anjatsikolo Vohimamy (Ifotaka)	B. Ferguson <i>pers. obs.</i>	24°45'39.86"S, 46°10'16.39"E
37	Zanavo (Ifotaka)	B. Ferguson <i>pers. obs.</i>	24°48'25.29"S, 46° 4'22.15"E
38	Ambolihena (Ifotaka)	B. Ferguson <i>pers. obs.</i>	24°47'42.77"S, 46° 8'31.59"E
39	Betamboro (Ifotaka SW)	King <i>et al.</i> (2011)	24°53'15.52"S, 46° 3'55.70"E
40	Behira (Beharimo)	B. Ferguson <i>pers. obs.</i>	24°51'46.68"S, 46°12'22.07"E
41	Vohondava (Tranomaro)	Ralison (2008); Raselimanana <i>et al.</i> (2005)	24°41'2"S, 46°27'2"E
42	Ampiaky Tsilamaha (Tranomaro)	B. Ferguson <i>pers. obs.</i>	24°43'14.57"S, 46°29'56.44"E
43	Bevia Gallery Forest (Behara)	Denton (2003)	24°50'56.32"S, 46°26'52.70"E
44	Bevia Spiny Forest (Behara)	Denton (2003)	24°51'26.24"S, 46°27'58.60"E
45	Ankodida (Amboasary Sud)	Gardner <i>et al.</i> (2008); B. Ferguson <i>pers. obs.</i>	25° 2'37.60"S, 46°30'51.71"E

unsurveyed suitable habitat without presenting any evidence for their assumption that these areas are devoid of ring-tailed lemurs: of our 45 additional localities, about half ( $N = 23$ ) lie outside of their suggested distribution areas.

## Conclusion

As both LaFleur *et al.* (2017) and Gould and Sauther (2016) highlight, there is ample evidence that the ring-tailed lemur has suffered population declines, local extinctions, and an overall range contraction in recent decades. However, the species continues to occur in at least 18 protected areas (Ambatotsirongorongo, Amoron'ny Onilahy, Ankodida, Analavelona, Andohahela, Andringitra, Angavo, Behara-Tranomaro, Beza-Mahafaly, Complexe Anadabolava, Complexe Mangoky-Ihotry, Kirindy-Mite, Mikea, Nord-Ifotaka, Ranobe-PK32, Tsinjoriake, Tsimanampesotse, Zombitse-Vohibasia) as well as community-managed and private reserves, and is protected by robust cultural norms (*fady/faly*) that prevent its consumption by people through much of its range. Therefore we do not believe that the species is “headed for imminent extirpation” as suggested by Gould and Sauther (2016, p. 89). Rather, we believe that both studies have likely greatly overstated the severity of the species' decline. LaFleur *et al.* (2017) suggest there may have been a 95% decline in the ring-tailed lemur population since 2000 by comparing their estimate to that of Sussman *et al.* (2006). However, both Sussman *et al.* (2006, p. 17) and LaFleur *et al.* (2017, p. 320) characterize their estimates as “preliminary.” Given the numerous caveats associated with both studies and their use of very different methods, the figure of 95% decline cannot be considered valid or reliable.

The use of unreliable scientific data in conservation can lead to suboptimal decision making and may also undermine the credibility that scientists and conservationists depend on for public confidence in our findings and actions. Recent online headlines such as “Ring-tailed lemur populations have crashed by 95%” (Platt 2017), generated by the research under discussion, are misleading and risk delegitimizing and undermining critical conservation and research efforts throughout Madagascar at a time when they are required more than ever. If population estimates are to be generated to inform the conservation of threatened primate species, then they must be based on rigorous census methods, robust density estimates (not counts of individuals), and make full use of existing knowledge of species’ range to ensure accurate and reliable assessments.

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