

The effect of collar weight and capture frequency on bodyweight in feral cats (*Felis catus*)

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ABSTRACT

Context. Animal-borne devices can affect animal survival, reproduction, and behaviour through both the addition of weight and bulk and the direct effects of initial and subsequent capture. Researchers commonly employ a general rule of thumb that weight of the device must be less than 5% of bodyweight for terrestrial animals; however, this threshold has little empirical basis. **Aims.** We evaluated the effects of environmental variables, repeated capture, and weight of animal-borne devices on bodyweight in free-ranging feral cats. **Methods.** We recaptured feral cats at varying frequencies, wearing GPS and/or VHF collars that ranged from 0.29% to 4.88% of bodyweight, and recorded change in cat weight over time. **Key results.** Collar weight as a percentage of bodyweight was not a significant predictor of feral cat weight change. Rather, change in bodyweight was best described by a negative relationship with an increasing temperature and number of captures, and a positive relationship with time since collar attachment. **Conclusions.** Capture had a significant influence on feral cat weight but collar weights up to 5% of bodyweight did not significantly contribute to weight loss. However, the absence of control cats without collars hindered definitive conclusions on the effect of collar weight on cat weight change. **Implications.** Researchers should space capture and handling events more than 30 days apart to reduce effects of weight loss from capture and handling. Researchers should also consider increasing collar weight and reducing frequency of capture (where collars are less than 5% of bodyweight), particularly if cat bodyweight is a parameter of interest.

Keywords: biollogger, bodyweight, capture, collar impacts, condition, handling, neophobia, recapture, stress, weight change.

Introduction

Of critical importance to wildlife conservation and management is ecological knowledge of animal life histories, such as habitat requirements, foraging and reproductive behaviour, movement, dispersal, and home-range attributes. Such data provide stakeholders with the practical knowledge required to make informed management decisions. However, gathering this information from wild animals in their natural habitat can be challenging. Many species are cryptic, whereas others live in environments where direct observation is challenging or impossible (Cooke *et al.* 2013; Wilmers *et al.* 2015).

The development of animal-borne devices or biolloggers to overcome these difficulties has dramatically expanded the range of animals that can be studied by researchers (Portugal and White 2018), as well as provided the opportunity to understand aspects of animal physiology and ecology that were not previously possible (Rutz and Hays 2009). These devices have revealed remarkable long-distance movements (McGregor *et al.* 2016; Pilfold *et al.* 2017; Pedler *et al.* 2018), exposed novel hunting behaviours (Sakamoto *et al.* 2009; Troschianko and Rutz 2015; Korpela *et al.* 2020), and allowed observation of environmental conditions in inaccessible habitats (Charrassin *et al.* 2008; Hussey *et al.* 2015).

However, in some studies, animal-borne devices have been found to change behaviour (Aldridge and Brigham 1988; Bruholt 2018), energetics (Godfrey *et al.* 2003), survivorship (Osborne *et al.* 1997; Rasiulis *et al.* 2014), and reproduction (Demers *et al.* 2003; Venturato

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et al. 2009), potentially introducing bias and compromising research validity (Casper 2009). Conversely, other studies have recorded no physiological or behavioural impacts on animals from biologgers (Hines and Zwickel 1985; Laurenson and Caro 1994; Thirgood *et al.* 1995; Bank *et al.* 2000; Golabek *et al.* 2008). Recognition of the potential for animal-borne devices to influence results is critical to making informed inferences and conclusions. Consequently, studies using animal-borne technologies commonly employ a general rule of thumb about the weight of the devices relative to the animal's body size. For non-flying terrestrial animals, a commonly used rule is that weight of the device must be less than 5% (e.g. Tuytens *et al.* 2002) or sometimes 3% (e.g. McGregor *et al.* 2017) of total bodyweight of the animal to reduce potential behavioural or physiological effects. However, the empirical basis and origin of these thresholds is unclear (Barron *et al.* 2010), and they have been frequently exceeded (see Portugal and White 2018). Negative effects have also been detected when the weight of the device is less than 5% of bodyweight (Aldridge and Brigham 1988; Coughlin and van Heezik 2015). For instance, several studies have demonstrated negative effects of biologgers on bodyweight. Adult red foxes (*Vulpes vulpes*) in captivity wearing collars of 1–2% bodyweight significantly decreased in weight relative to uncollared control foxes (Bruholt 2018), while San Joaquin kit foxes (*Vulpes macrotis mutica*) experienced a decrease in bodyweight shortly after collaring relative to uncollared foxes. Collars ranged from 3% to 7% of bodyweight, but decrease in bodyweight did not differ significantly among collar designs (Cypher 1997).

Fixed limits on device weight are commonly accepted by ethics committees and adopted by researchers because of the lack of more refined knowledge on species and device-specific effects. Ideally, guidelines should be based on empirical examination of the negative effects, or lack thereof, caused by device deployment, as determined for the species, device size and deployment duration required for a particular study (Casper 2009; Barron *et al.* 2010; White *et al.* 2013; Bodey *et al.* 2018; Portugal and White 2018).

Introduced cats (*Felis catus*) are one of the most harmful and widespread of invasive mammalian predators (Doherty *et al.* 2016), found on many offshore islands and on all continents bar Antarctica. Feral cats have had substantial impacts on wildlife populations (Loss *et al.* 2013; Nogales *et al.* 2013; Bellard *et al.* 2016; Duenas *et al.* 2021), and have been especially detrimental on islands (Burbidge and Manly 2002; Medina *et al.* 2011). Because of their cryptic nature, many studies have used biologgers to gather information on cat hunting behaviour (Moseby and McGregor 2022), home-range size and habitat use (Moseby *et al.* 2009; Recio *et al.* 2010, 2014; McGregor *et al.* 2014, 2017), long-distance movements (Guttila and Stapp 2010; McGregor *et al.* 2016; Jansen *et al.* 2021), and predation rates (Lloyd *et al.* 2013; McGregor *et al.* 2015), to better inform management of the invasive species. All of these studies used collars of <5%

bodyweight and, in some cases, <3% or 4%. However, Coughlin and van Heezik (2015) put GPS collars between ~0.86% and 3.11% of bodyweight on 20 domestic cats, and found collars greater than 2% bodyweight could reduce cat home range by 15% relative to lighter collars. These tracked domestic cats had smaller home ranges (<2 ha) than those reported for feral cats (e.g. 50–12,300 ha Moseby *et al.* 2009). They were also fed by their owners so did not need to hunt to satisfy their energy requirements and could potentially afford to reduce their ranging and hunting behaviour. The authors suggest that this evidence for reduced mobility in domestic cats indicates that feral cats wearing devices may also be similarly affected, and recommend that collars on feral cats should be no more than 2% of the cat's bodyweight (Coughlin and van Heezik 2015).

As well as the potential effect of wearing a logging device, study animals must also cope with the stress involved in the capture and fitting or checking of devices. Wild mammals exhibit acute stress responses in reaction to researcher interventions (see also Engelhard *et al.* 2002; Harcourt *et al.* 2010; reviewed by Cockrem 2013). Significant human-induced stress responses have been associated with reduced fecundity (Alibhai *et al.* 2001), lower survival (Breed *et al.* 2019), and altered behaviour (Rachlow *et al.* 2014). To cope with the energetic cost incurred by mounting a stress response, an animal must either use stored reserves, or divert resources used for other physiological functions (Moberg 2000). Energy reserves are usually stored as fat, and the biological cost model (Moberg 2000) predicts that stress should cause a loss of bodyweight as fat and other energy stores are expended. Consequently, change in bodyweight has been shown to be a practical and relevant proxy for chronic stress responses (McLaren *et al.* 2004; Moorhouse *et al.* 2007; Gelling *et al.* 2010).

In the present study, we used change in bodyweight to estimate the potential for adverse impacts of bilogger collaring on feral cats, and investigated whether lighter collars reduced this impact. We used data from 50 free-living feral cats collared during two time periods in the same study area (McGregor *et al.* 2020a; Van der Weyde *et al.* 2023), with collars ranging between 0.29% and 4.88% of total bodyweight. We measured the effect of collar weight, number of recaptures, period of deployment, and environmental variables on the change in bodyweight over time.

Methods

Study site

Our research was conducted at Arid Recovery, a 123 km² fenced conservation reserve in central South Australia (−30.37144°N, 136.90409°E). The climate is arid with hot dry summers and mild winters, likelihood of rainfall does not vary

by month and the long-term average annual rainfall is 144.5 mm (Records from Olympic Dam Aerodrome, www.bom.gov.au/climate/data, accessed March 2022). The habitat is dominated by longitudinal dunes separated by interdunal clay swales, with a small number of minor ephemeral creek lines. Dunes support sparse *Acacia* and *Dodonaea* shrubland, whereas swales are covered in low (~50 cm) chenopod (*Maireana* spp. and *Atriplex* spp.) species. The reserve is divided into six paddocks, with cats, foxes, and rabbits (*Oryctolagus cuniculus*) removed from four of these, totalling 60 km², whereas the remaining two paddocks 'Red Lake' (25 km²) and the 'Experimental Paddock' (37 km²) contain populations of feral cats and rabbits and are used for landscape-scale manipulation experiments (e.g. Moseby *et al.* 2012; West *et al.* 2018; Ross *et al.* 2019; McGregor *et al.* 2020a).

Study design

Our study took place in the Experimental Paddock across two periods, the first from August 2016 to February 2017, and the second from April 2021 to December 2021. In the first period, resident cats were captured in the Experimental Paddock using cage traps and soft-jaw leg traps (Victor #1.5), with cat urine as lure. The purpose of this study was to understand how cats responded to rabbit control (McGregor *et al.* 2020a). For the second period, cats were caught for a study testing the extent of neophobia towards a novel method of feral cat control. These cats were primarily caught outside the reserve using the same methods as in 2016–2017, and released into the Experimental Paddock. Cats were removed from traps and placed into a dark canvas handling bag and were then semi-restrained and fitted with either a VHF, GPS, or video collar of varying weight. No chemical restraint was used, and fitting of collars typically took less than 15 min. Cats were then either released immediately at point of capture, or if temperatures were above 37°C held and housed within a covered cage trap in a cooled shed, and released in the evening at point of capture. Because the cats were collared to monitor their movement and survival, we did not release and recapture a control group of cats without collars.

Cats were typically recaptured after 1 week to 6 months by tracking them, and then netting them or chasing to their daytime burrow and placing a cage-trap at the entrance. Once captured, cats were placed in a dark bag and processed without sedation. We measured weight with a tared 10 kg spring scale (Salter Super Samson 10 kg, 50 g accuracy). In most instances, a new collar of variable weight was placed on the cat, and it was re-released. Cats were recaptured up to six times over the course of the study to check collar fit, change collars and/or download data. Methods were approved by University of Tasmania (A0015720), University of Adelaide (S-2016-112), and University of New South Wales (#20-109A) Animal Ethics Committees.

Analysis

Change in bodyweight was analysed using a candidate set of multivariate linear mixed models using the function *glmmTMB* (Brooks *et al.* 2017) in R ver. 4.3.2 (www.r-project.org, accessed April 2024). Explanatory variables included collar weight as a percentage of bodyweight (calculated from weight at previous capture), total number of days since collar was deployed to investigate whether cats habituated to collars over time, the number of times the cat had been recaptured, to test the effect of repeat-handling stress, weight of cat when first captured as a demographic measure, experimental period (2016–2017 or 2021) to explore changes caused by experimental design, rainfall in the past 6 months, and average maximum daily temperature in the month preceding capture, with individual cat ID included as a random effect. Rainfall and temperature data were sourced from the Bureau of Meteorology (<https://reg.bom.gov.au/climate/data/>) from the closest registered recording location for which data were available over the study period (Olympic Dam Aerodrome, 25 km from the Experimental Paddock, or Andamooka, 30 km from the Experimental Paddock). Because comparable information on prey availability was not available for both study periods, we used rainfall and temperature as an indication of resource availability. Rainfall triggers resource booms in arid Australia, which lead to increases in abundance of a range of desert animals that are preyed on by cats (Letnic *et al.* 2005), and temperature also alters prey availability because it influences the breeding patterns of rabbits in the study area (Bowen and Read 1998).

We compared models of all combinations of variables without interactions (128 models) by using the Akaike information criterion corrected for small sample sizes (AICc). Parameter estimates were derived for models with delta AICc of 2 or less, and averaged in a model-averaging information-theory framework using the R function *MuMIn::model.avg*, ver. 1.47.5, available at <http://CRAN.R-project.org/package=MUmin> (Barton 2011). Models were visually presented with the R function *effects::predictorEffects* ver. 4.2-2, available at <https://CRAN.R-project.org/package=effects> (Fox and Weisberg 2018).

Results

Over the two study periods, we caught and collared 50 feral cats and recorded a total of 98 recaptures. Cats carried collars for a minimum of 1 day and a maximum of 231 days between captures (mean = 54.8, s.d. = 44.3 days), and were recaptured on average 1.91 times, with s.d. of 1.18 (min = 1, max = 6 times). Collars ranged between 0.29% and 4.88% of total bodyweight (mean = 2.04, s.d. = 1.22), and cat weight averaged 4.04 kg (s.d. = 0.93 kg), with a minimum of 2 kg and a maximum of 6.4 kg (Fig. 1).

Of the 128 models compared, seven had delta AICc of ≤2 (Table 1), and were subsequently averaged in an information-theory framework.

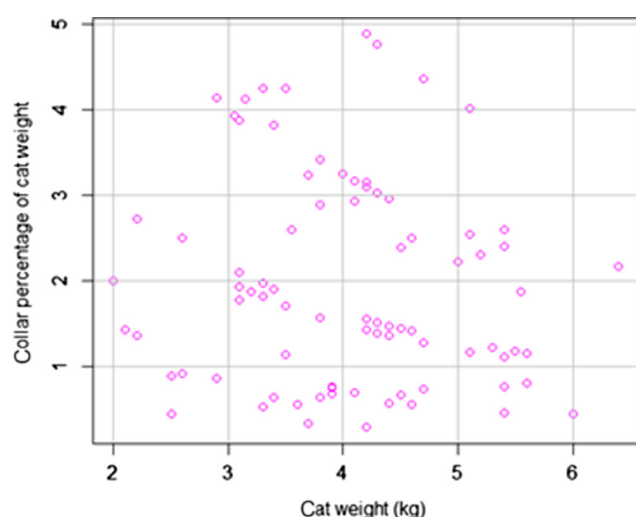


Fig. 1. Spread of cat weights (kg) and percentage weights of collar deployed on feral cats at Arid Recovery in 2016–2017 and 2021.

The most important variables for explaining changes in cat weight on recapture were the preceding average maximum monthly temperature, the number of recaptures, and the number of days the collar had been on since last recapture (Table 2). Experimental period, rainfall in the previous 6 months, initial cat weight, and the percentage of bodyweight of the collar were also included in the model averaged output; however, these terms were not significant predictors of cat weight (Table 2).

Table 1. Model selection table of top candidate models with delta AICc ≤ 2 , predicting change in cat weight with variables such as average maximum temperature (max temp.), number of captures, days since collar was deployed (days), experimental period 2016–2017 or 2021 (exp. period), rainfall in the past 6 months (rainfall), weight of cat at first capture (initial weight), and collar percentage of bodyweight (collar percentage).

Model	d.f.	LogLik	AICc	Delta	Weight
Max temp. + number of captures + days	6	−78.31	169.53	0.00	0.26
Max temp. + number of captures + days + exp. period	7	−77.73	170.71	1.17	0.15
Max temp. + number of captures + days + exp. period + rainfall	8	−76.62	170.85	1.31	0.14
Max temp. + number of captures + days + rainfall	7	−77.87	170.99	1.45	0.13
Max temp. + number of captures + days + initial weight	7	−77.87	170.99	1.45	0.13
Max temp. + number of captures + collar percentage + days	7	−78.08	171.40	1.87	0.10
Max temp. + number of captures	5	−80.41	171.48	1.94	0.10

Table 2. Averaged parameter estimates of models with delta AICc ≤ 2 selected from 128 models of combinations of explanatory variables.

Explanatory variable	Number of models	Importance	Coefficient	s.e.	Adjusted s.e.	z	P-value
Average maximum temperature	7	1	−0.024	0.010	0.010	2.44	0.015
Number of captures	7	1	−0.116	0.050	0.050	2.30	0.022
Days collar on	6	0.9	0.003	0.001	0.001	2.05	0.040
Experimental period	2	0.28	0.185	0.145	0.147	1.26	0.208
Rainfall in the past 6 months	2	0.26	0.002	0.002	0.002	1.16	0.245
Previous weight	1	0.13	−0.061	0.065	0.066	0.92	0.357
Collar percentage of bodyweight	1	0.10	−0.031	0.046	0.047	0.67	0.506

Terms in bold indicate statistically significant variables.

Collar weight as a percentage of bodyweight (Fig. 2a) was not a significant predictor of change in cat weight on recapture ($P = 0.506$). Rather, our model predicted that cat weight change declined by 24 g (s.e. 10 g, $P = 0.015$) for each increase in temperature of one degree Celsius (Fig. 2b). After each successive recapture, predicted cat weight change declined by 116 g (s.e. 50 g, $P = 0.022$) (Fig. 2c). However, we also found a positive relationship between weight change and the amount of time that had passed since the cat was last captured, whereby weight change increased by 3 g per day (s.e. 1 g, $P = 0.040$) between successive recaptures (Fig. 2d).

Discussion

We found no significant relationship between collar weight and cat weight change in recaptured feral cats. However, our experimental design does not allow us to rule out a potential effect of wearing any collar on effecting weight change, because we did not have a control sample of uncollared feral cats.

Coughlin and van Heezik (2015) described reductions in movement from domestic cats wearing collars of approximately 3% bodyweight. Likewise, it is possible that our cats reduced movement but that this did not lead to weight loss. Coughlin and van Heezik (2015) indicated that the impact of heavier devices on home-range size and distances travelled suggested

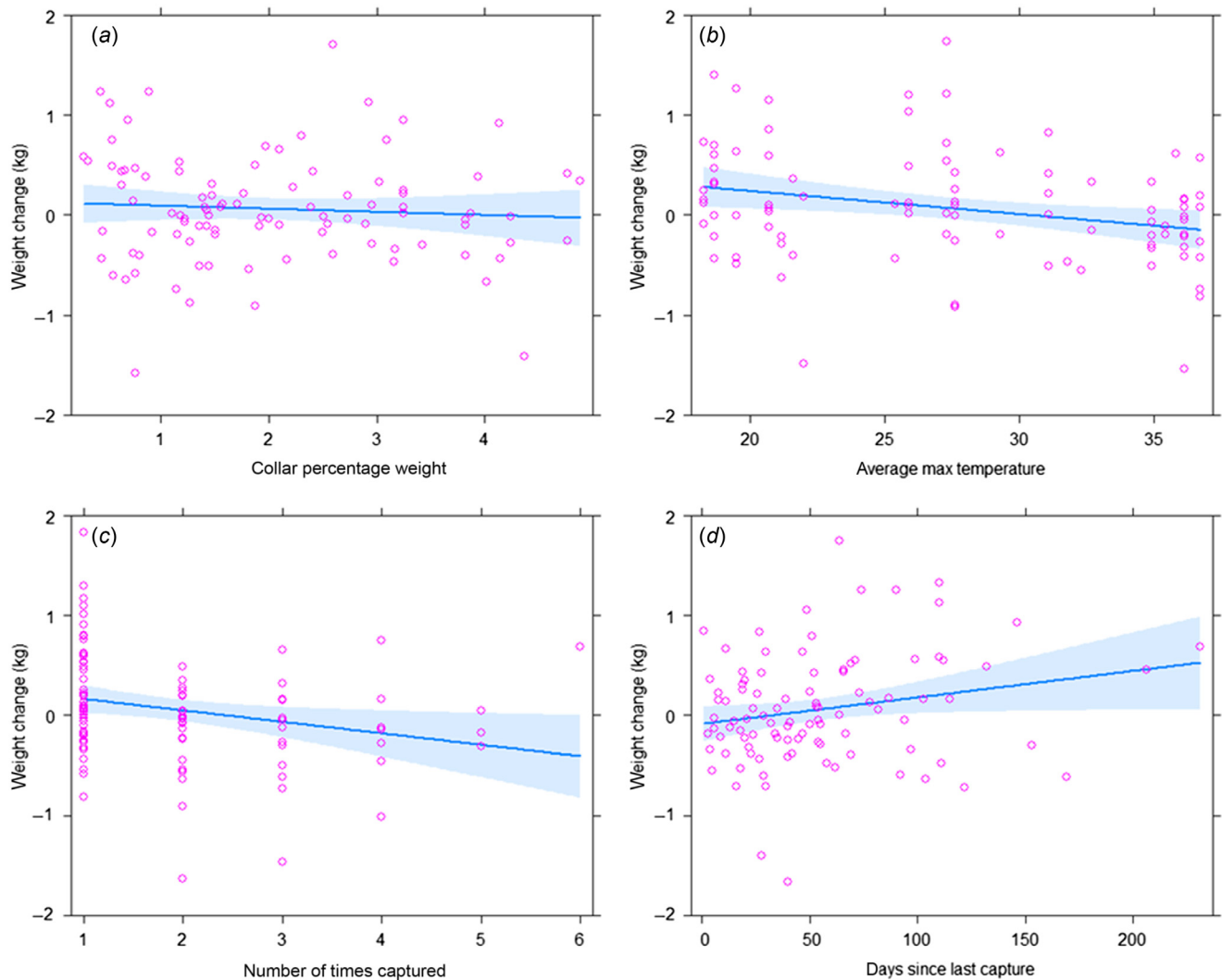


Fig. 2. Model output of predictor variables (a) collar percentage of bodyweight, (b) average maximum temperature, (c) number of times captured and (d) days since the last capture, versus change in cat bodyweight (kg) on recapture.

that devices worn by cats may influence energy expenditure, and to accommodate increased energy expenditure cats could reduce high-energy behaviours, such as ranging and hunting. However, unlike feral cats, domestic cats are fed by their owners and do not need to hunt to satisfy their energy requirements; so, they can potentially afford to reduce their ranging and hunting behaviour, whereas feral cats may not. Unfortunately, as we did not directly measure movement or energy expenditure, we were unable to monitor for any behavioural change that may have offset the increased energy requirements. Alternatively, just as other research has found no influence of animal-borne devices on energy expenditure or foraging behaviour (Berteaux *et al.* 1996; Golabek *et al.* 2008), feral cats may simply be more tolerant of heavier collars. Cats are primarily ambush predators, relying on a 'sit-and-wait' strategy that relies on stalking and camouflage (e.g. Judge *et al.* 2012; Moseby and McGregor

2022); so, carrying the extra weight of a collar may not have a material impact.

Monthly maximum temperature was found to have a significant negative effect on feral cat bodyweight. This may occur because juvenile rabbits are less abundant in late summer, because rabbits breed from late winter to early summer in the study area (Bowen and Read 1998). Small juvenile rabbits are likely to be easier for smaller non-breeding female cats and/or younger inexperienced cats to hunt, because smaller cats may be less effective at catching larger prey (Read and Bowen 2001; Fleming *et al.* 2020). This is supported by Moseby *et al.* (2021), who found a significant interaction between bodyweight and temperature on rabbit consumption by feral cats, with smaller cats feeding on rabbits only in the cooler months whereas larger cats fed on rabbits regardless of temperature. Approximately 215 g of fresh rabbit is capable of meeting a feral cat's daily energy

requirements (Plantinga *et al.* 2011), and so a reduction in the availability of a high-energy resource would likely affect feral cats' ability to maintain weight. In addition, higher temperatures could cause thermal stress in cats. Feral cats experience rapid increases in evaporative water loss and core body temperature when ambient temperatures rise above 30°C, increasing energy requirements to support thermoregulation, while also decreasing potential foraging time as cats seek refuge from extreme heat (Briscoe *et al.* 2022).

Rainfall in the previous 6 months was included in the model-averaged output; however, there was no support for this variable predicting cat bodyweight. Other studies have shown relationships between rainfall and small rodent abundance because they respond to the abundance of food provided by heavy rains (Read 1992; Brandle and Moseby 1999; Letnic *et al.* 2005). When numbers are high, rodents can be a key food resource for cats (Read and Bowen 2001; Plantinga *et al.* 2011; Doherty *et al.* 2015), and their availability is likely to influence change in cat bodyweight. Because we were unable to directly measure rabbit and rodent activity across the entire study period, it is possible that a relationship between bodyweight and prey availability was missed, or that prey abundance was always high enough to sustain the weights of feral cats in our study. However, it should be noted that although experimental period (2016–2017 or 2021) was not found to be a significant predictor of change in bodyweight, during the 2016–2017 study, there was a large and abrupt experimental reduction in rabbit numbers in the Experimental Paddock, which did cause a significant decline in survival and condition of feral cats (see McGregor *et al.* 2020a). In total, 8 of 21 cats survived by hunting native rodents along the southern fence line, where their abundance was likely to be greatest because of the proximity to the rest of the fenced reserve (McGregor *et al.* 2020b; Moseby *et al.* 2020), potentially causing a decline in small mammals in the Experimental Paddock also (McGregor *et al.* 2020a). In contrast, native rodent numbers were reported to be high throughout the 2021 period (Arid Recovery, unpubl. data) following good summer rains.

The number of times a cat was recaptured had a significant negative effect on bodyweight. After each successive recapture, our model predicted that change in feral cat weight was reduced by 116 g (s.e. 50 g). However, of 98 recaptures, only 25 represented cats caught three or more times. Although our model predicted a linear reduction in weight as cats were successively recaptured, confidence intervals around model predictions increased greatly after more than two recaptures, likely owing to small sample sizes. Without more data, we cannot conclusively demonstrate that change in weight was monotonic, and could potentially have been a single-step reduction in weight change that was maintained after multiple recaptures, possibly owing to cats acclimating to capture.

Regardless, reduction in weight owing to capture may be attributable to repeated stress caused by the capture and handling methods used. Wild mammals show an acute

stress response when they are captured and handled (Engelhard *et al.* 2002; Harcourt *et al.* 2010; Breed *et al.* 2019), which incurs an energetic cost (Moberg 2000) that could translate into an impact on bodyweight. Repeated handling stress has been shown to cause permanent reduction in bodyweight of adult lab rats (Harris *et al.* 1998; Zhou *et al.* 1999). In addition, other felids such as cheetah, *Acinonyx jubatus* (Braud *et al.* 2019), European wildcats, *Felis silvestris* (Monterroso *et al.* 2022), Bornean leopard cats, *Prionailurus bengalensis borneoensis* (Nájera *et al.* 2014), and Sunda clouded leopards, *Neofelis diardi* (Nájera and Hearn 2022), have also been recorded exhibiting stress responses to capture and handling. However, standard error was considerable, potentially because of differences in duration of recapture attempts, or transport of cats to cooled sheds for collaring on hot days. The stress caused by our most commonly used trapping method burrow traps in warrens may also be different from that caused by other methods such as cage trapping, spotlight netting, or leghold trapping. Changes in capture methods used between recapture attempts could also have contributed to the significant variation described by our model; however, methods were recorded inconsistently between sessions and so we were unable to include this explanatory variable in our models. Additionally, we did not use anaesthesia during restraint and collar fitting so as to minimise handling and recovery times; however, possibly handling aware animals is more likely to cause acute stress.

Another contributing explanation for a reduction in weight as a result of capture could be that neophobia induced by handling resulted in behavioural changes, potentially reducing foraging activity. Neophobia (aversion to new or unfamiliar stimuli) can be a plastic trait within individuals, which can be induced by exposure to high-risk environments (Brown *et al.* 2013). Neophobia benefits animals in high-risk environments, where novel stimuli are likely to be hazardous and so avoidance is advantageous (Greenberg 2003). However, putting energy into avoidance of novel stimuli can incur other costs such as reduced access to resources (Sol *et al.* 2011). Reduction in cat weight as a result of capture may also have been related to reduced access to resources. The sudden, stressful experience of capture and handling may have triggered an alteration of the cats perceived environmental risk, thereby creating a sustained reduction in their capacity to forage effectively.

Bodyweight was also positively correlated with the amount of time the collar remained on, or the time between successive recaptures. This could be attributed to younger cats growing and gaining weight steadily over time (Jones and Coman 1982); however, the absence of a reliable ageing mechanism for feral cats makes it difficult to determine whether there was a demographic effect at play. Heavier cats are perhaps likely to be older, but although the previous weight of cats was included in the model-averaged output, the term had low importance and the estimate was not statistically significant.

Additionally, longer periods between recaptures could also have allowed more time for cats to recover from associated stress, although an interaction between recapture number and time did not feature in any of the top-ranked candidate models. Regardless, because weight change was predicted to increase by 3 g each day post-capture, researchers seeking to minimise the physiological impact of multiple recaptures on feral cats could consider extending the intervals between captures to a minimum of 30 days. This approach could mitigate the adverse effects on cat weight attributed to the stress response induced by frequent recaptures.

Conclusions

Our results showed that captures affect bodyweight in cats. Research involving cat captures should factor that into their experimental design, especially if feral cat weight or condition over time is a parameter of interest.

Although we cannot conclude that wearing a collar had no effect on feral cat bodyweight, we did not find any evidence to suggest that increasing collar weight as a percentage of bodyweight influenced cat weight when collars were <5% of bodyweight. However, as we did not directly measure movement or energy expenditure, we were unable to detect any behavioural change that may have offset the possible increased energy requirements imposed by heavy collars. Future research should address this knowledge gap.

Given that increasing collar weight up to 4.88% did not affect cat weight, but number of recaptures did, it may be more prudent to increase collar weight to maximise data, and so reduce the need for successive recaptures. Alternatively, increasing the time between recaptures to at least 30 days could mitigate weight loss resulting from capture and handling. Future experiments should compare capture and handling methods (particularly with and without anaesthesia) to determine how they influence weight loss and stress levels in feral cats.

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Data availability. Our final raw data can be found at https://github.com/nedschofield/collar_impacts. Rainfall and temperature data are publicly available through sources cited within the text.

Conflicts of interest. Sarah Legge is an Editor of Wildlife Research. To mitigate this potential conflicts of interest they were blinded from the review process.

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