Trapping and capture myopathy in Ludwig's Bustard

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Received 15 April 2013. Accepted 22 August 2013

Banding and deploying tracking devices are important techniques to study birds of conservation concern, but require that individuals can be safely and efficiently caught and handled. We describe the trapping techniques used to catch Ludwig's Bustards (*Neotis ludwigii*) in the Karoo, South Africa, for a satellite tracking programme aiming to better understand the movement biology of this poorly known and threatened bird. Trapping sites on transformed land used as congregation sites were difficult to locate for these nomadic and partially migratory birds, but six of nine prospective trapping trips were successful. Although labour-intensive, extensive deployment of leg nooses coupled with guide-lines to direct birds proved effective. We caught 12 bustards at four sites across the Karoo over 37 trapping days in 2010–2012. Success was male-biased, with only two females caught. Noose traps were safe, with no injuries to captured birds. However, in common with other studies, we encountered problems with capture myopathy after handling five bustards; two subsequently died and three recovered. We designed a 'harnessing chair' to reduce the risk of capture myopathy, but still encountered problems. We recommend noose traps with guide-lines to catch other large, wary birds in open environments where there is some predictability of habitat use, but caution against long handling times and trapping in extreme temperatures.

Key words: *Neotis ludwigii*, noose traps, capture myopathy, guide-lines, Karoo.

INTRODUCTION

Ringing, marking and satellite tagging are important techniques in bird research and conservation, but they rely on developing safe, efficient and often species-specific trapping methods (Bub 1991; Kenward 2001; Ponjoan *et al.* 2010). Ludwig's Bustard (*Neotis ludwigii*) is a large (2.2–6.0 kg), open-country bird endemic to the dry Karoo and Namib regions of southern Africa (Allan 2005). This species is wide-ranging through poorly understood nomadic and migratory movements, and is highly susceptible to collision with overhead power lines (Allan 1994; Jenkins *et al.* 2010). Levels of mortality observed on power lines are thought to be unsustainably high, and Ludwig's Bustard was listed as globally Endangered in 2010 (Jenkins *et al.* 2011; BirdLife International 2012). A satellite tracking study was initiated to better understand both the bird's basic ecology and the collision threat posed by the power grid (Shaw 2013), which required that we capture and tag live birds.

Many techniques have been trialled worldwide for trapping bustards in various habitats and conditions, including cannon nets, rocket nets, spotlighting, herding with vehicles into static nets, noose traps, decoys, dummy eggs, trained falcons and clap traps (*e.g.* Launay *et al.* 1999; Seddon *et al.* 1999; Alonso 2008; Ziembicki 2009; Ponjoan *et al.* 2010; Packman 2011). However, many of these techniques are unsuitable for Ludwig's Bustards, because unlike larger and smaller bustards they will usually flush from a great distance, rather than hiding or running when they feel threatened (J.M.S. pers. obs.). Previously, the few Ludwig's Bustards that have been caught were trapped opportunistically (*e.g.* Herholdt 1987) because they are extremely wary and are usually found in open habitats where they can maintain high vigilance (Herholdt 1987). Their presence in an area is also largely unpredictable and breeding sites unknown (Allan 2005), so targeting specific areas is difficult.

Potential negative effects of the trapping and handling process must be balanced with the research value of successfully tagging birds. A concern in trapping Ludwig's Bustards is the potential for capture myopathy, which particularly affects long-legged birds (Hanley *et al.* 2005) and has been reported in Kori Bustards (*Ardeotis kori*;

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Bailey *et al.* 1996), Houbara Bustards (*Chlamydotis macqueenii*; Bailey *et al.* 1996), Little Bustards (*Tetrax tetrax*; Marco *et al.* 2006) and Australian Bustards (*Ardeotis australis*; Ziembicki 2009). Capture myopathy can occur in animals during pursuit, capture and restraint (Spraker *et al.* 1987; Rogers *et al.* 2004). Affected individuals undergo complex physiological changes causing muscle tissue damage which can lead to death, either directly or because of the increased risk of predation while incapacitated (Marco *et al.* 2006). Numerous factors can affect the incidence of capture myopathy, including handling times, age of the bird, time of year, trapping method and environmental conditions (Spraker *et al.* 1987; Nicholson *et al.* 2000; Ponjoan *et al.* 2008). In this paper, we describe our methods for trapping Ludwig's Bustard, as well as the incidence and factors affecting capture myopathy in this species.

METHODS

Trapping sites

The main land use in the semi-arid Karoo is extensive livestock farming, principally of sheep (*Ovis aries*), and the landscape is typically flat to slightly undulating, with short shrubs or grasses (Mucina & Rutherford 2006). Much of the Karoo is untransformed, but cultivation occurs in areas of higher rainfall (mainly in the east and at higher elevations in the west) and along drainage lines (Mucina & Rutherford 2006). Ludwig's Bustards often use such transformed areas to congregate in the early morning and late afternoon, remaining there longer when the weather is overcast and cool (<25°C), and typically spend the rest of the day dispersed widely in natural vegetation (Shaw 2013). We identified such transformed areas as good potential trapping sites, as the birds returned fairly predictably, but left during the day when traps could be set. Our requirements were that sites be of a manageable size (<1 km^2), and experience minimal disturbance from people or livestock, because once disturbed by, for example, passing farm workers, the bustards do not return that morning/afternoon and livestock can damage traps.

We successfully caught bustards at four sites. The first site was on the farm Damlaagte, which lies along the Varsch River in the Knersvlakte (31°29′45″S, 18°41′10″E), and includes a strip of pasture grazed by sheep. The second and third sites were identified from data of birds tagged at Damlaagte; we caught birds in a bare area below a dam on the farm Eensaam in Bushmanland (31°05′33″S, 20°10′59″E), and in a fallow ploughed triangular field on the farm Bathseba in the Upper Karoo (29°16′25″S, 25°25′00″E). At the fourth site on the farm Nooitverwag in the Upper Karoo (31°24′00″S, 24°10′43″E), bustards were observed and subsequently caught in a grazed patch of land sparsely planted with prickly pear cactus (*Opuntia ficus-indica*).

Trap design

At Damlaagte, we spent two days trying spotlighting and static nets, before focussing our effort on leg noose traps. We manufactured 1000 nooses suited to Ludwig's Bustard, consisting of a strong anchor line (white 2 mm nylon parachute cord) to which clear 1.3 mm monofilament fishing line (breaking strength 72 kg) nooses were tied (50 nooses per 20 m of anchor line; Fig. 1). We chose high-gauge fishing line to ensure that bustards did not break the line, to minimize the risk of injury from the noose cutting into the skin, and because it was stiff enough to remain upright in a moderate wind. Each noose (20 cm diameter when set) was attached with black duct tape to an 18 cm mild steel peg (5 mm diameter) that was

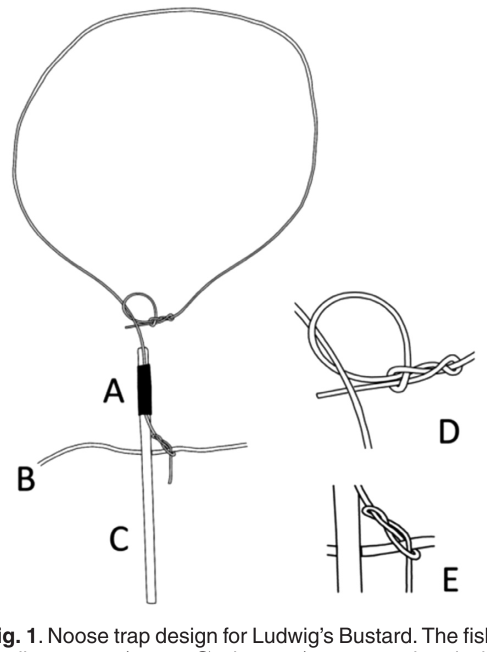

Fig. 1. Noose trap design for Ludwig's Bustard. The fishing line noose (20 cm Ø when set) was completed with knot D (eye 20 mm Ø), attached with duct tape (**A**) to a mild steel peg (**C**) and tied to the parachute cord anchor line (**B**) with a secure knot (**E**).

hammered into the ground deeply enough to keep the noose upright and aligned to stand perpendicular to the trap line. Nooses were deployed at approximately 30 cm intervals with the slack anchor line lying on the ground, so each deployed trap line was approximately 12 m long. The ends of the anchor line were pegged down with fencing posts or large, angled tent pegs to prevent trapped birds flying off with the traps (although this was highly unlikely given the weight of the trap lines). The nooses were carefully checked daily, as sheep often caused damage by chewing or escaping when they were occasionally caught.

Ludwig's Bustards are opportunist omnivores (Earlé *et al.* 1988; Allan 2005) so we tried to increase our chances of capture by baiting the traps at various times using bird-seed, fruit, sugar and insects. We also tried adding pieces of shiny foil to the traps and making a decoy bustard from wire mesh and bustard feathers from birds killed in power line collisions. Finally, we erected guide-lines linking the trap lines that were designed to funnel birds towards the nooses, which allowed us to double the area over which we could trap (Fig. 2). Guide-lines were 2–3 lengths of nylon twine or cord strung between fence posts 20 m apart. The height of the lower (10–20 cm above ground depending on vegetation cover), middle (35 cm) and upper (60 cm) cord was important to ensure bustards did not go under, through or over the guide-lines.

On arrival at trapping sites, bustards were observed for one evening and noose traps set the following day according to their use of the field. At each site, we covered 5–15% of the field with long lines of traps and guide-lines, setting double trap lines a few metres apart in particularly heavily used areas. We set lines at right angles to fences where present, as bustards were observed following these features, and birds usually changed direction to walk along guide-lines when encountered, so we put short trap lines (5–10 nooses) at right angles at the end of some of these. We also deployed short trap lines around gates and holes in fences, as bustards often walked through these gaps rather than flying over fences. Once traps were set, we watched with a telescope from a vantage point approximately 1 km away whenever bustards were present in the fields.

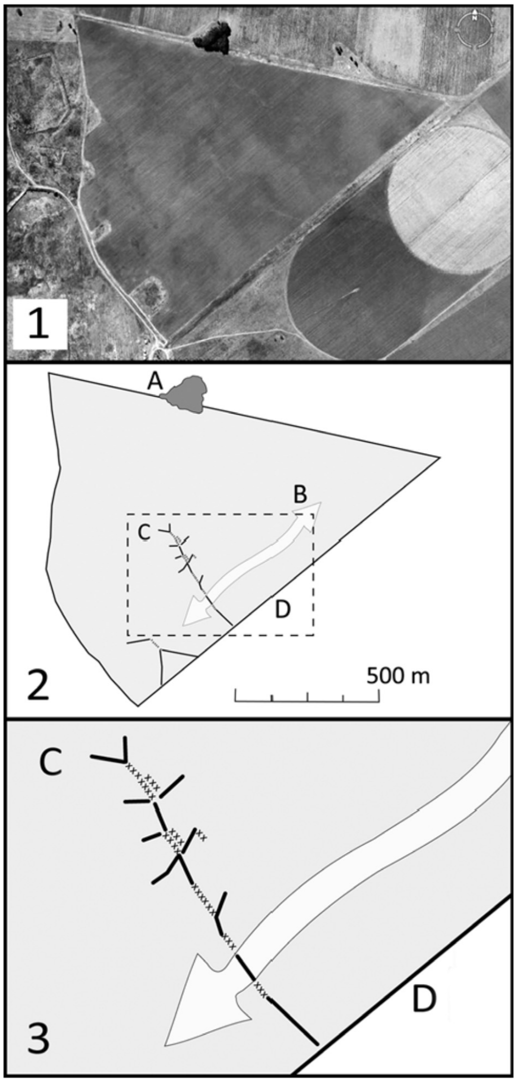

Fig. 2. Example of a typical trap deployment. These trap lines were set at Bathseba, a fallow ploughed triangular field (1) in the Upper Karoo (29°16′25″S, 25°25′00″E). Ludwig's Bustards usually moved along the southern fence line (**2**, D) in both directions as indicated (**2**, B). Lines of traps (x) and guide-lines (**–**) were set at right angles to the fence (**3**, C) and observed from a vantage point under a stand of trees (**2**, A).

Bird handling

When a bird was caught we immediately drove to the field and removed it from the trap (always within 5 min). The bird was ringed, weighed and measured, and if heavy enough (>3 kg, Kenward 2001) a GPS satellite transmitter (PTT, programmed to take 4–15 fixes per day) was attached using a Teflon ribbon harness in a backpack design, similar to those used for other large bustards (Alonso 2008; Ziembicki 2009). The process was completed as quickly and quietly as possible, with

Fig. 3. Harnessing a Ludwig's Bustard in a modified garden chair designed to minimize the incidence of capture myopathy.

the bird's head covered throughout to help keep it calm. At the first two sites birds were held in a sitting position on the ground during the harnessing process, but following problems with capture myopathy at the second site, we used a modified garden chair (Fig. 3) to hold birds at all subsequent captures. Restricting a bird's legs can result in cramp and paralysis, and rehabilitation of myopathic birds often involves putting the bird in a sling to reduce pressure on the legs (Rogers *et al.* 2004; Hanley *et al.* 2005; Marco *et al.* 2006). The chair was designed to comfortably support and restrain the bird, but to leave its legs free to maintain blood flow, and to speed up the harnessing process. The priority was weighing and tagging, so at the second two sites birds were released without ringing or taking further measurements if they showed any sign of distress.

RESULTS

From 2010–2012 we made nine prospective trapping trips, successfully locating sites, setting traps and catching bustards on six of them. Locating suitable sites was difficult as bustards are not necessarily in an area at any one time, and do not use all transformed areas when they are, so the other trips failed because we could not find sites with bustards or arrived too late at those indicated by tagged birds (1–2 weeks after sites had been identified). Static nets were unsuccessful because Ludwig's Bustards could not be herded, and spotlighting failed because roost sites were difficult to find and bustards typically flushed long before we could get close enough to catch them (usually when we were >100 m away, and invariably >50 m). Leg noose traps were effective; on the 37 days when noose traps were set we caught 12 bustards, and successfully deployed satellite transmitters on eight birds (Tables 1 and 2). While bustard numbers and the amount of time they were present in the fields was limited (Table 1), birds were rarely stationary and covered plenty of ground. Only two females were caught, although they were present at all sites. It was difficult to age birds, but based on measurements, wear on the bill and moult (Allan 2005) we judged two males to be subadult, with all others adult. We trapped non-target wild animals only once, with five Helmeted Guineafowl (*Numida meleagris*) caught and safely released at Bathseba. At Eensaam, bustards were particularly sensitive to disturbance, and did not return to the site after three days of trapping there.

Bustards were generally not wary of traps even

Table 1. Ludwig's Bustard (LB) trapping effort and success (2010–2012).

Site and date	Site area (km^2)	Days with traps set	LBs caught	Mean daily maximum (range) number of LBs present in trapping fields	Mean minutes/day LBs present in trapping fields	Mean number of nooses set	LB captures per noose per day
Damlaagte (Aug–Oct 2010)	0.39	19	4	11 (0–38)	154	624	0.006
Eensaam (June 2011)	0.38	6	3	2 (0–6)	71	717	0.004
Bathseba (Dec 2011)	0.85	6	3	3 (0–10)	105	467	0.006
Nooitverwag (Mar 2012)	0.23	6	2	5 (0–8)	259	675	0.003

though we made no attempt to camouflage the nooses or anchor line; we frequently observed birds stopping to inspect nooses before walking over, showing that they were interested but not suspicious. Sometimes, lone bustards would hurry across the field to join groups of other birds when they were clearly not aware of the traps. Birds were usually caught as they tried to fly, tightening the noose/s around their leg/s. However, the traps were not entirely effective; we observed birds stopping to shake off nooses several times, and had one incident when a bird escaped because of a faulty noose. The chances of capture were fairly low as the fields were large (Table 1) and birds crossed the lines without being caught approximately 60% of the time, although setting double lines in heavily used areas improved success rates. The various baits trialled and our decoy bustard failed to elicit any response from the bustards, but guide-lines were effective at funnelling them towards the traps.

No bustards were injured by the leg nooses, and they were generally quiet during handling and harnessing. All birds caught at Damlaagte were relaxed and did not show any signs of capture myopathy despite our relative inexperience and the resultant fairly long processing times (Table 2). At Eensaam, the weather was cold which made our processing times longer, and on release the two tagged birds appeared disorientated. They flapped their wings but could not fly, were vocal, aggressive and unsteady on their legs as they slowly and reluctantly walked away, rather than flying away as the birds at Damlaagte had. Five days later we received the first data that indicated that one bustard had likely died the first night (no further movement), and we retrieved the PTT at his scavenged carcass <500 m from the release site. The other bustard moved little in the first few days, with the PTT readings mainly 'no fix'. Canopy cover and steep terrain are typical reasons for GPS fix failures (Frair *et al.* 2010), but neither issue is likely in the flat, open Karoo environment. Most operational PTTs failed to take fixes during the night (Shaw 2013), which is probably because birds cover the GPS transmitter when sleeping with their heads over their backs. We suspect that the lack of fixes for this bustard resulted from him resting to recover from the myopathy. After seven days he began to move more and the PTT generated a typical number of fixes relative to later readings, which suggested that he had recovered enough to behave normally. This bird was ulti-

Table 2. Incidence of capture myopathy (CM, denoted with *) in Ludwig's Bustards (2010–2012).

Site	Approximate daytime temperature	Season	Processing time (mins)	Outcome and incidence of CM
Damlaagte	20°C	Spring	3, 34, 37, 43	First bird caught trialling nooses and released without satellite tag; next 3 birds successfully tagged; no evidence of CM
Eensaam	<10°C	Winter	7, 43*, 49*	Female released without PTT, 2 males tagged. Both males exhibited CM: 1 died, 1 recovered
Bathseba	30°C	Summer	13, 16*, 23*	3 birds tagged, 2 with CM: 1 died, 1 recovered
Nooitverwag	25°C	Autumn	19, 20*	2 birds tagged, female with CM recovered

mately tracked for 346 days until he collided with a power line, in which time he covered >500 km.

At Bathseba, the modified chair greatly improved processing times but we still experienced problems with two birds showing the same myopathy symptoms as before. One died within three days and was found 2 km from the release site, but the PTT reading from the other appeared normal from the outset. At Nooitverwag only one bird appeared stressed, failing to fly properly when released, but her symptoms did not seem as bad as the other affected birds, and the PTT readings did not show any abnormal behaviour subsequent to release. This bird went on to breed nine months after being trapped. Overall, data from the recovering bustards showed that after the initial periods described, all appeared to be behaving normally and were clearly capable of sustained flight. They all survived >11 months after release, so there is no reason to think that they were permanently affected by the experience.

DISCUSSION

While labour-intensive, nooses proved to be safe and reliable traps for catching Ludwig's Bustards in the Karoo, with birds caught at all sites where these traps were set. Previous studies using this method to catch Little and Houbara Bustards were successful only when restricted to very small areas, *e.g.* display or nest sites, or when using decoys (*e.g.* Launey *et al.* 1999; Seddon *et al.* 1999; Ponjoan *et al.* 2010). This is the first study in which more extensive areas have been successfully trapped, with guide-lines enhancing capture probability. As long as there is some predictability of site use, this technique is likely to be suitable for other large terrestrial birds, particularly those that are too wary to be approached and caught using other methods. Our main constraint was finding appropriate sites, which meant that trapping these transient birds had to be opportunistic. However, tracking the position and habitats of already tagged birds was useful, and is likely to have been more successful if we had gone to potential sites as soon as they were identified.

Like other bustards (Bailey *et al.* 1996; Marco *et al.* 2006; Ziembicki 2009), we found that Ludwig's Bustards are at risk of capture myopathy. While we cannot be certain of the diagnosis (the birds may also have been suffering from other conditions), the observed symptoms were consistent with myopathy (Marco *et al.* 2006). We did not see the affected birds after release and so did not know whether they had recovered until the first data transmission from the PTT 3–5 days later. At this point, the two birds that died were too decomposed and scavenged for *post mortem* tissue analysis which could have confirmed the diagnosis (*e.g.* Hanley *et al.* 2005; Marco *et al.* 2006). We did not attempt to recapture the affected birds for rehabilitation as there were no appropriate facilities near the trap sites, and we were concerned that the additional stress of being recaptured would be fatal. Recovery rates were similar to those described for myopathic Little Bustards, with individuals presenting milder symptoms surviving more often (Ponjoan *et al.* 2008). The recovery period was also consistent with other studies; Little Bustards that survived capture myopathy recovered over 1–11 days (Ponjoan *et al.* 2008), and a study of rehabilitated shorebirds showed that recovery often happens quite suddenly (Rogers *et al.* 2004).

For Little Bustards, longer handling and restraint times, as well as the use of cannon nets (rather than leg nooses) and the capture of juveniles all increased the likelihood of developing this condition (Ponjoan *et al.* 2008). Our harnessing technique was time-consuming, so handling time is also likely to have been a factor in myopathy incidence for Ludwig's Bustards, especially at Eensaam. However, the link was not clear with no incidence at the first site despite relatively long handling times, and continued occurrence despite much shorter times at later sites. There was no apparent effect of age or sex (although our sample size is very small), but it is possible that the cold weather at Eensaam could have been a contributing factor (Nicholson *et al.* 2000; Hanley *et al.* 2005). After our experience at Eensaam, we reduced handling times to a minimum, stopped trapping in extreme temperatures and used the modified chair for harnessing. Despite these precautions, some birds still showed symptoms of capture myopathy, although recovery was quicker. In general, we found that capture myopathy is difficult to predict in Ludwig's Bustard, and that response to capture is highly variable among individuals. We advise that in any future trapping attempts researchers exercise extreme caution with regard to handling times and ambient temperature.

ACKNOWLEDGEMENTS

We are grateful to Boetie Louw, Hein Visagie, S.W. van der Merwe and Handré Viljoen for their kind hospitality and for allowing us to trap on their land, to field assistants Ross Wheeler and Viviane Barquete, and to Bradley Gibbons who told us of the site at Nooitverwag. We thank Juan Carlos Alonso, Mduduzi Ndlovu, Tim Osborne, Kabelo Senyatso, Kevin Shaw and Alexandre Villers for valuable bustard catching and harnessing tips, Andrew Jenkins for his involvement in the project, Janelle Ward for capture myopathy advice and Kerryn Morrison for lending us prototype traps. The project was supported financially and logistically by Eskom, the Mazda Wildlife Fund, Abax Foundation, Mohammed bin Zayed Species Conservation Fund, Percy FitzPatrick DST/NRF Centre of Excellence and the University of Cape Town. We conducted this work under permits issued by the UCT Science Faculty Animal Ethics Committee(clearance numbers 2009/V20/JS, R2010/V6/JS, 2011/V1/JS-R and 2011V19R/JS), SAFRING (ringer number 1573), CapeNature (CapeNature #0035-AAA007-00053) and the Northern Cape Department of Environment and Nature Conservation (FAUNA 853/2009, FAUNA 817/2010 and FAUNA 1025/2011).

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