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Tracking and data–logging devices attached to elephant seals do not affect individual mass gain or survival

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ABSTRACT

Understanding the cryptic lives of wide–ranging wild animals such as seals can be challenging, but with the advent of miniaturised telemetry and data–logging devices this is now possible and relatively straightforward. However, because marine animals have streamline bodies to reduce drag in their aquatic habitats, attaching external devices to their back or head may affect swimming performance, prey capture efficiency and ultimately, fitness. Given this, and allied welfare concerns, we assessed the short- and long-term consequences of external devices attached to southern elephant seal juveniles and adults under varying environmental conditions. We also assessed the effects of multiple deployments on individuals. There was no evidence for short-term differences in at-sea mass gain (measured as mass on arrival from a foraging trip) or long-term survival rate. The number of times that a seal carried a tracking device (ranging from 1 to 8 times) did not affect mass or estimated survival. Further, there were no tracking device effects in years of contrasting environmental conditions measured as ENSO anomalies. Consequently, we conclude that the current tracking devices available to researchers are valuable conservation tools that do not adversely affect the performance of a large marine mammal in terms of mass gain or survival probability over short (seasonal) or long (years) temporal scales.

1. Introduction

Studies of how species respond to variation in their environment require a range of techniques to record pertinent data such as estimates of trends in population size, survival and recruitment, mark–recapture and telemetry of individual movements and other behaviours. Combining mechanistic behavioural approaches with population–level data is particularly powerful for predicting a species' response to future environmental change (Both et al., 2006; Parmesan and Yohe, 2003; Perry et al., 2005). For wide–ranging species, examining foraging dynamics is a particularly important component of these studies because such data summarise information on energy acquisition and expenditure at a variety of spatial and temporal scales. Studies designed to collect such information assume that natural behaviours are not compromised by the experimental procedures themselves. Furthermore, these types of field experiments may raise many ethical issues including the trade-off between individual welfare and information required to conserve threatened species (Minteer and Collins, 2005; Putman, 1995).

Documenting the life history of cryptic species can be especially difficult, particularly for marine species that are only rarely observed during brief feeding or breeding events close to or onshore (Bradshaw, 2007). Recent technological advances have provided detailed behavioural information that would be otherwise impossible to collect (Hooker et al., 2007 and references therein). Miniaturisation, long–life batteries and large data–storage capacity mean that data–logging devices can potentially be deployed for years (Hays et al., 2007b). However, it is still necessary that researchers weigh the benefits of these long-term deployments against their potential effects on reproduction, foraging success, energetics and survival of the sampled individuals. Some of the many considerations include the tracking device's (hereafter termed “device”) ergonomics, location of attachment, mass relative to body size, additional energetic cost induced by drag, increased agonistic behaviour by conspecifics, and impairment of camouflage and foraging efficiency. Because many studies often require longitudinal information on particular individuals, repeated deployment of devices may also be required (Bradshaw et al., 2004a). It is possible that although a single or short-term deployment may not be harmful to an individual, the cumulative effects of multiple deployments may be ultimately detrimental (as is the case for flipper bands in penguins – Gauthier-Clerc et al., 2004). The need for information on the potential effects incurred

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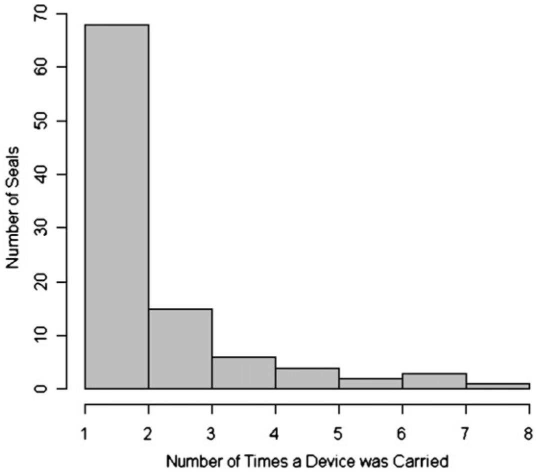

Fig. 1. The number of individual deployments of southern elephant seals that carried bio-logging devices from Macquarie Island from 1999 to 2005.

by multiple deployments of devices is especially important because detrimental impacts may only appear during periods of resource scarcity. For example, a device's effect may be exacerbated in years when prey are scarce (more dispersed or deeper in the water column), thus requiring that the foraging animal expends more energy to catch prey. Despite the importance of these potential detriments to animal performance, there has been little quantification of the effects of the devices especially over multiple deployments (see Wilson and McMahon, 2006 for a recent review).

An important Southern Ocean predator that has been the subject of much research in this area is the southern elephant seal (*Mirounga leonina*). This species is particularly tractable to research because: (a) they are an important Antarctic apex predator that has shown protracted and substantial declines in some regions (McMahon et al., 2005b), (b) there are established demographic links in this species to environmental change (de Little et al., 2007; McMahon and Burton, 2005), (c) they are wide-ranging and incorporate information over broad spatial and temporal scales (Bradshaw et al., 2004a; Bradshaw et al., 2004b; Field et al., 2004; Hindell et al., 2003), (d) they are easily accessible during defined haul-out periods onshore (Hindell, 1991), and (e) their large size means that small devices are less likely to modify behaviour (Ropert-Coudert and Wilson, 2005). Although the effects of marking (McMahon et al., 2006) and handling (Engelhard et al., 2002, 2001; McMahon et al., 2005a) have been examined for this species, the potential effects of data–logger deployment on elephant seal performance in terms of energy (mass) gain and survival probability have never before been assessed empirically. Because the potential effects are likely to differ between small and large, and between young and old seals, we calculated age–specific survival estimates for seals from a wide range of ages (1–13 years) equipped with devices and those without, as well as assessing the consequences of multiple deployments on individuals. It might be expected that the growth of small and young seals could be compromised by the additional cost of carrying a device, with flow-on effects such as delayed age of primiparity, reduced population growth rate and elevated extinction risk in small populations.

The aims of this study were four-fold: (1) To determine if there was any evidence of an energetic cost to seals carrying data–loggers by comparing variation in arrival masses between instrumented and non-instrumented elephant seals at Macquarie Island (Pacific sector of the Southern Ocean). We predicted that the attachment of devices may increase the cost of transport (via increase in drag), thus potentially reducing individual fitness. This increased fitness cost, if it compromises survival via poorer foraging performance, may be measureable by either increased time at sea or decreased overall mass gain when compared to animals not carrying devices (Boyd et al., 1997; Ropert-Coudert et al., 2007a,b); (2) We hypothesised that the evidence for any short-term effects of data–logger deployment might be masked by subtler long-term effects on average demographic rates. We therefore estimated apparent survival rates of instrumented versus non-instrumented seals relative to the environmental conditions encountered while foraging; (3) To assess the additional influence of multiple deployments on individuals; (4) To assess the influence of inter-annual variability in environmental conditions on mass gain and survival when carrying a device.

2. Materials and methods

2.1. Deployment

A large sample ($n = 12251$) of recently weaned southern elephant pups was hot–branded between 1993 to 1999 on Macquarie Island

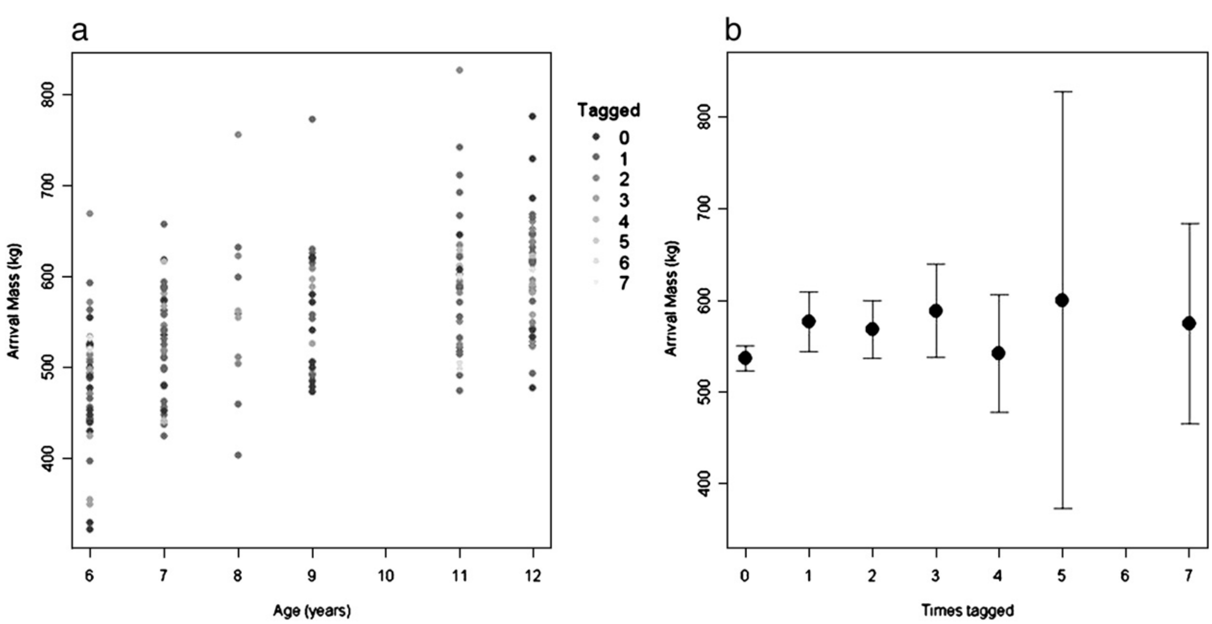

Fig. 2. Post-moult arrival weights of adult female elephant seals expressed as a function of (a) age and (b) the number of times the seal had carried a device.