The Devil is in the detail: conservation biology, animal philosophies and the role of animal ethics committees

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ABSTRACT

Good conservation outcomes depend on sound science that underpins management actions. Good data are becoming increasingly difficult to obtain as competing philosophies and emotive debate interfere with the processes that regulate conservation science. Iconic wildlife species are highly vulnerable to decline and are subject to intense scrutiny, particularly attracting people whose philosophies are closer to animal liberation than animal welfare. We demonstrate through a case study just how vulnerable conservation projects are to emotive pressures on the operation of Animal Ethics Committees (AECs). Our research, which was stopped, used proximity sensing radiocollars to obtain information on disease transmission important for managing a novel contagious cancer that is threatening the Tasmanian devil with extinction. Important lessons include the need for a governance structure of AECs that allows for independent review of decisions, the need to carefully screen potential committee members, and the need for AECs to both apply the code appropriately and then to stand by their decisions and the research in the case of emotive attack. We suggest that AECs and institutions should be less risk--averse about emotive attack in the media and focus on the more important goal of preventing extinction and the broader benefits of the proposed research.

Key words: conservation, animal welfare, animal liberation, radiocollars, animal ethics committees

Introduction

Effective conservation outcomes depend on good data, but these are becoming increasingly difficult to obtain as emotional debates and competing philosophies interfere with the processes that regulate conservation research. In some high profile cases, outrage in the media from animal liberation/rights groups and from the public has resulted in key research techniques being banned by government ministers, conservation programs for threatened species being stopped, and in lawsuits against researchers using "invasive procedures" (Dalton, 2005). Conservation studies, like all scientific research on animals, must meet the standards of humane and ethical use and care of the animal subjects set down in a recognised code of practice that is followed by Animal Ethics Committees (AECs) in their assessment and approval of projects; in Australia, this is the "Australian code of practice for the care and use of animals for scientific purposes" (The Code) (NHMRC, 2004). Animal ethics committees are vulnerable, however, to pressure from individuals, both from outside and from within, whose philosophy is more closely aligned with animal liberation or animal rights causes than with animal welfare upon which the code is based, or who have personal or political agendas to pursue. This can result in unrealistic expectations on the operation of research and the closure of projects that provide important data for the conservation of threatened species.

Figure 1: Photograph of a Tasmanian devil with a tumour on its face. In eastern Tasmania, two-thirds of diseased devils will disappear from the population within 3-6 months from the appearance of a tumour (Hamede *et al.*, 2011). Eighty-five percent of tumours are on the facial region, inside and around the mouth and on the jowls (Hamede et al.; Hamede *et al.*, 2008). Very few of these are in a position that would interfere with a radiocollar. Photo, R. Homede.

While good science underpins effective conservation, it can have an impact on the study animals (Casper, 2009). It involves studying wild animals *in situ* where the threat is occurring. Obtaining the type of information needed to

Pp79-88 in *Science under siege: zoology under threat*, edited by Peter Banks, Daniel Lunney and Chris Dickman. Royal Zoological Society of New South Wales, Mosman, NSW, Australia. 2012.

DOI : 10.7882/FS.2012.040

mitigate the threat or population decline usually involves catching and individually marking the animals so that population vital rates can be estimated and monitored (McMahon et al., 2007). Attachment of radiotracking devices enables study of movements, behaviour and habitat use. In special cases, such as novel infectious diseases like the Tasmanian devil facial tumour disease, understanding transmission dynamics and incubation period of the disease may require the use of new telemetry technologies that document contacts between animals (Jones et al., 2007a; Hamede et al., 2009).

Confusion exists in society regarding the competing philosophies of animal welfare and those that define debates about animal liberation and animal rights (Lunney, 2011). The Australian code of practice for the care and use of animals for scientific purposes (NHMRC, 2004) is explicitly concerned with animal welfare. The Code requires that scientific research is justified, taking into account its scientific benefits and the potential impact on animal welfare, and that researchers adhere to the principles of replacement, reduction and refinement (NHMRC, 2004). Scientific research is a legitimate activity and there is no requirement in The Code for there to be no impact on the animals used. Committees and researchers are required to justify benefits against impacts. Animal liberation and animal rights philosophies, on the other hand, are driven by the rights of individual animals to not have procedures done to them. When these philosophical approaches are confused, the implications for conservation are potentially serious. McMahon *et al.* (2007) have raised concerns that the "guilty until proven innocent stance" often adopted by institutions and AECs in consideration of the welfare impact of scientific research should yield to the more important aim of minimising extinction risk.

There is an inconsistency in the way that society views species. Species such as large carnivores and marine mammals attract people with an animal liberation philosophy. They are iconic and attain a spiritual dimension, becoming untouchable. It is these large, iconic wildlife species, that are at the top of the food web and have large space requirements, that are most vulnerable to anthropogenic change. These are the species that are going extinct (Gittleman et al., 2001).

The roles of political agendas and professional jealousies are well documented in stalling conservation efforts until it is too late. Protection of the thylacine (*Thylacinus cynocephalus*), which became a scapegoat for livestock losses from other causes including unrestrained dogs, was granted only after the species was virtually extinct. In the Tasmania of the 1920s, the expertise of the specialists, the scientists and naturalists, was deliberately ignored; their unanimous concern was taken as an indication of their obvious bias and untrustworthiness (Paddle, 2000). The invasive *Caulerpa* seaweed was allowed to spread beyond the possibility of control, with devastating effects on marine ecosystems globally, while agency buck-passing and professional jealousies dominated the agenda. The warnings of specialist scientists were not heeded; indeed, sound science was deliberately discredited in attempts to exculpate those responsible (Meinesz, 1999). In a more recent case that received high profile attention, uninformed emotive coverage in the media resulted in a ministerial intervention to stop the use of branding to individually mark seals in Australian subantarctic islands. This resulted in the closure of long term research projects and compromised conservation research on the endangered southern elephant seal (*Mirounga leonina*) (McMahon et al., 2007).

While outrage is a useful tool for some advocates, it remains unclear how AECs can protect themselves from its undue influence while still fulfilling their vital role of balancing the welfare of animals with the benefits of research programs, especially those programs with urgently needed conservation-oriented outcomes. The likelihood of successful management intervention in the conservation of endangered species improves with knowledge of the system. It is important that research that has demonstrable benefits to endangered species conservation should be allowed to proceed where it can be demonstrated that techniques are effective, that animal welfare concerns are minimised and documented, and where best practice as laid out in the "Australian code of practice..." (NHMRC 2004) is followed by researchers. All parties involved (scientists, animal ethics committees, the public) have a responsibility both for animal welfare and for the conservation of biodiversity.

In this paper, we demonstrate through a case study just how vulnerable conservation projects are to emotive pressures that have their origin in other philosophical approaches. We provide some insights into how institutions and AECs can deal with these pressures: in their selection of members, their operation and governance. We offer some guidance on how researchers can improve conservation outcomes through effective engagement and communication with AECs.

Case Study

In early 2008, animal ethics approval was withdrawn for a study that was using radiocollars, fitted with proximity-sensing data loggers, to study transmission dynamics of Tasmanian devil facial tumour disease (Hamede et al., 2009). Tasmanian devils (*Sarcophilus harrisii*) face a real risk of extinction in the wild within about 35 years due to a novel and unusual infectious cancer, devil facial tumour disease (DFTD) (McCallum et al., 2007; McCallum, 2008; McCallum et al., 2009). Since its first detection in the mid-1990's, this consistently fatal disease has spread across the majority of the species' populations, causing more than 95% local population decline in those populations where the disease has been present the longest. Formerly a common species, devils are now classified as Endangered on the IUCN Red List and on national and state threatened species lists. This conservation problem is both urgent and challenging because DFTD is a rare new type of disease threat (McCallum and Jones, in press), one of only two known naturally-occurring infectious cancers, and was initially poorly known (McCallum and Jones, 2006).

Management options for restoring Tasmanian devils as an ecologically functional species in the wild are very limited: to isolating healthy devils in insurance populations for reintroduction in the event of extinction in the wild, culling of infected individuals, or managing virulence through detecting and spreading resistant or tolerant host genotypes or less virulent tumours, with the development of an effective and safe, broad-scale field-deliverable vaccine or treatment a small possibility (Jones et al., 2007b; Lachish et al., 2010; McCallum and Jones, in press). A major knowledge gap, that underpins estimates of extinction risk and all management activities, is an understanding of transmission dynamics in the wild, including the latent period of the disease. Specifically, the latent period (the interval between infection and the first detection of clinical signs of the disease) has a major influence on R_0, the reproductive number of the disease. Elimination of disease from a population requires reducing R_0 to below one. Poor knowledge of the latent period of DFTD has hampered estimation of R_0 (McCallum et al., 2009) and in turn makes estimating the rate of removal of infected animals sufficient to eliminate disease very difficult (Beeton and McCallum, 2011).

Our research project was providing empirical data on patterns of social contact leading to disease transmission in a wild Tasmanian devil population (Hamede et al., 2009). A very new technology, proximity-sensing loggers fitted in standard VHF radiocollars, record the time, duration and identity of a "contact" when two collared individuals come within a pre-set distance of each other (30 cm in our study) (Hamede et al., 2009). From these data, it is possible to construct a network of social contacts relevant to disease transmission and to parameterise models capable of predicting likely patterns of epidemic outcome. If contact network data were to be collected in the early stages of disease invasion at a site, it would be possible to directly construct a "who infects whom" matrix (Dobson, 2004), a level of information which has not been available outside of human epidemiological research. This might enable the identification of "superspreaders", classes of individuals that are particularly important in disease transmission (Lloyd-Smith et al., 2005). Interventions targeted at superspreaders can be very effective in preventing disease threat. Data of this kind can also reveal the latent period of the disease, a parameter that is difficult to obtain from wild populations. The location and timing of our study was fortuitous and not easily repeated. We had collected two years of social contact data from a wild population of Tasmanian devils at a study site with natural isolation (ocean and inlet on two sides) enabling a very high proportion of the adult population to be collared, and thus a high proportion of contacts relevant to disease transmission to be recorded. At the time when the project was terminated by the AEC (April 2008), the disease had recently (October 2007) been detected at the site as predicted. In the final year of this three year study, we estimated that we would capture about five individuals with DFTD. With our frequent trapping program (10 days every second month) and subsequent immediate removal and euthanasia of these individuals from the population (as per government policy at the time), we would catch only individuals with small, early stage tumours located on the head where the collar would not cause abrasion problems (85% of initial tumours are on the head) (Hamede et al., 2008). This prediction was subsequently fulfilled in 2008 but no transmission data were obtained. The loss of AEC approval for this study was significant in many ways, most importantly the loss of information on disease transmission that would inform and refine conservation management strategies.

The scenario leading up to withdrawal of AEC approval for this study involved an objection lodged against the study from an individual external to the AEC. In turn, this objection led to a media report that implied we were killing devils with the radiocollars (Darby, 2008). The AEC had approved the third year of this radiotracking study in November 2007. The Responsible Investigator (RI) with legal responsibility for the project (MEJ) received a verbal communication from the university Animal Welfare Officer in January 2008 that an objection to the study had been made and that the AEC would make a decision in its February 2008 meeting as to whether the existing approval of the study would be upheld or revoked. Following usual procedure in the conduct of AEC-approved research when there is any adverse incident, the RI interpreted this communication from the Animal Welfare Officer as a call to stop all research activity until further advice from the AEC as to whether the study could continue or not. Accordingly, the RI delayed the January field trip, which was critical both for checking the fit of the collars and for replacing batteries for ongoing operation of the loggers and VHF transmitters, whilst awaiting a decision on the approval status of the study following the February AEC meeting. However, the devil traps required to conduct field trips were heavily booked and were unavailable until March. This meant that the next opportunity to get into the field and trap the collared animals to check the fit of the collars (as well as change the batteries in the loggers, almost all of which were now dead as they were due to be replaced in January), lay in the middle of the mating season when capture rates of adults are known to be low. The RI was very concerned about this and during a presentation to the February AEC meeting clearly explained the consequences of missing this field trip; that this delay in timing of the field trip could lead to collar abrasions following weight changes. This presentation focussed on the science underpinning the research and conservation benefits and the likely welfare impacts from devils acquiring a tumour whilst collared. At this point in time, the RI still thought that she had acted appropriately in terms of compliance to usual procedures in cancelling the January field trip, although in retrospect this may not have been the most appropriate decision for the subsequent welfare of the animals. The RI failed to capture the attention of the committee on this issue, and despite a lengthy presentation and discussion, neither the science nor the welfare concern of cancelling the January field trip was reported in the record of the meeting. The RI did convince the committee of the importance of the research to conservation management and approval for the study was upheld at the February meeting. The AEC withdrew approval and terminated the study in writing in April 2008, because of an increased rate of collar abrasions found during the March trapping trip, including two devils who had put a front leg through a loose collar (detailed below) . We were also very distressed at the animal welfare situation that had resulted from delaying the January trapping trip.

Up until January 2008 when the external objection to our study was lodged, we had been meticulous in ensuring that all collared individuals could be retrapped regularly to check collar fit. With the exception of the October 2007 to January 2008 interval, which was a bit longer because of logistic constraints of trap availability and a change in field trip personnel, field trips to check on collar fit were conducted every second month. This high frequency of field trapping was a refinement devised by the RI to improve on the collar abrasion rates experienced during a previous radiotracking study (see Table 2). This bi-monthly field trip frequency was not a directive of the AEC. Indeed, the RI advised the AEC that this high frequency of trapping trips was desirable and they subsequently made it a requirement of approval. We achieved a high frequency of recaptures by only collaring individuals that had a known trapping history of regular and frequent capture (caught once or more times per 10 day field trip). Indeed, the Responsible Investigator had developed and refined the protocols for radiotracking Tasmanian devils over a 20 year period.

Following the formal withdrawal of approval for the study (in April 2008), we were asked to remove all of the collars from the devils. This should have been quite straightforward and achievable in two 10 day field trips, given the geographically discrete nature of the population, our detailed data and knowledge of individual capture rates and locations, as well as a complete history of proximity logger performance (Tables 1 and 2). The detailed contact data downloaded from all collars in the field put us in an unusually good position to obtain records of the presence (live or dead) of all collared devils in the population. In addition to numerous trapping trips (Table 1), we conducted extensive radiotracking to detect the two animals whose collars might have had functioning batteries (replaced in March 2008) in August 2008 (2PC87 and 2PC61). After August 2008, none of the collars would have been expected to have functioning batteries. We do not routinely use radiotracking to find collared devils as recapture rates of devils are high and we can predictably retrap all individuals to check collar

Table 1. The capture history of Tasmanian devils carrying unrecovered radiocollars; the number of times that were trapped each month from collar deployment in January 2007 through to August 2008. The age that these individual devils would have been in late March 2009, if they had survived, when the researchers requested that the matter be finally closed. Only three animals were less than 5 years old, the age of senescence in the wild. Also shown is the number of different individual devils caught in each of the trapping sessions; the number of collars removed or recovered in each session; the number of collars from the original deployment not yet retrieved at the conclusion of the trapping bout; and the cases of DFTD amongst the collared cohort. Shading indicates the period over which these animals with unrecovered collars were known to be alive. Individuals that would be 4 years old and still in the population, if they had survived, are shown in bold.

Collars deployed in 2007-2008																							
Year				2007												2008							
Month				J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
# trap days				10	6		8			10	10		10					10		10	5, 10	11	15
Collar ID	YOB	Age 2009	sex																				
2PC61	**2005**	**4**	**M**	**4**	**3**		**7**			**6**	**5**		**2**					**1**		**0**	**0**	**0**	**0**
2PC29	2003	5	M	3	1		1			8	4		7					0		0	0	0	0
2PC11	**2002**	**6**	**M**				**3**			**0**	**0**		**0**					**0**		**0**	0	0	0
2PC65	2004	5	M	2	1		2			2	6		4					0		0	0	0	0
2PC25	**2005**	**4**	**M**	**6**	**2**		**4**			**6**	**4**		**7**					**0**		**0**	**0**	**0**	**0**
2PC5	2004	5	F	5	3		1			0	0		2					0		0	0	0	0
2PC87	**2005**	**4**	**M**	**3**	**2**		**4**			**2**	**3**		**1**					**1**		**0**	**0**	**0**	**0**
2PC31	**2004**	**5**	**F**	**1**	**3**		**3**			**0**	**0**		**0**					**0**		**0**	0	0	0
2PC35	2002	7	M	1	2		0			0	1		2					0		0	0	0	0
No. Devils caught				61	43		48			50	47		48					40		40	42, 35	40	42
# Collars removed /recovered							1						7					2		8	3		
# Collars out				28	28		27			27	27		20					18		10	7		
# DFTD cases in collared devils													2								2		
Dates when: A) severe drought commenced; B) field trip delayed; C) started recovering/removing collars														A		B		C					

Table 2. Injury rates, retrieval rate of collars and fate of collared individual Tasmanian devils from two radiotracking studies of Tasmanian devils in which individuals carried collars for 6 months or more.

Study	Date ranges that individual devils carried collars and frequency of checking	Number individual devils collared (number of collar deployments – on different individuals)	Rate (%) and total number of incidents of injuries from collars. Collars often redeployed once chafing healed.		Retrieval rate of collars	Collar retrieved (number of collars)			Collar not retrieved (number of collars)			
			Chafing	Entrapment		Devil trapped	Collar located on ground; not on devil	Roadkilled devil found on roadside	Dead devil (other causes)	Devil slipped collar; collar not found	Devil not seen again; contact data logged beyond last time trapped	Devil not seen again; no subsequent contact data
Narawntapu (this study)	Jan. – Jul. 2006	46	2%	0	83% (38/46)	31	3	4	0	1	3	4
Narawntapu (this study)	Jan. 2007 to Jul. 2008 (collars removed from Feb. 2008 onwards)	29	7% (2/29) in 2007; 27% (4/15) in 2008	0 in 2007; 13% (2/15) in 2008	69% (20/29)	17	1	1	1 (dead in trap)	0	0	9
Freycinet (MEJ)	Nov. 2000 to Nov. 2001; checked every 3 months	47 (54)	15% (8/54)	2% (1/54)	83% (45/54)	34	1 slipped; 1 suspect devil shot	6	1 shot; 1 suspect shot; 1 crushed in rubbish tip compactor	1	NA	7 (of these 5 disappeared in mass event; 1 female probably died of old age; 1 two year old male)

fit and replace batteries. Batteries on most of the collars in this study were due for replacement in January 2008, so even by March when we were able to obtain traps for a field trip and when issues of recapture became evident, many of these were not functioning.

There were 20 devils with collars at the conclusion of the October 2007 field trip. Of those, two (2PC11 and 2PC31) were almost certainly dead by October 2007, as they had not been seen since April 2007 (Table 1). The remaining 18 collars were on animals known to be alive at that time, because they were caught in the October field trip or subsequently. Two of those were removed in March 2008. The committee asked us to remove all collars in April 2008, and by June 2008, 11 further collars had been successfully removed, leaving seven unaccounted for (including the two mentioned above).

Issues with failure to recapture all collared individuals

During the ensuing months, outrage was expressed by the external objector and from the AEC about the seven collared individuals that remained to be captured. Against our advice, we were required to trap at a very high frequency at the site, equivalent to one out of three nights for 3 months. Too frequent trapping reduces overall capture rates, and increases captures of "trap-happy" individuals with consequent animal welfare implications as these individuals cannot hunt whilst in traps. We deployed several remote techniques (cameras, drop traps over carcasses monitored at night) to detect collared individuals that might have suddenly changed their behaviour and become less trappable. The AEC requested that we trap a 400 km^2 area around the original study area for a full month, in case the missing adult animals had dispersed. And finally, the AEC requested that we continue monitoring the population for a total of another three years until any remaining individuals would have died from natural causes. At this time, a media report was published (Darby, 2008) with the implication that the devils were being killed by the collars, and the photo caption "Collared … lesions on the face of a Tasmanian devil" could be read to suggest even that the collars caused the cancer. There were implications of cruelty: "There seemed to be a lack of determined effort to recover these animals until it was too late". We finally submitted a request to the AEC that no further attempt be made to trap missing individuals.

All these requests from the AEC seem reasonable. Indeed, the use of remote cameras to find the last collared individuals is a useful technique. The devil is in the detail! We believe for the following reasons that if the missing collared devils were alive, we would have trapped them readily within their usual home range.

First, we only radiocollared individuals that had a regular capture history (trapped at least once and sometimes multiple times every field trip), to ensure regular recaptures for checks of collar fit. The behaviour of these collared individuals was consistent throughout the study until they disappeared, after which they were never detected again (Table 1). This is concordant with the consistent individual patterns of behaviour, either regular or irregular and frequent or infrequent trappability, that we have recorded throughout individual devil's lifetimes during a long term study encompassing entire life spans (Jones, unpublished data). There is no indication that devils suddenly change their individual behavioural attributes or phenotype; for example, a very trappable individual does not suddenly become trap shy.

Second, devils follow the typical mammalian pattern of male-biased post-natal dispersal (Lachish et al., 2011). Again, long term, landscape-scale studies (study areas of 160-400 km^2), including this study, do not indicate any subsequent period of dispersal or shifting home range once the devil has become an adult at the age of two years old. Following subadult dispersal, individuals appear to be resident for life in a defined home range from before age two years (Jones, unpublished data). In our broad-scale trapping around the study area, we detected a small number of devils last trapped as subadults in the core study area, but as would be predicted from known devil life history and behaviour, no collared adults.

Third, the reality of high rates of natural mortality in a wild population (see, for example, Nussey et al., 2008a) did not seem to be fully appreciated by the members of the AEC. We have documented natural annual mortality rates for wild adult devils (3-4 years old) of 45% (Lachish et al., 2007a), based on analysis of mark-recapture data. The annual death rate for animals 4 years and older is almost certainly higher, but so few remain alive that this death rate cannot reliably be estimated from field data. Dead Tasmanian Devils are very rarely recovered in the field and we have rarely recovered any collar from an animal that has died. In this study, from a total of 75 collar deployments, the only collars retrieved that were not removed from a live devil were 4 collars found on the ground that had slipped over the heads of the animals, 5 collars retrieved from devils that were killed by a vehicle and were found dead on the road, and one that died in the trap (an autopsy indicated that the death was not trap-related and that the animal had pneumonia). As road-killed devils frequently move well off the road before dying (Jones, 2000) and sick animals are likely to die in a burrow, the retrieval rate of collars from dead Tasmanian devils is expected to be low. In any radiotracking study that runs for a biologically significant period of time, it is therefore unrealistic to expect to retrieve all of the collars. The retrieval rate and fate where known of collars from a previous 12 month radiotracking study of Tasmanian devils (MEJ) are reported in Table 2. In this study, 55 collar deployments were made on 47 individual devils over a 12 month period. The collar retrieval rate was identical to that at Narawntapu in 2006, the first year of the study. Of the collars that were retrieved but not from trapped devils, one had slipped over the head of the devil and was found lying on the ground, 6 were retrieved from road-killed devils found on the road, two were shot or strongly suspected of being shot and one was killed in a council rubbish compactor truck, probably picked up as it hid trapped in a rubbish skip bin. It is noteworthy that during this earlier study, in one single period between trapping sessions (between April and July field trips), 15 devils disappeared, including three radiocollared individuals. These devils ranged in age from subadult to five years old and many of them had already been studied in their established home ranges at the site for three years, which is most of their natural adult life span. An explanation was never found for the disappearance of these animals, despite considerable searching for radio signals, for carcasses, and questioning of local livestock managers and landowners. It is worth noting that DFTD first appeared in the collared population at Narawntapu in October 2007, which may have further increased the death rate. Of the 18 collared devils known to be alive in October 2007, just 5 were unaccounted for at the end of June 2008. Only three of these individuals would have been four years old if they had remained alive. The remaining Devils would be at least 5 years old, which is close to the maximum recorded lifespan of Tasmanian Devils in the wild. None of these were captured in the intensive and broad-scale trapping conducted between March and July 2008. This is a loss rate of 28% over 8 months. This is well within the bounds expected given an annual mortality rate of 45%. It does not suggest either that unrecovered collared animals were still alive in June 2008, or that the mortality rate of collared animals was excessively high. Finally, there was no indication of any change in recapture rates in the remaining devils, collared or not, in the population in early 2008 when we were trying to retrieve the outstanding collars. As can be seen in Table 1, no collared individuals were caught beyond June 2008. Of the outstanding collars, none were retrieved in five successive trapping bouts since March 2008, each of which was successful in trapping over 35 different individual Tasmanian devils. As can be seen from the trapping success up to October 2007, there was a high probability that devils present in the population would have been caught. This can be seen by noting that there are only two individuals in this dataset that were missed on two successive trapping occasions and subsequently re-caught, and that most individuals are caught multiple times in each trapping occasion. We can quantify this probability more accurately using our analysis of the Freycinet dataset (Lachish et al., 2007b) employing a very similar survey design, which shows that animals present in the population had a 79% chance of being recaptured in a seven-day trapping bout. Assuming that this probability is independent between trapping bouts, this would mean that an individual had a chance of being missed on five successive occasions of $(1-0.79)^5$ or 0.0004. Thus there would be a chance of about one in 2500 that each individual last caught in March 2008 could have been missed in the five trapping occasions until August 2008.

We concluded from these multiple lines of evidence that there was a very high probability indeed that none of the outstanding collars remained on live devils by August 2008. Our study design that took into account the behavior and life history of devils, should have minimized the chance of not recapturing devils if they were alive in the population (see Casper, 2009). The normal substantial rate of mortality in the wild may have been further exacerbated by the severe and prolonged drought afflicting the study site from November 2007 to May 2009. All surface water within a 20 km radius disappeared. There was massive mortality of macropods in the park at this time (Park Rangers, pers. comm.) and the numbers of spotted-tailed quolls (*Dasyurus maculatus*) also declined dramatically and have not yet recovered (in 2011). As this drought coincided with the first detection of DFTD in the park, we cannot discriminate between disease and drought as causal factors in the now dramatic decline in devil numbers at this site (70% decline by 2011). We have no data or prior experience of the effects of drought on Tasmanian devils. Drought has been shown to be as powerful a cause of mortality in other dasyurids (*Antechinus* spp.) in southeastern Australia as other well known factors such as fire (Recher et al., 2009).

Issues of injury from the collars

The longer than usual time period between captures that occurred in early 2008 resulted in an increase in the number of incidents of chafing and entrapment from collars, relative to both the previous year and to a previous study (Table 2). Chafing occurs when an adult devil puts on fat around the neck, causing the collar to become tight. This causes irritation and redness of the skin, which will lead to weeping and to abrasion through the skin if the animal continues to gain weight. Entrapment can occur when a collar becomes loose and the animal gets a front leg caught through the collar. This will lead to major chafing which usually becomes very swollen and cuts through the skin. The immediate solution to both is to remove the collar and release the devil immediately back into the wild. Healing of the site of chafing takes between a week for minor chafing to two months for major chafing (resulting from a leg through the collar). A correctly fitted collar can be replaced once the wound has completely healed.

We recorded low collar abrasion rates in the 6 months from January to July 2006 of 2% (1/46 deployments), slightly higher in the 10 months from January to October 2007 with 7% of devils or 2/29 individuals carrying collars experiencing a degree of irritation or abrasion at some time, but the rate of incidents increased to 27% or 4/15 individuals collared between February and June 2008 as collars were being removed. This compares with 15% or 8 cases in 54 collar deployments over a 12 month period in a previous study (Table 2). The generally lower rates of collar abrasion in this study at Narawntapu reflect a refinement in the trapping program to increase frequency of monitoring of collar fit from every third to every second month, specifically as a result of learning from the previous study. At Narawntapu, we trapped two devils with a front leg caught through the collar in early 2008, a higher rate than expected. This represented 13% of the 15 collars known to be on devils at that time (Table 1); and was higher than the 0% in 46 deployments between January to July 2006, and the 0% cases in 29 deployments from January to October 2007, both at Narawntapu, and the 2% or 1/54 collar deployments over a 12 month period recorded in a previous study (Table 2). Both of the cases in the Narawntapu were unusual in that they were females.

In addition to increased energetic requirements or obstructions to normal behaviour caused by the weight, bulk or profile of a tracking device, three types of problems can arise from attachment of tracking devices to wild animals: chafing from the device or its attachment (collar, harness, glue pad), entanglement (collar, harness), and that of the individual being able to shed the device if it is not recaptured. Animals such as dasyurids which rapidly gain and lose fat around the neck are prone both to chafing from tight collars and to getting a front leg through a loose collar if they lose weight. Males, in particular, are prone to getting loose collars during the mating season when they lose 25% of their body weight. That the two devils that became entrapped with a front leg through their collar in this study were females and were healthy (no DFTD) provides further support for drought being a causal factor in the disappearance of devils at the site.

At the time our study was conducted, we had no alternative other than to attach the proximity loggers to the devils packaged within a radiocollar. Chafing from collars in species where neck diameter is expected to increase is sometimes addressed by inserting an expandable section or an elastic segment into the radiocollar. We considered that this method would dangerously increase the chance of entanglement with legs or vegetation for a ground-dwelling species that pushes through thick scrub. Timed release mechanisms which address the issue of the animal shedding the collar if it is not recaptured, whilst still unreliable, became available part-way through our study. It was not possible to retrofit them because they would have increased the bulk of the collar right in the section of collar that is most likely to cause chafing. Methods for incorporating degradable links into collars were not available at the time and would have required significant time for development. Future miniaturisation of electronic circuitry and particularly batteries will almost certainly open up alternative less invasive methods of attachment for increasingly smaller species, such as gluing onto fur, although the likely success of this attachment method for an animal like a devil that can scratch every part of its body is questionable.

These potential impacts of radiocollaring on the study animals are an animal welfare issue and need to be minimised in any study design (Casper, 2009). Up until the point when we received notification from the AEC that they had received an objection to our study, we had meticulously followed a study design to miminise these impacts. After this point, we clearly had an issue with increased chafing and entrapment rates from the collars because of the longer period between recaptures in early 2008, and this was possibly exacerbated by the drought. The collar injuries are unlikely to have killed devils in our study. Devils sustain and recover from frequent and severe biting injuries during the mating season each year. A leg through a collar for a long period of time could kill an animal through reduced ability to run and hunt. There was no indication that the devils with a leg through the collar had been in that state for a long period of time. The collars had chafed through the skin, which was swollen. However, the devils were still in reasonable body condition (estimated using a standard condition index score) given that the study site was in drought, and there condition was similar to that of other adult devils in the population at that time. Following removal of collars, all minor chafing had healed with three weeks and injuries that had penetrated the skin, with associated swelling, had healed within 8 weeks.

Procedural issues

We consider that two separate issues underlay the development and progress of the interaction between the AEC and the researchers. First, the committee and the outside objector were being unrealistic in their expectations of the operation and outcomes of the field research, confounded as it is with natural ecological processes, and in their expectations of both the potential impacts (injury) from deploying collars and of collar recovery rates. There is no requirement for no impact in The Code (NHMRC, 2004). Indeed, the philosophy of the code, requiring justification, replacement, reduction and refinement, implies that the use of animals in scientific research inevitably has some detrimental impact on the animals "used". The use needs to be justified as "essential" for one or more of five reasons. We argue that the "use" of Tasmanian Devils in our study was essential according to at least four of these justifications: "to obtain and establish significant information relevant to the understanding of ... animals"; "for the maintenance and improvement of .... Animal health and welfare" ; "for the improvement of animal management or production"; and "to obtain and establish significant information relevant to the understanding, maintenance or improvement of the natural environment".

In our opinion, the detailed scientific information made available to the AEC was not fully appreciated and the interests and concerns of the researchers were not adequately dealt with. Second, it is also our opinion that the AEC was more concerned with the impact of emotive (and inflated) media exposure of the issue on itself and on the institution than it was with the value of the research for conservation. It was easier to place the burden on the researchers, by stopping the study and by asking the investigators to do more and more, even in contradiction to their advice. In this case, the Responsible Investigator had knowledge and skills derived from more than 20 years experience of conducting ecological and conservation field research on Tasmanian devils, including developing and refining protocols for radiotracking devils through four tracking projects, including at large landscape scales (100 km^2). This scientifically grounded expertise is not matched in any other researcher working with this species.

Both of these issues indicate a confusion of philosophical approach. The accusation by the anonymous objector in the media that "There seemed to be a lack of determined effort to recover these animals until it was too late." (Darby, 2008) was an emotive statement that implies cruelty and sits within an animal liberation framework. It also flies in the face of the scientific information from this and other radiotracking studies (see Casper, 2009). The potential impacts of radiotracking and natural mortality rates were known and were articulated by the researchers. The effect of the threat of going to the media was to suppress objective scientific information and rational debate. This is typical of an animal liberationist approach, in which animals have a right not to have things done to them, rather than animal welfare, in which science is legitimate and impacts are expected and minimised within a logical framework.

Insights for AECs and for researchers

There are several lessons to be learnt from this case study for AECs and the institutions that govern them. First, it is imperative that the governance structure of AECs allows for independent review of committee decisions. Second, committees need to carefully screen potential committee members. Third, they need to be alert to potential agendas both within and outside the committee. Overall, AECs and institutions need to take a strong and clear stance on scientific research projects, publically if necessary, that is grounded in the principle of animal welfare under which they operate and which underpins The Code. Whilst there is a legitimate philosophical debate concerning the balance between the welfare of individual animals and the conservation of populations, species and ecosystems as a whole, an AEC is not the place for such a debate. The role of an AEC should be to ensure that the code is appropriately applied in particular cases. If an AEC approves a procedure in accordance with the code, they have a responsibility to protect the researchers from emotive attack. There are appropriate procedures to handle such grievances. These issues are particularly important when research projects directed toward improving conservation outcomes for endangered species are involved in a dispute.

For the researchers, it is important to be proactive in openly providing considerable detail about their study system and to ensure that this information has been understood by the committee. This may involve meeting with committee members or with the full committee. In retrospect, we think that a problem in our particular case was that veterinarians and lay members of the community, being familiar with pets and livestock, have the view that animal mortality should be low until old age unless something has "gone wrong". Wildlife biologists are well aware that mortality in the wild is such that animals in the wild rarely survive long enough for senescence to be detected, except in large samples analysed with the most sophisticated statistical analysis (Nussey et al., 2008b; Knape et al., 2011). The researcher should be the specialist on their study animal. Researchers need to be prepared to stand up and explain their rationale.

Most importantly, the process of AEC assessments of scientific research will work best if committee members and researchers recognise that they share similar goals. Most wildlife researchers are passionately devoted to the welfare of the animals they research. Committee members serve on animal ethics committees because they have a genuine desire to contribute to good animal welfare outcomes. Respect for these shared goals and consultative communication will lead to the best outcomes. Committee members from diverse backgrounds, particularly those with little exposure to science, can provide valuable new insights into the conduct of research. Engaging willingly with this process can lead to the emergence of fresh perspectives and new ideas which is productive for all parties.

A recent review of instrumentation in wild birds and mammals concluded that the causes of the negative effects of attaching collars (and other devices) to mammals are multiple, complex and variable within and between species and are thus best assessed on a case by case basis (Casper, 2009). Casper (2009) provides a useful framework of guidelines that will be useful for researchers and animal ethics committees alike that allow such studies to be assessed in a comprehensive manner.

The "guilty until proven innocent stance" (McMahon et al., 2007) is a risk-averse approach for institutions and AECs to pursue, but when the more important goal of preventing a species from going extinct is at stake, perhaps this is not the best approach, assuming that the welfare impacts of the study are not major on either individuals or populations. If the question "how would you save this species from going extinct?" is posed to those people who would like to ban these studies, what would they say? It is clear that conservation efforts grounded in science, many of which do involve some welfare impact on animals, are more likely to be effective in reversing declines towards extinction. This paper is intended to focus this debate so that we can move towards better engagement between researchers and AECs that are beneficial for conservation outcomes.

References

Beeton N, McCallum H. 2011. Models predict that culling is not a feasible strategy to prevent extinction of Tasmanian devils from facial tumour disease. Journal of Applied Ecology 47:1315 - 1323.

Casper R. 2009. Guidelines for the instrumentation of wild birds and mammals. Anim. Behav. 78:1477–1483.

Dalton R. 2005. Animal-rights group sues over 'disturbing' work on sea lions. Nature 436:315.

Darby A. 2008. Devils up to their necks in trouble. In: The Sydney Morning Herald.

Dobson A. 2004. Population dynamics of pathogens with multiple host species. American Naturalist 164:S64-S78.

Gittleman JL, Wayne RK, Macdonald DW, Funk S, editors. 2001. Carnivore conservation. Cambridge, U.K.: Cambridge University Press.

Hamede R, Jones ME, McCallum H. 2008. Patterns of biting injuries and transmission of Tasmanian devil facial tumour disease.

Hamede R, Lachish S, Belov K, Woods G, Kreiss A, Pearse AM, Lazenby B, Jones M, McCallum H. 2011. Reduced effect of Tasmanian devil facial tumor disease at the disease front. Cons. Biol. accepted 28 July 2011.

Hamede RK, Bashford J, McCallum H, Jones M. 2009. Contact networks in a wild Tasmanian devil (Sarcophilus harrisii) population: Using social network analysis to reveal seasonal variability in social behaviour and its implications for transmission of devil facial tumour disease. Ecol. Lett. 12:1147-1157.

Hamede RK, McCallum H, Jones M. 2008. Seasonal, demographic and density-related patterns of contact between Tasmanian devils (Sarcophilus harrisii): Implications for transmission of devil facial tumour disease. Austral Ecology 33:614-622.

Jones M, Jarman P, Lees C, Hesterman H, Hamede R, Mooney N, Mann D, Pukk C, Bergfeld J, McCallum H. 2007a. Conservation management of Tasmanian devils in the context of an emerging, extinction-threatening disease: Devil Facial Tumor Disease. EcoHealth 4:326-337.

Jones ME. 2000. Road upgrade, road mortality and remedial measures: Impacts on a population of eastern quolls and Tasmanian devils. Wildl. Res. 27:289-296.

Jones ME, Jarman PJ, Lees CM, Hesterman H, Hamede RK, Mooney NJ, Mann D, Pukk CE, Bergfeld J, McCallum H. 2007b. Conservation management of Tasmanian devils in the context of an emerging, extinction-threatening disease: Devil facial tumor disease. EcoHealth 4:326-337.

Knape J, Jonzén N, Sköld M, Kikkawa J, McCallum H. 2011. Individual heterogeneity and senescence in Silvereyes on Heron Island. Ecology 92:813-820.

Lachish S, Jones M, McCallum H. 2007a. The impact of disease on the survival and population growth rate of the Tasmanian devil. J. Anim. Ecol. 76:926-936.

Lachish S, Jones ME, McCallum HI. 2007b. The impact of devil facial tumour disease on the survival and population growth rate of the Tasmanian devil. Journal of Animal Ecology 76:926-936.

Lachish S, McCallum H, Mann D, Pukk C, Jones ME. 2010. Evaluation of selective culling of infected individuals to control Tasmanian devil facial tumor disease. Cons. Biol. 24:841–851.

Lachish S, Miller KJ, Storfer A, Goldizen AW, Jones ME. 2011. Evidence that disease-induced population decline changes genetic structure and alters dispersal patterns in the Tasmanian devil. Hered. 106:172-182.

Lloyd-Smith JO, Schreiber SJ, Kopp PE, Getz WM. 2005. Superspreading and the effect of individual variation on disease emergence. Nature 438:355-359.

Lunney D. 2011. Ethics and Australian mammalogy: reflections on 15 years (1991 - 2006) on an Animal Ethics Committee. Aust. Mammal.:published on-line 23 November 2011.

McCallum H. 2008. Tasmanian devil facial tumour disease: lessons for conservation biology. Trends Ecol. Evol. 23:631-637.

McCallum H, Jones M. 2006. To lose both would look like carelessness... Tasmanian Devil Facial Tumour Disease. Public Library of Science. PLOS Biology 4:1671 - 1674.

McCallum H, Jones M. in press. Infectious Cancers in Wildlife. In: Aguirre AA, Daszak P, Ostfeld RS, editors. Conservation Medicine: Applied cases of ecological health. Oxford, UK: Oxford University Press.

McCallum H, Jones M, Hawkins C, Hamede R, Lachish S, Sinn DL, Beeton N, Lazenby B. 2009. Transmission dynamics of Tasmanian devil facial tumor disease may lead to disease-induced extinction. Ecology 90:3379-3392.

McCallum H, Tompkins DM, Jones M, Lachish S, Marvanek S, Lazenby B, Hocking G, Wiersma J, Hawkins CE. 2007. Distribution and impacts of Tasmanian devil facial tumor disease. EcoHealth 4:318-325.

McMahon CR, Bradshaw CJA, Hays GC. 2007. Applying the heat to research techniques for species conservation. Cons. Biol. 21:271–273.

Meinesz A. 1999. Killer Algae. The true tale of a biological invasion. Chicago: The University of Chicago Press.

NHMRC. 2004. Australian code of practice for the care and use of animals for scientific purposes. Canberra Australia: Australian Government.

Nussey DH, Coulson T, Festa-Bianchet M, Gaillard JM. 2008a. Measuring senescence in wild animal populations: towards a longitudinal approach. Funct. Ecol. 22:393-406.

Nussey DH, Coulson T, Festa-Bianchet M, Gaillard JM. 2008b. Measuring senescence in wild animal populations: towards a longitudinal approach. Functional Ecology 22:393-406.

Paddle R. 2000. The Last Tasmanian Tiger. The History and Extinction of the Thylacine. Cambridge, England: Cambridge University Press.

Recher HF, Lunney D, Matthews A. 2009. Small mammal populations in a eucalypt forest affected by fire and drought. I. Long-term patterns in an era of climate change. Wildl. Res. 36:143–158.