J Agric Environ Ethics (2009) 22:361–378
DOI 10.1007/s10806-009-9158-5

ARTICLES

Convergence of Culture, Ecology, and Ethics: Management of Feral Swamp Buffalo in Northern Australia

Glenn Albrecht · Clive R. McMahon · David M. J. S. Bowman · Corey J. A. Bradshaw

Accepted: 16 February 2009 / Published online: 11 March 2009

Abstract This paper examines the identity of Asian swamp buffalo (*Bubalus bubalis*) from different value orientations. Buffalo were introduced into Northern (Top End) Australia in the early nineteenth century. A team of transdisciplinary researchers, including an ethicist, has been engaged in field research on feral buffalo in Arnhem Land over the past three years. Using historical documents, literature review, field observations, interviews with key informants, and interaction with the Indigenous land owners, an understanding of the diverse views on the scientific, cultural, and economic significance of buffalo was obtained. While the diverse stakeholders in buffalo exploitation and management have historically delivered divergent value orientations on the nature of the human–buffalo relationship, we argue that over time there is the possibility of values and ethical convergence. Such convergence is possible via transdisciplinary and transcultural agreement on the value stances that constitute the construction of the being or identity of buffalo in the face of the overwhelming need to manage population density and gross numbers.

Keywords Buffalo · Ethics · Culture · Management · Australia

G. Albrecht (✉)
School of Sustainability, Murdoch University, South Street, Murdoch, Western Australia 6150, Australia
e-mail: G.Albrecht@Murdoch.edu.au

C. R. McMahon
School for Environmental Research, Charles Darwin University, Darwin, Northern Territory 0909, Australia

D. M. J. S. Bowman
School of Plant Science, University of Tasmania, Private Bag 05, Hobart, Tasmania 7001, Australia

C. J. A. Bradshaw
Research Institute for Climate Change and Sustainability, School of Earth and Environmental Sciences, University of Adelaide, Adelaide, South Australia 5005, Australia

C. J. A. Bradshaw
South Australian Research and Development Institute, P.O. Box 120, Henley Beach, South Australia 5022, Australia

Introduction

The introduction of Asian swamp buffalo (*Bubalus bubalis*) into Australia was undertaken initially for strictly utilitarian purposes. As a meat supply and as beasts of burden, they were exploited on the basis of their use value. As settlements failed, buffalo no longer possessed such a value and were released into the wild. Once in the wild, they reproduced rapidly and became so numerous that they were perceived by colonists as pests. Aboriginal people, when confronted with these alien megafauna, had to adjust rapidly to their presence. Europeans too had to re-evaluate their relationship to the buffalo and new avenues of exploitation were opened from the nineteenth century onwards.

Indigenous hunting of buffalo for meat would have acted as a minor impediment to the population explosion; however, a tropical monsoon ecosystem was suitable for their virtually unchallenged and rapid colonization across Northern Australia. Europeans began to exploit the buffalo for their hides from about 1886 onwards. The hide industry continued until the late 1950s when an industry to supply meat for human and pet needs was established. In addition, a trophy-hunting industry developed in the late 1950s and some tourism in the Northern Territory has been based on the presence of iconic animals such as buffalo and crocodiles in the national parks.

In spite of the demands of the meat industry, Indigenous hunting and trophy hunting, the Top End buffalo population continued to expand such that, by the late 1980s, numbers were in the hundreds of thousands. The feral buffalo was seen as a disease risk to the Northern Territory cattle industry and the multi-million dollar Brucellosis and Tuberculosis Eradication Campaign (BTEC) was introduced in 1980 with a capture and "shoot-to-waste" policy in operation from 1988 to 1992 to eliminate those animals (cattle and buffalo) that could not be included in a disease-testing regime. Since 2002 there has been an industry based on the capture of buffalo and their live export into Indonesia where they are placed in feedlots before slaughter. There is also a small-scale crossbred Tenderbuff® meat production industry based on farmed stock in the Northern Territory.

Since the cessation of the BTEC campaign, buffalo numbers have again increased to approximately 150,000 animals (Garnett, Kakadu National Park Feral Animal Management Symposium. Jabiru Northern Territory, 3–4 December 2008). Apart from traditional Aboriginal owners who want some buffalo available as a "meat bank," and the live export meat industry, others have expressed concerns about the negative impact of feral buffalo. Such concerns have focused on the ecological integrity of ecosystems within national parks (Bradshaw et al. 2007), renewed disease threats (McMahon and Bradshaw 2008) and human safety (Robinson et al. 2005). Despite all these concerns, trophy hunters and tourists still perceive buffalo as iconic megafauna and want to experience wild buffalo in the Top End.

In what follows, distilled from these different conceptions of the roles buffalo play in history, culture, ecology, and economy, distinct buffalo value orientations can be determined. The different positions with respect to buffalo and their interaction with humans shall be treated chronologically, starting with historical and Indigenous evaluations and concluding with contemporary thinking about ethical ways of treating buffalo within research, wildlife management, and natural resource exploitation contexts.

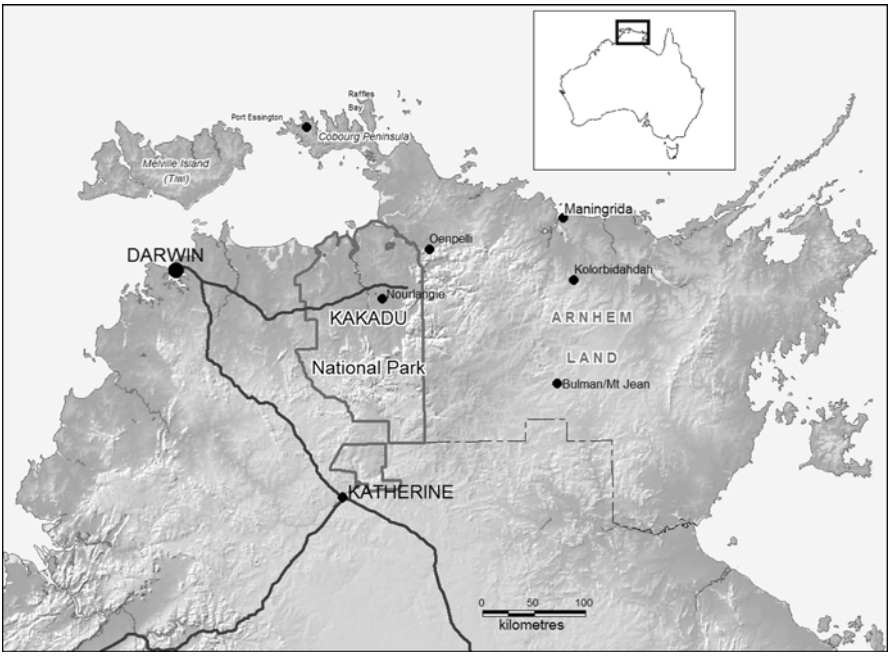
Understanding the perceptions people have towards buffalo is informative and important because they provide insights into how best to manage buffalo and reconcile the utilitarian and other values placed upon them by humans. Here we explore this relationship and how it has changed between humans and buffalo since their introduction in the early 1800s.

Historical Context

Asian swamp buffalo were introduced in the early nineteenth century from what were once known as the Dutch East Indies to an ancient landscape and culture in the Top End of Australia. Idriess (1946) claims that it was the Commandant of Fort Dundas on Melville Island, Maurice Barlow, who imported the first three buffalo in 1825 into what are now called the Tiwi Islands. In 1826 another sixteen animals were imported from Timor to Fort Dundas on Melville Island primarily to be used as a meat supply for the garrison. In 1827 they were also introduced to Raffles Bay on the Cobourg Peninsula (Tulloch 1969, 1970). Raffles Bay and Fort Dundas were abandoned in 1829. In 1838, eighteen buffalo were obtained from Kissa Island, which is to the north of Timor, and were introduced to mainland Australia at Victoria Settlement on Port Essington on the Cobourg Peninsula. It too was abandoned in 1849, leaving all the buffalo behind (Earle 1863, in Tulloch 1970). There were also early introductions of buffalo into the Darwin and Pine Creek areas and they then spread out in the coastal zone of the Alligator Rivers' region and into Arnhem Land and finally Kakadu National Park.

By 1844, only 16 years after the introduction of the buffalo, the explorer Ludwig Leichhardt reported numerous sightings of wild buffalo and their tracks in the vicinity of the East Alligator River. Leichhardt recounts an Aboriginal man (named "Bilge") who "… frequently mentioned 'Devil devil,' in referring to the (expedition's) bullock, and I think he alluded to the wild buffaloes, the tracks of which we soon afterwards saw." (Leichhardt 1844–1845). Leichhardt also reported in his journal:

> They (the Aboriginal people) called the buffalo "Anaborro" and stated that the country before us was full of them. These buffaloes are the offspring of the stock



> which had either strayed from the settlement at Raffles Bay, or had been left behind when that establishment was broken up. They were originally introduced from the Malay islands (Leichhardt 1844–1845).

Earle (1846) confirmed Leichhardt's account of the spread of the feral buffalo:

> The buffaloes that had been left behind when the settlement at Raffles Bay was abandoned have increased to a surprising degree, and wander about the country near the neck of the peninsula in herds of forty and fifty. Stragglers have often been encountered in the immediate neighbourhood of the settlement—large unwieldy bulls that have been driven out of the herd by others stronger than themselves (Earle 1846, in Tulloch 1970).

It is clear that, from the outset of their introduction to Australia, buffalo were seen as something to be exploited for their meat and strength. No consideration was given by the early colonists to the possible implications of the introduction of a megafauna herbivore into a complex cultural and ecological setting.

Cultural Construction of the Buffalo

Indigenous Cultural and Economic Valuations

The being, nature, or essence of an animal is generally defined in the context of those who are doing the defining. We suggest that the value or ethical being of any particular animal is constructed as part of the unique identity bestowed by members of specific human cultures and sub-cultures to non-human species, and, individuals within those species. Indigenous cultures have special relationships with non-human species, so much so that, in certain circumstances, cultural identity is almost completely associated with a particular animal or species.

In parts of Indonesia, buffalo are revered and are considered as symbols of wealth and power. The regional architecture is strongly influenced by buffalo with the classic scimitar shape of the horn reproduced in the roof lines. The height of the building and the "horns" reflect the wealth and status of the owner of the building.

Newsome (1980), following the anthropologist Strehlow's work in the1970s, has shown how, for the Krantji Kangaroo clan, northern Aranda Aboriginal people, the red kangaroo (*Macropus rufus*) is a key totem and is central to their understanding of landscape and ecology (Newsome 1980). In North America, the relationship between the Crow tribe and the bison (*Bison bison*) highlights the strength of such identity. Lear (2006) gives an account of the Crow nation after its disintegration by the settler society. Plenty Coups, the last leader of the Crow nation, spoke about the loss of buffalo in the Crow territory:

> But when the buffalo [bison] went away the hearts of my people fell to the ground, and they could not lift them up again. After this nothing happened. There was little singing anywhere… You saw what happened to us when the buffalo went away (Lear 2006).

The first-hand account of Indigenous contact with buffalo in Arnhem Land by Leichhardt suggests that, initially, the local people did not have a comfortable or workable relationship with wild buffalo. Bilge's use of the term "devil devil" for buffalo (or bullock) implies that these animals were feared and seen as a threat to humans. The term "devil

devil" is also connected to Arnhem Land Dreaming stories based on a creator woman who had both "good mother" and destructive or "bad mother" manifestations (Altman 1982). It was this powerful woman who created the waterways and the waterholes; however, she was also capable of destruction and would punish those who broke laws with floods and mayhem. She was also known as the Rainbow Serpent. Connections to the Christian "devil" and the notion of transgressions of the law or natural order of things (sin) are easily made.

Over time, it is clear that the uncomfortable relationship changed to one of greater accommodation. For example, the people of Arnhem Land have incorporated the buffalo into The Dreaming where they are now considered part of the constellation of Rainbow Serpent creation forces. This makes complete sense, since buffalo have huge impacts on waterways and billabongs as was paralleled with the power of the Rainbow Serpent to carve out serpentine river channels and streams in the Dreamtime. As Altman has observed:

> In eastern Gunwinggu myth, and today in bark paintings, there is a Rainbow serpent that has ears (*gunemno*) and horns (*djupanano*) identified by Gunwinggu as those of the buffalo. This (serpent) called *Inanga* is said to have as its mother the Rainbow serpent, and as its father *nganaparru* (buffalo) (Altman 1982).

Rather than seeing buffalo as simply aliens that have no place in culture or ecology, Indigenous people have integrated them into their culture and given them an identity or culturally defined value that is inclusive and educative. In addition, as is noted below, buffalo are dangerous animals and their connection to the Rainbow Serpent provides a foundation for teaching clan members about how to avoid them and behave when they are near. While buffalo are conceptualized as potentially "destructive" of both humans and ecosystems, they are also part of a productive regime where, as a reliable source of fresh meat in the landscape, they are a vital part of the food bank available for people living off the land (Bowman and Robinson 2002).

The nature of the human–buffalo relationship is also exemplified in the practical life of a hunting and gathering culture. Indigenous men with traditional weapons would not have been able to kill an adult buffalo quickly. Buffalo have thick hides and a spear would have to hit a vital organ for a quick death. Even then, there was danger of charging from a wounded animal and a long pursuit to finish them off with more spears, knives, and clubs. There would have been great suffering of the hunters and hunted during the chase and, at least initially, buffalo would not have been a totem animal subject to traditional taboos on where, when, and how it was killed. Therefore, there would have been no great concern about its welfare. There was, however, plenty of concern about the welfare of the hunter. From a report by Donald Thompson of his time in Arnhem Land in the 1930s, we get a glimpse of what the hunting entailed:

> As we lay down to sleep under some stunted trees one of them (a native carrier) looked up at the tree above him and observed: Suppose buffalo come, this one belong me; I go climb up. This led to a talk on their adventures with buffalo and Raywala (native companion) told me that a man had been killed by a buffalo while out hunting…some months earlier. He told me that although metal shovel-nosed spears were sometimes used for buffalo hunting, they preferred the stone-head spears because they made a greater wound and caused such a loss of blood (Thompson 2003).

With the introduction of firearms, Indigenous men hunted buffalo on foot in much the same way as with iron or stone spears. The shotgun was not capable of killing a buffalo

with one shot and the method of killing involved shooting at close range (usually at the legs or shoulder) and then rapidly retreating before the wounded animal could charge:

> Rarely is a buffalo shot dead, and usually the exciting part of the hunt involves chasing the wounded buffalo. I have seen it take as many as seven or eight hits to kill a buffalo. Sometimes, if nightfall is approaching, a buffalo is allowed to die overnight: people are particularly sensitive about staying out after dark, with an injured animal about (Altman 1982).

Despite the dangers of hunting such a large animal, Indigenous men enjoyed the challenge and as Altman reported, "…eastern Gunwinggu men thoroughly relish a successful buffalo hunt. They enjoy hunting in general, but a buffalo hunt is special" (Altman 1982). There is no doubt that hunting buffalo with stone-head spears or shotguns would have been an ordeal. Indigenous people had concerns about their own welfare, but what is not so clear is whether they had concerns about the welfare of the animals they hunted.

On the issue of Indigenous treatment of cruelty to animals, Simpson argues that Aboriginal people "appear to have been less cruel, and markedly less sadistic than most other races" (Simpson 1951). However, he also states, "all pre-literate people are sickeningly insensitive to animal suffering" (Simpson 1951). The imperative to eat, the enormous strength and endurance of wild buffalo and the use of spears and shotguns all meet at a point where animal suffering is unavoidable. The seemingly callous treatment of other animals such as sea turtles[1] also reinforces the idea that Indigenous people kill and eat animals at times that suit their needs, and with little regard for the welfare of the individual animal.

However, the needless killing of juvenile animals is the subject of Indigenous ethical consideration. When, during the conduct of research field work, Indigenous people were asked about the killing of young buffalo, they answered that it is wrong to kill neonates and juveniles. They reasoned that young animals have the potential to grow larger and be "better" as food for a larger number of humans if they are left to mature. While the rationale for limiting the hunt to adults does not imply a welfare consideration per se, the outcome is identical.

As the population and density of buffalo increase, their inclusion and acceptance within culture give way to other types of value consideration as they become more of a threat to human safety and compromise the ability to gather for sustenance within a given landscape. Indigenous men have been killed or maimed by buffalo while hunting them as have women and children when engaged in gathering on traditional country (Robinson et al. 2005). At this point, an inclusionary concept of value is replaced by one that wishes to exclude buffalo on safety and sustenance grounds.

Places such as billabongs and water courses are attractive both to humans and buffaloes because they are rich in plant and animal sources of food. Women are often unarmed and without the company of armed men while gathering on their land, live in fear of buffalo attack.[2]

[1] By turning captured turtles over and leaving them for many hours, sometimes days in the sun, Indigenous treatment of turtles has been seen to be the epitome of unethical treatment. However, a turtle represents a potentially large meal for a community and to kill it and eat it at a time of maximum use is prudent. Turtles, even after they have had their heads severed, have been known to "walk" back into the ocean and swim away. Perhaps turning turtles and leaving them alive until killed and eaten "fresh" is the lesser of two evils.

[2] The women rangers program operating out of Maningrida now arms and trains female rangers to protect them from buffalo attack while on country (Personal Communication: Interview with female ranger at Maningrida).

It is possible to view the fear that women have of buffalo in an ecological light. Following the research of Ripple and Beschta (2004) on the reintroduction of wolves into Yellowstone National park in the USA, we can speculate on how the wetland ecosystems of Arnhem Land are being influenced by an "ecology of fear." In much the same way as the fear of wolves has altered the browsing behavior of ungulates leading to a recovery of riparian vegetation and avifauna; the fear of buffalo has fundamentally changed the behavior of Aboriginal people, thus altering the flora and fauna of Arnhem Land. For example, when gathering is no longer undertaken on a regular basis, the cycle of harvesting and replanting of yams is no longer possible. Buffalo do not simply disturb plant ecosystems; they disturb an "edible landscape," one partially created by Indigenous people to sustain themselves.

As a result of the fear of buffalo, there are consequent knock-on effects for the cultural and physical health of people and the health of ecosystems. Information gathered for the "Healthy Country: Healthy People" research project (Johnston et al. 2007) reinforces this view. Women interviewed as part of this project indicate that they valued being "on country" but that buffalo were a big problem. Three of the interviewees made the following statements:

> Leila—*I was listening to my mother and she was telling me old people are tired eating all this Balanda* [non-Aboriginal] *food and I just wanted to go out and get food from bush and bush tucker* [food]—*sort of long yam, yam, chestnuts, water lilies…all them bush food.*
> Linda—*Buffalo and pigs—ruining bush foods, especially when we go hunting like to find turtle, it's hard.*
> Valerie—*And if I want to camp out, I just make fire, biggest fire, sleep, don't worry about anything, except maybe buffalo.*

In the light of such testimony we can conclude that buffalo are no longer culturally valued as creators, but as destroyers of landscape. As a result of the change in cultural valuation, the need to manage numbers of buffalo to reduce undesirable ecological and human welfare impacts becomes more acceptable. The identity of a buffalo from an Indigenous perspective is then multi-layered. The Rainbow Serpent identity remains, but buffalo are also conceived as "humbug" (annoying and bothersome) and must be controlled and/or removed from country. In the past, the killing of buffalo would have been undertaken by Indigenous men using antiquated and poorly maintained .303 caliber rifles.[3] Today, it is possible for the management of buffalo to be achieved by men and women using modern, high-powered rifles and this improves the chance of killing a buffalo with the least possible pain and welfare implications for buffalo and improved safety standards for humans.

Non-Aboriginal Cultural and Economic Valuations

After the failure of the settlements on Melville Island and Port Essington, the first Europeans who made contact with feral buffalo were able to demonstrate to Indigenous people that hunting with the aid of horses and guns was far more effective than with spears. There was still considerable danger as an early account of a hunt by Leichhardt attests:

[3] The issue of gun control in the Northern Territory works against the use of high-powered rifles as weapons of first choice in the killing of buffalo. Access to high-powered rifles has important complex cultural, legal, and animal welfare implications.

> We encamped at a good-sized water-hole in the bed of this creek, the water of which was covered with a green scum. As the dung and tracks of the buffaloes were fresh, Charley went to track them… At the discharge of the gun a buffalo started out of a thicket, but did not seem inclined to go far; Brown returned, loaded his gun with ball, went after the buffalo and wounded him in the shoulder. When Charlie came back to camp, he, Brown and Mr Roper pursed the buffalo on horseback, and after a long run, and some charges, succeeded in killing it. It was a young bull, about three years old, and in most excellent condition (Leichhardt 1844-45).

By 1886, due to their steady population increase, a buffalo hide industry in Arnhem Land was possible and from 1886–1956, about 4,000–7,000 hides were exported annually. In 1886, Paddy Cahill was killing buffaloes at the rate of 1,500 a month (Simpson 1951). Buffalo hunting camps were set up and a permanent settlement was attempted in 1906 at Oenpelli. The technique used to kill buffalo under the commercial imperative of quality hides was discussed in graphic detail by Simpson:

> You know what they did in the early days, using horses? They used to ride right up to the buffalo's rump, the way we do, shooting—but they didn't shoot. They used to lean from the horse and whang into them at the base of the spine with an axe (Simpson 1951).

The gun later replaced the axe, but Simpson asked key ethical questions about the treatment of the buffalo in the hide industry. He raised the issue of leaving buffalo that had been shot in the base of the spine and paralyzed to be left until the following day to be killed and skinned. While the hides were kept "fresh" and flies kept at a minimum, no doubt the animals suffered. In his field notebook Simpson recorded the details of what happened when the paralyzed buffaloes were found the next day:

> The first one [of the buffaloes shot the previous afternoon] we came up with was paralysed but very alive… Aub shot it between the horns and it keeled over. The skinners got on to it and it moved and shook and rolled as the tail was cut… I am writing this near the skinned carcass of another one which was alive when we came up. Len leaned from the cabin of the truck to shoot, the bull shook its head and knocked the rifle aside. One of the boys got down and shot it between the horns. Len assured me that its raising one leg and the other movement as its ear was cut off (for head skinning) were purely reflexes (Simpson 1951).

Simpson then asked "how much was the buffalo paralyzed, how much pain and thirst did an animal like that have to suffer, an animal that has no bellow? I didn't know and I still don't know. I have tried to find out, but nobody you can talk to is a buffalo" (Simpson 1951). As we shall see below, this question is one that many other perspectives in animal ethics are still trying to answer.

The buffalo hide industry finished by the 1950s and small-scale hunting for human consumption and pet meat commenced. The trophy hunting industry also developed in the late 1950s. Allan Stewart (1969), who ran a trophy hunting and safari business at Nourlangie in Western Arnhem Land, gives a first-hand account of both the buffalo meat industry and buffalo trophy hunting. After warning the reader about the dangerous and unpredictable nature of the buffalo, Stewart provided an analysis of the way buffaloes are killed. He suggests that the use of "any calibre less than .303 is inhumane" and even the .303 is not an effective weapon for killing buffalo. He argues:

> There is no denying that the .303 is a reasonable all-round Territory rifle, and that it will kill buffaloes; but it was designed to kill men, not thick-hided bovines. A buffalo becomes insensate to shock after the first impact and follow-up shots do not appear to visibly affect it. I have had to follow a badly wounded bull, on foot, over three miles before it collapsed from a lung shot by a .303 (Stewart 1969).

Stewart also observed many occasions where professional buffalo hunters would not be able to kill an adult buffalo with a .303 even after five shots and that his own use of a .375 caliber rifle was far more effective.[4] Simpson (1971), however, did not share Stewart's views on the hunting of buffalo for sport. He suggested:

> Buffalo-shooting is a business, but it can never be a sport. Racing up on them in a jeep and pumping bullets into a bull with a big set of horns to mount on a wall as a trophy has no more validity as hunting than going into a paddock and shooting a dairy cow (Simpson 1971).

In spite of live animal capture, Indigenous hunting and trophy hunting, the Top End buffalo population continued to expand such that, by the late 1980s, numbers were in the hundreds of thousands. Both wild cattle and feral buffalo were seen as disease risks to the Northern Territory cattle industry and, as indicated above, the multi-million dollar Brucellosis and Tuberculosis Eradication Campaign (BTEC) was introduced in 1980.

From an animal welfare and ethics perspective, it was the shoot-to-waste policy, implemented via helicopter, which caused the most concern. Robinson and Whitehead (2003) detail the level of concern in the late 1980s:

> Meanwhile, animal welfare groups argued that the damage caused by shooting animals to waste was not just economic. While helicopter shooting was efficient, it was a method that could include wounding. Concern escalated to the threat of abuse and bomb threats to Australian staff in Europe, the boycott of Australian goods, and the initiation of a senate inquiry…while the main concern arose over horses, this pressure extended to the treatment of buffalo (Robinson and Whitehead 2003).

While there was near total eradication of the free-ranging buffalo population in Kakadu National Park, the difficulty and cost of complete extinction meant that when the disease control program ended in the late 1980s, there was the opportunity for rapid population recovery. Such has been the rate of recovery that in the last decade there has been a growing industry based on the live export of buffalo from Port Darwin to markets in Asia. In 2006, 6,000 animals were exported to Malaysia alone and with an agreement with Indonesia in 2005 exports will increase. At present, many of the buffalo mustered and exported come from the Bulman—Mount Jean region of southern Arnhem Land.

The introduction of new technologies such as four-wheel drive vehicles, helicopters, and road trains in the mustering, capture, and transport of buffalo has generated new ethical issues. The capture and export of live buffalo raises considerable animal welfare issues but in the context of the isolation of this industry within the Northern Territory, few people are

[4] The possible ineffectiveness of the .303 with respect to hunting buffalo was confirmed in 2005 by the authors while observing a local Indigenous man hunt and shoot buffalo at Kolorbidardah. Many shots were fired from an antiquated and poorly maintained .303 but often target animals were hit without any immediate impact and no kill resulted. Later, when driving though the bush, buffalo were found that at first glance appeared healthy but were not chosen as targets to be shot. These animals seemed more reluctant to run away than others and were described as "sick" by the men. Most likely, these animals had been hit in previous hunts and were slowly dying of their infected wounds.

directly aware of what happens to the animals. The animal welfare implications of mustering, yarding, tagging, de-horning, trucking, mother-calf separation, and live shipping are indeed complex and formidable. Primary amongst them is lethal capture myopathy (Chalmers and Barrett 1982) due to the stress put on animals under the mustering and yarding process, and de-horning, which may place considerable physiological and social distress on the animals.

Recent research and experience suggest that great improvements can be made in animal health by mustering in less stress-inducing ways. Lemke, writing in the context of the handling of farmed buffalo in the NT, has documented the ways of minimizing handling stress, including the process of de-horning (Lemke 2006). However, little published research is available on what happens to wild buffalo when they are mustered, what the impacts of all processing are, including the de-horning, and, finally, the stress of transport by truck and ship to export destinations.

Clearly, there is scope for improvement in the management of feral buffalo. Simpson (1971) was in the forefront of those who helped to get spine shooting stopped, but even he suggests that it was the move from hides to meat that eliminated that "abominably cruel" practice. Now that the growth industry is the live export of buffalo, raising the bar of ethical treatment should be a high priority if the industry is to continue without controversy.

Scientific and Philosophical Conceptions of Value and Being

Species Being

We define "species being" as the identity or being conferred by the scientific community on an organism by virtue of its membership to a unique species. Humans have created ways of categorizing organisms under, for example, the Linnaean system of classification that includes the recognition of distinct species.[5] Morphological similarity, ability to reproduce sexually with conspecifics and genetics all play a part in the recognition of a unique species. The exact origin of the buffalo that were introduced into northern Australia remains obscure. However, recent DNA evidence suggests that all buffalo originated from India and China (Lei et al. 2007), but more recent work suggests at least some South East Asian origin (McMahon et al., unpubl. data).

The genetic identify of Australian buffalo is important because value implications follow. For example, if the Australian population represents the last stronghold of wild swamp buffalo in the world (as is the case for introduced banteng [*Bos javanicus*] in northern Australia; Bradshaw et al. 2006), then conservation ethics might have to play a role in future management of the population. It has been suggested that the "true" wild swamp buffalo only remains in isolated populations in Bhutan, Nepal, India, and Thailand and that the species is under threat of extinction (*Critically Endangered*) (IUCN 2008). Domestication and cross-breeding with other types of buffalo (e.g., riverine buffalo) have also eroded the genetic identity of free-ranging buffalo in their native range.

It is possible that the Australian population of buffalo represents a viable population of the last remaining wild type of buffalo left on the planet. Therefore, from a conservation perspective, protection of the wild Australian population might be required for the species to persist. If the Australian animals are indeed an isolated population of a threatened species, then preservation rather than continued culling may be in order. Conversely, if it is

[5] Often closely matched by Indigenous classifications (Berkes 2008).

found that Australian feral swamp buffalo are "hybrids," with no particular genetic distinctiveness from the rest of the domesticated population in South East Asia, the ethical imperative to conserve evaporates (Bradshaw et al. 2006; Brook et al. 2006).

From a more general ethical perspective, it could be argued that the buffalo has characteristics that require ethical attention over and above their dubious genetic classification. In addition to being scientifically defined as a unique species, buffalo are "sentient" creatures in that they have a central nervous system and can experience pleasure and pain (suffering). For philosophers such as Bentham and Singer, the central ethical issue with respect to non-human animals is the prevention of suffering. Singer (1975) argues:

> If a being suffers there can be no moral justification for refusing to take that suffering into consideration. No matter what the nature of the being, the principle of equality requires that its suffering be counted equally with like suffering…the limit of sentience is the only boundary of concern for the interests of others.

From the perspective of supporters of animal liberation, the being of a buffalo is crucially determined by its sentience, and failure on the part of humans to respect its ability to experience pleasure and pain amounts to the ethical failure of "speciesism."

Buffalo Research

Sentience-based ethics is now the cornerstone of the treatment of animals within research protocols. Researchers are required to justify their use of animals and address pain and welfare implications of their interventions. The species being of a buffalo puts it within the category of sentient animals and, hence, the subject of ethical considerations.

The authors of this paper sought and were given ethics approval to undertake a population study of feral swamp buffalo in locations in the Northern Territory and Tiwi Islands. In addition, they were required to seek permission to be on traditional Indigenous land and to take "the" animals for research purposes. With a research project based on the necessity of gaining a random, cross-sectional sample of wild buffalo, lethal methods must be employed. Shooting using a high-powered and well-maintained gun is the most efficient and ethical way to obtain such samples. So far, from 2003-2007, ground-based culling has used a .338 caliber rifle and the indications are that the average time from bullet impact to death is approximately one minute. In addition, the use of a well-maintained .308 rifle resulted in a time of two minutes between impact and death. Helicopter-based culling using a .308 increased the time efficiency of the process, but so far no systematic assessment of the kill rate versus the wounding rate has been attempted. The advantage of the helicopter is that the shooter can get within 20–30 m of the target animal and can therefore shoot with greater accuracy and impact. However, while the larger caliber gun is more effective in rapid killing of buffalo than those of lower caliber, factors such as the skill of the marksman and the condition of the gun are important contributing factors. A hovering helicopter is also important for the remote delivery of drugs by dart to immobilize buffalo for live capture requirements (e.g., placing tracking collars) (McMahon & Bradshaw 2008).

The use of helicopters in any form of animal culling can be problematic. The experience of the National Parks and Wildlife Service of New South Wales with the aerial culling of wild horses in the Guy Fawkes River National Park in 2000 is instructive. With evidence of distressed, wounded animals coming to the public attention, there was a massive outcry about the lack of ethical content in the management plan (Chapple 2005). Under public pressure, aerial culling was abandoned in 2002 and other forms of humane entrapment were implemented to remove feral horses from national parks.

The introduction of sentience-based ethics has transformed the way research on animals is conducted, the treatment of animals in commercial contexts, and the range of accepted animal management practices used in feral animal control. Given the close interaction between population biologists, an ethicist, and Indigenous people in the research project described by this paper, it is possible that the influence of sentience-based ethics will expand and be incorporated into Indigenous value systems in the future.

In addition, a fundamental aim of the research is to offer sound advice on how to calculate and manage the numbers of buffalo such that population density is low enough to satisfy the requirements of human and ecological health and safety. Science-based information is then fed into Indigenous knowledge and a joint management strategy to control buffalo numbers can be put into effect. Such a joint management strategy ought to include respect for buffalo sentience as one of its foundations.

Individual Being and Value

According to many religious and philosophical traditions, individual life is intrinsically valuable (valuable in and for itself) and is perhaps the foundation for many other values. Under the idea of intrinsic value, the lives of individual organisms are inherently valuable to them (in their interests) and we should avoid all unnecessary harm or suffering to living organisms. This source of value is independent of the ethical consideration of sentience as it applies to all life forms. The traditions most strongly associated with this position would be a Schweitzerian total life-respecting ethic, Jainism (protect all life from harm) and Deep Ecology (biocentric egalitarianism). Within these traditions all organisms are viewed as unique and valuable and as such they command our respect and care. They can be harmed only to satisfy vital needs or to protect one's own life. Given that most humans living in urban contexts could live on a vegetarian diet, the sentience and intrinsic value conceptions of the being of a buffalo would ensure that they should be left alone to live their lives unimpeded by humans. Albert Schweitzer, writing in the 1920s, put the case that all humans need to pay greater attention to the suffering of animals. He argued:

> While so much ill-treatment of animals goes on, while the moans of thirsty animals in railway trucks sound unheard, while so much brutality prevails in our slaughter houses…while animals have to endure intolerable treatment from heartless men… we all share the guilt (Schweitzer 1967).

On the intrinsic value account, Indigenous Australians living on their own country and engaging in a traditional lifestyle are entitled to hunt, kill, and eat feral buffalo. This is because their own well-being, like that of other omnivores and carnivores, is vitally tied to the killing and consumption of non-human organisms. Hunters and gatherers cannot allow an intrinsic value and life respecting view of being to override a utilitarian view.

Humans who are not hunters and gatherers, on the intrinsic value argument, cannot proffer a similar justification for killing buffalo. The only circumstances where killing would be justified would be cases of self defense. Given that buffalo occasionally attack human beings (without provocation), killing them in self-defense would be ethically justifiable.

From the historical accounts, it seems unlikely that considerations of individual being and intrinsic value could have flowed into early Indigenous and colonial cultural contexts. In both situations, vital needs were satisfied by exploiting buffalo. In the modern context, those who promote an intrinsic value-based environmental ethic would wish to protect all living beings, not only those with sentience, on the assumption that humans can live a healthy and happy life without the need to kill and eat animals at all. However, such a

"hands off" approach to buffalo would also see the population explosion problem rapidly move into animal welfare and ecological issues as starvation and devastation of habitat take their toll. Those who hold an intrinsic value orientation must then consider the limitations of their position in the light of the overpopulation problem.

Ecosystem Being and Values

The concept of ecosystem being (Albrecht 1999, 2001) is based on the idea that a species and an individual member of that species have an identity by virtue of their relationships with elements within a given ecosystem. The identity and distinctiveness of species are forged by interactions within what Leopold (1949) called "the biotic community." Feral buffalo are now a well-established component of a complex adaptive ecosystem and they have major ecological impacts.

On the creation of diversity side, the invasion of saltwater into the freshwater ecosystems resulting from high buffalo densities brings new opportunities for colonization by estuarine species. Buffalo also eat much vegetation… they are the modern megafauna of the top End of Australia (Bowman 2003). Without their browsing, the impacts of wildfire, already immense in the Northern Territory, could be even greater and more destructive. On the destructive side, buffalo reduce endemic biodiversity and as Bowman has noted:

> Mobs of buffaloes trampled rainforests and paperbark forests, created 'swim' channels through coastal landforms that enabled salt from seawater to poison the freshwater floodplains, and turned billabongs boiling with wildlife into stinky, black quagmires (Bowman 2003).

The breeding of Magpie Geese and other wetland birds has been severely hampered by buffalo invasion of wetlands and fresh water turtles have had their habitat altered to such an extent that they too cannot breed.

Hence, from the perspective of ecosystem being, buffalo are negative as well as positive forces. On the negative side, an ecological ethic might come down in favor of greatly reducing densities (Bradshaw et al. 2007). On the positive side, an ecological ethic might suggest that the buffalo should remain and be protected because they are megafauna herbivores in a fire-prone landscape (Bowman and Robinson 2002).

There is possible ethical synergy between an Indigenous cultural perspective on buffalo and the concept of ecosystem being. As with the Aranda and the red kangaroo, incorporation of the buffalo into the Dreaming guarantees a value beyond sentience or simple utility. Further consideration of ecosystem being might be useful in other contexts where a transdisciplinary view of health has ecological dimensions. For example, high buffalo density might be related to the possibility of reduced disease transmission to humans from mosquitoes. As observed by Desowitz in the context of Northern Thailand, water buffalo acted as "blotters," taking the main impact of mosquito-borne viruses such as encephalitis. When buffalo were replaced by tractors, mosquitoes switched from beef to humans with deadly consequences (see Higginbotham et al. 2001).

Discussion

There is potential for great conflict between the views of scientists, traditional people, conservationists, pastoralists, live animal exporters, animal welfare groups, trophy shooters, and tourists about the treatment of animals in general, and buffalo in particular. The

ethics of buffalo control in northern Australia are highlighted by the contradictory demands of conserving buffalo as a culturally significant animal, a gene pool of a potentially endangered species, a meat bank for subsistence and export, iconic megafauna for tourism, sport hunting, and trophies, and de-population for maintaining and restoring ecosystem health, fire control, disease mitigation, and human safety. Depending on which of the many cultural, ecological, and economic frameworks for the construction of buffalo being is consulted, different ethical considerations seem to apply. Such value and ethical considerations range from utilitarian to intrinsic value positions. At this stage in the history of the Top End, anyone wanting to interact with buffalo must, at the very least, acknowledge the complexity of the competing value positions and find, if this is at all possible, an acceptable compromise.

However, there is some possibility for convergence in value orientations and ethical stances through the appearance of divergence. As the need for buffalo population control becomes a major concern for both Indigenous and non-indigenous interests, knowledge systems converge and a pragmatic hybrid ethical position emerges. For Indigenous people, cultural and ecological value positions are reconcilable. Although buffalo are culturally defined and valued by Indigenous people, the cultural meanings are underpinned by experiential knowledge of their danger to humans and their ecological impacts. Some consideration of the ecosystem being of the buffalo is built into the Indigenous construction of its culturally defined being and the buffalo is now part of the Rainbow Serpent Dreaming. As one senior Indigenous person argued, "Buffalo belong here, as long as he doesn't do too much damage, he can stay." (Robinson et al. 2005a)

As we have observed above, traditional people, operating in the context of a hunting and gathering economy, have not had animal welfare considerations in the forefront of their culture. This was particularly the case with respect to individual animals that are killed to be eaten, where they were treated as objects, devoid of any relevant ethical consideration. However, given an emergent hybrid economy (Altman 2005, 2006) in Arnhem Land, it is also possible to conceive of an emergent hybrid culture where a blend of traditional and "Western" knowledge, technologies and values will become mainstream. In such a hybrid culture, the incorporation of some aspects of new Western value orientations such as respect for sentience and the corresponding ethical requirement to minimize suffering is possible, but not guaranteed. The collaboration of scientists, working under animal care and ethics protocols, and Indigenous land owners, as described in the research documented in this paper, serves as a pioneering model for how different value systems can interact and make possibilities for new, inclusionary hybrid positions to emerge. Such an inclusive, hybrid ethical position, as a foundation for good environmental management, may well serve as a best-practice model for all situations where potential conflict between Indigenous beliefs and sound conservation is likely to occur.

A related ethical issue is Indigenous involvement in the active environmental management of their lands, including the management of feral animals such as buffalo (Bradshaw & Gorman 2007). In the past, there has been an almost complete exclusion of Indigenous people from the management process. Such exclusion may have contributed to the appearance that they are somehow indifferent to animal suffering and environmental degradation on their own lands. Not only do some Indigenous people want buffalo to remain in their traditional land, they want a more active role in the management of the total environment, including the feral buffalo "problem" (Bradshaw et al. 2007). By being employed in paid management of their lands, the current group of Indigenous rangers are playing their part in the maintenance of ecosystem and, ultimately, human health. Indigenous people are able to engage in nationally important work such as safeguarding

Australia from disease, managing carbon storage, and conserving heritage while at the same time escaping from poverty and lifestyle-related disease (Johnston et al. 2007).

Indigenous values are then incorporated into a culturally defined hybrid adaptive management system suitable for application in Indigenous Protected Areas (IPAs) and joint management of national parks such as Kakadu (Field et al. 2006; Bradshaw et al. 2007). As argued above, such an adaptive management system also introduces Indigenous people to Western values and technologies relevant to feral animal control and good environmental management. Under these new educative regimes it is no longer possible for Indigenous people to remain outside of the influence of the dominant colonizing culture and its prevailing cultural values.

However, it must be noted, there remain tensions between territory and national conservation law and policy and the claim for traditional hunting rights by some Indigenous groups. The claim to a right to hunt, kill, and eat endangered animals such as dugong (*Dugong dugon*) is difficult enough, but to hunt them using traditional weapons would see a rise in intercultural conflict over animal welfare.

The treatment and use of buffalo by the colonists of northern Australia has been ethically problematic from its beginning. Uncontrolled introductions and ruthless exploitation using the highly unethical methods that we documented show that historical Western constructions of the buffalo were nothing more than as a source of hides, meat, and sport (utility value). Clearly, species being and individual being and their associated values have not been major sources of ethical consideration in the colonial context. The most recent phase of that colonial exploitation, mustering, and live export, continues the tradition of ethically problematic impacts on the well-being of buffalo. However, even here, with due consideration to humane methods of handling and management en route to shipping, there is a possibility of meeting minimal acceptable ethical standards for the treatment of animals. These minimum standards are unlikely to satisfy those who apply strict sentience and intrinsic value tests to claims for legitimate animal use. Moreover, if ethically acceptable methods of achieving population density reduction are actually successful, it is likely that the live meat trade will become economically unviable.

Another element in the buffalo mustering and export chain that remains in the ethical spotlight is the halal method of killing[6] in Indonesia and other parts of Muslim Asia. The impact of the animal liberation movement has seen public exposure of unethical practices and reform in many animal industries worldwide. International pressure to respect the sentience of buffalo and minimize pain and suffering is likely to be directed at the halal method of killing in Asia in much the same way as it has been directed at the practice of mulesing[7] in the sheep/wool industry in Australia. Value orientations based on species and individual being have been added to the utility value paradigm, and organizations such as the Royal Society for the Prevention of Cruelty to Animals and the Australian Quarantine and Inspection Service enforce new standards of welfare and care.

[6] In countries outside of Australia, this method of killing an animal involves the cutting of the throat (severing the jugular veins, the carotid arteries and/or the trachea–oesophagus) with no prior stunning, and leaving the animal to bleed to death. In the case of halal killing of buffalo, this process would inevitably take a considerable amount of time and involve suffering in the animal as it dies. In Australia, there are guidelines for halal methods of killing for meat export to individual countries. The guidelines for Malaysia include stunning (electrical) prior to throat cutting and bleeding. See: www.daffa.gov.au/data/assets/pdf_file/0006/128940/malaysia_appendix_1_er.pdf.

[7] The method of surgically removing skin and wool from around the rear end of sheep without anaesthesia in order to protect the animal from blowflies and infection from maggots within faeces- encrusted wool.

Scientific research on buffalo operates under quite recently articulated and legally accepted definitions of the being of buffalo. Closely tied to a sentience view, the primary motivation behind contemporary animal care and ethics protocols is the elimination or minimization of pain and distress in the use of animals. As we have observed in the context of the research on buffalo, large, wild animals present particular difficulties in the elimination of such pain and distress. However, refinement of research interventions is improving this situation.

The Asian swamp buffalo is a versatile animal that has managed to transcend the limitations of its evolutionary origins. In so doing, it has built transcultural economic significance and generated transdisciplinary research information ranging from environmental history to eco-anthropology and genetics. In the context of contemporary northern Australia, it is possible to see a degree of convergence of Indigenous cultural, colonial cultural, scientific and ecosystem-based conceptions of the being and value of buffalo founded on the issue of the management of population density. Here, an inclusionary hybrid position is one that respects the being of buffalo but recognizes the need for population control.

Likely to be excluded on ethical grounds as a result of the application of the full range of value orientations covered in this paper are the capture and export of live buffalo for the commercial meat industry, the sport trophy industry, and ongoing traditional hunting using traditional weapons or firearms inadequate for the task of humanely killing sentient animals.

Beyond the specific ethical issues that relate to buffalo, complex human ethical dilemmas have also been revealed. The incorporation of indigenous land holders in wildlife management programmes on their own land is non-negotiable as is the mutual respect required to bring different cultural and knowledge traditions together in emergent hybrid positions. Scientifically and ethically based management of the buffalo population will require of Indigenous people the incorporation of leading-edge Western thinking on animal ethics into their own culture, while some non-indigenous people will have to accept that some of their own economic enterprises will need to be phased out as the new ethical landscape emerges.

Acknowledgments We thank: Jill Albrecht, Anthony Albrecht, Pat Carmody, Beth Cookson, Carmen Crossing, Gavin Enever and the Djelk Rangers, Anne Ferguson and the Kakadu National Park Rangers, Iain and Kate Field, Damian Fordham, F. Hunter, Gehan Jayawardhana, Jonas Klein, Barry Lemke, David Lindner, W. Marika, N. Marawilli and the Laynhapuy Yirralka Rangers, Kirsty Mines, Ian Munro, Calvin Murakami, Tom Noiduna, Piers Peters and the Adjumarllar Rangers, Brian Radunz, Markus Rathsmann and the Gulin-Gulin buffalo company, Olivier Rey-Lescure, Joshua Rostron, Mischat Rostron, Victor Rostron, Matthew Ryan, Buck Salua, Joe Schmidt, Adam Teesman, Chris–Heather–Henry–Melisa Whatley, Phil Wise and the Dhimurru Rangers. This project was funded by an Australian Research Council Linkage Project grant (LP0669303) to CJAB, CRM and DMJSB with GAA as an invited associate investigator.

References

Albrecht, G. A. (1999). The case for and some consequences of employing an ecological ethic to guide wildlife research. In D. Mellor & V. Monamy, (Eds.), The use of wildlife for research. Glen Osmond: ANZCCART Conference Proceedings.

Albrecht, G. A. (2001). The Koala and a native sense of place: The urgent need for a distinctively Australian environmental ethic, In 'Spirit of the land' Australian Koala Foundation Conference on the Status of the Koala in 2000, Brisbane: AKF.

Altman, J. C. (1982). Hunting buffalo in north-central Arnhem land: A case of rapid adaptation among Aborigines. *Oceania, 52*(4), 274–285.

Altman, J. C. (2005). The Indigenous hybrid economy. Address to the Australian Fabian Society 26 October 2005. http://www.fabian.org.au/1043.asp. Accessed 16 October 2008.
Altman, J. C. (2006). Alleviating poverty in remote indigenous Australia: The role of the hybrid economy', Development Bulletin, No. 72, March 2007: 47–51, 2007.
Berkes, F. (2008). *Sacred ecology*. New York: Routledge.
Bowman, D. (2003). Running with buffaloes. Nature Australia. *Autumn, 2003*, 63–69.
Bowman, D., & Robinson, C. J. (2002). The getting of the Nganabbarru: Observations and reflections on aboriginal buffalo hunting in northern Australia. *Australian Geographer, 33*(2), 191–206.
Bradshaw, C. J. A., Field, I. C., Bowman, D. M. J. S., Haynes, C., & Brook, B. W. (2007). Current and future threats from non-indigenous animal species in northern Australia: A spotlight on world heritage area Kakadu national park. *Wildlife Research, 34*, 419–436.
Bradshaw, C. J. A., & Gorman, J. T. (2007). A case for Indigenous feral pest management. In M. K. Luckert, B. Campbell, J. T. Gorman, & S. T. Garnett (Eds.), *Investing in indigenous Natural Resources Management* (pp. 31–37). Darwin, Australia: Charles Darwin University Press.
Bradshaw, C. J. A., Isagi, Y., Kaneko, S., Bowman, D. M. J. S., & Brook, B. W. (2006). Conservation value of non-native banteng in northern Australia. *Conservation Biology, 20*, 1306–1311.
Brook, B. W., Bowman, D. M. J. S., Bradshaw, C. J. A., Campbell, B. M., & Whitehead, P. J. (2006). Managing an endangered Asian bovid in an Australian national park: The role and limitations of ecological-economic models in decision-making. *Environmental Management, 38*, 463–469.
Chalmers, G. A., & Barrett, M. W. (1982). Capture myopathy. In G. L. Hoff & J. W. Davis (Eds.), *Noninfectious diseases of wildlife* (pp. 84–94). Ames: Iowa State University Press.
Chapple, R. (2005). The politics of feral horse management in Guy Fawlkes River National Park, NSW. *Australian Zoologist, 33(2)*, 233–246. Retrieved November, 2008, from http://www.rzsnsw.org.au/az%20dec%2005/chapple.pdf.
Field, I. C., Bradshaw, C. J. A., Haynes, C. (Eds.) 2006. Feral animals in Kakadu national park: A management strategy for the future. Report submitted to the Australian Department of Environment and Heritage, School for Environmental Research, Charles Darwin University, Darwin, Northern Territory, Australia.
Garnett, S. (2008) Kakadu National Park Feral Animal Management Symposium. Jabiru Northern Territory, 3-4 December 2008.
Higginbotham, N., Albrecht, G. A., & Connor, L. (2001). *Health social science: A transdisciplinary and complexity perspective*. Melbourne: Oxford University Press.
Idriess, I. L. (1946). *In crocodile land: Wandering in northern Australia*. Sydney: Angus and Robertson.
IUCN (2008) Retrieved February 16, 2009, from http://www.iucn.org/).
Johnston, F., Jacups, S., Vickery, A., & Bowman, D. (2007). Ecohealth and aboriginal testimony of the nexus between human health and place. *EcoHealth, 4*(4), 489–499.
Lear, J. (2006). *Radical hope: Ethics in the face of cultural devastation*. Cambridge, Massachusetts: Harvard University Press.
Lei, C. Z., Zhang, W., Chen, H., Lu, F., Liu, R. Y., Yang, X. Y., Zhang, H. C., Liu, Z. G., Yao, L. B., Lu, Z. F., Zhao, Z. L. (2007). Independent maternal origin of Chinese swamp buffalo (*Bubalus Bubalis*). *Animal Genetics 38*(2), 97–102. Retrieved October 10, 2008, from http://www.blackwell-synergy.com/doi/abs/10.1111/j.1365-2052.2007.01567.x.
Leichhardt, L. (1844–1845). Journal of an overland expedition in Australia from Moreton Bay to Port Essington, a distance of upwards of 3000 miles, during the years 1844–1845. eBooks@Adelaide (2004), Retrieved February 16, 2009, from http://ebooks.adelaide.edu.au/l/leichhardt/ludwig/l52j/.
Lemke, B. (2006) *Water buffalo, in the new rural industries: A handbook for farmers and investors. Rural Industries Research & Development Corporation. Retrieved February 16, 2009, from http://www.rirdc.gov.au/pub/handbook/waterbuff.html.*
Leopold, A. (1949). *A sand county almanac and sketches here and there*. New York: Oxford University Press. Special Commemorative Edition, 1989.
McMahon, C. R. B., & Bradshaw, C. J. A. (2008). To catch a buffalo: Field immobilization of Asian swamp buffalo using etorphine and xylazine. *Australian Veterinary Journal, 86*, 235–241.
Newsome, A. E. (1980). The ecomythology of the red Kangaroo in central Australia. *Mankind, 12*, 327–333.
Ripple, W. J., & Beschta, R. L. (2004). Wolves and the ecology of fear: Can predation risk structure ecosystems? *BioScience, 54*(8), 755–766.
Robinson, C. J., Smyth, D., & Whitehead, P. J. (2005). Bush tucker, Bush pets, and Bush threats: Cooperative management of feral animals in Australia's Kakadu national park. *Conservation Biology, 19*(5), 1385–1391.

Robinson, C. J., & Whitehead, P. (2003). Cross-cultural management of pest animal damage: A case study of feral buffalo control in Australia's Kakadu national park. *Environmental Management, 32*(4), 445–458.

Schweitzer, A. (1967). *Civilization and ethics*. London: Unwin Books.

Simpson, C. (1951). *Adam in Ochre: Inside aboriginal Australia*. Sydney: Angus and Robertson.

Simpson, C. (1971). *The new Australia*. Sydney: Angus and Robertson.

Singer, P. (1975). *Animal liberation: A new ethics for our treatment of animals*. London: Jonathon Cape.

Stewart, A. (1969). *The green eyes are buffaloes*. Melbourne: Lansdowne Press.

Thompson, D. (2003). *Donald Thompson in Arnhem land*. Carlton: Meigunyah Press.

Tulloch, D. G. (1969). Home range in feral water buffalo *Bubalus Bubalis Lydekker*. *Australian Journal of Zoology, 17*, 143–152.

Tulloch, D. G. (1970). Seasonal movements and distribution of the sexes in the water buffalo, *Bubalus Bubalis,* in the northern territory. *Australian Journal of Zoology, 18*, 399–414.