

Managing an Endangered Asian Bovid in an Australian National Park: The Role and Limitations of Ecological-Economic Models in Decision-Making

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ABSTRACT / Should north Australia's extensive populations of feral animals be eradicated for conservation, or exploited

as a rare opportunity for Indigenous enterprise in remote regions? We examine options for a herd of banteng, a cattle species endangered in its native Asian range but abundant in Garig Gunak Barlu National Park, an Aboriginal land managed jointly by traditional owners and a conservation agency in the Northern Territory of Australia. We reflect on the paradoxes that arise when trying to deal effectively with such complex and contested issues in natural resource management using decision-support tools (ecological-economic models), by identifying the trade-offs inherent in protecting values whilst also providing incomes for Indigenous landowners.

One of the great intellectual challenges facing humanity in the 21st century is finding a socially acceptable balance between the imperatives of security and certainty against an increasingly dangerous and risky environment (Beck 1992). The need to deal with this uncertainty is apparent in all facets of life, ranging from geopolitics, to local responses to extreme weather phenomena, to sustainable exploitation of dynamic living systems (Ludwig and others 1993; Deville and Harding 1995). Conservation biology provides numerous examples where programs designed to reduce the risk of species extinction are based on imperfect knowledge about the causes and trajectories of threatening processes (Caughley and Gunn 1996). The inability of conservation science to provide a single, optimal strategy to address management questions inevitably results in conservation managers having to select a particular response from a multitude of possible options (Burgman and others 1993). Furthermore, conservation biologists are increasingly aware that species management and biodiversity conservation programs often fail because they lack the appropriate understanding of the eco-

nomical context in which conservation interventions are developed and implemented (Adams and Hulme 2001). Unprecedented global environment change demands adaptive rather than deterministic management regimes to cope with the inherent complexity and uncertainty involved, yet pathways to changes in policy and decision-making are often unclear and confused (du Toit and others 2004). A classic example of this is the tension between the western models of National Parks imposed in the developing world settings (e.g., Indonesia) where exploitation of natural resources forms a key component of local subsistence (non-market) economies (Curran and others 2004).

The disciplines of ecology and economics show both striking similarities and fundamental differences because they have largely developed in isolation from each other, despite both seeking to understand complex and dynamic systems (Costanza 1996). For example, ecology is characterised by a well-developed descriptive tradition and limited engagement with society, whereas economists have a stronger development of mechanistic theories to predict costs-benefit trade-offs and far-reaching influences on society. More recently, ecologists, particularly in the applied facets of the discipline such as conservation biology, have had to look beyond the plot- and population-scale to protect effectively species threatened with extinction and, consequently, they have had to engage actively with the political process (Balmford and others 2002). This raises a conundrum for conservation biologists: should

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they “tack” economics onto their ecological analyses, or must they become more economically sophisticated (or involve economists) in addressing applied ecological problems?

The introduced banteng (*Bos javanicus* D’Alton 1823) herd of northern Australia represents a remarkable system because it encapsulates many of the competing interests in the exploitation of wildlife in a globally unique situation (Bowman 1992). Here there is an intriguing juxtaposition of a longstanding “European” tradition of national park management and an economically disadvantaged indigenous population seeking to maintain customary use of natural resources while also exploring engagements with the mainstream economy. Bradshaw and Brook (2007) developed some ecological-economic models to consider possible management options to accommodate this unique situation. The purpose of this report is to map the many constraints on the application of quantitative analyses that do not (and probably cannot) capture the inherent socio-political complexities. This approach not only permits us to understand the current management arrangements and identify common ground for stakeholders, but also provides a more general appreciation of both the role and limitations of ecological-economic analyses that are designed to underpin sustainable wildlife management.

The Banteng Paradox

The banteng is a bovid with a Southeast Asian distribution. The species has been used as a domestic species there for many hundreds of years (Calaby 1975). In 1849, twenty domesticated banteng were imported from Timor to the Cobourg Peninsula in Western Arnhem Land of the Northern Territory of Australia to provide meat for the fledgling British military outpost of Port Essington (Letts and others 1979). Later that year following crop failures and outbreaks of tropical disease, Port Essington was abandoned, dashing any imperial hopes of establishing a trade-hub on the maritime route between the Pacific and the East Indies. The banteng were released and established a feral population that went unnoticed until official rediscovery in the 1960s of a small population estimated at about 1500 animals (Letts 1964). Recent aerial surveys suggest a current population size of about 4000 to 7000 animals (K. Saalfeld, Parks & Wildlife Service Northern Territory, unpublished data). The banteng population never expanded its range beyond Cobourg Peninsula, possibly because of unfavourable habitat conditions (Bowman and Panton 1991), but a system of fences across the neck of the

Peninsula was built as a management precaution to prevent this contingency and to manage other feral species (e.g., swamp buffalo, *Bubalus bubalis*). Genetic analyses have recently confirmed that the Australian herd is comprised of individuals genetically identical to Asian *Bos javanicus* (Bradshaw and others 2006).

Garig Gunak Barlu National Park (GGBNP) occupies most of the Cobourg Peninsula and surrounding coastal waters encompassing a spectacularly beautiful tropical coastal environment with negligible development and pristine waters renowned for pearl farming, sport fishing, and pleasure sailing. GGBNP has been recognised internationally for its conservation values, being the first park in the world to be declared under the RAMSAR Convention because of its significant wetlands (Whitehead and Chatto 1996). Initially established as a flora and fauna reserve in 1924, it was enacted as a jointly managed Park in 1981 with traditional owners and a government park agency having dual responsibility for its supervision (Foster 1997). When the GGBNP Board of Management (a statutory authority in control of the Park and which we will subsequently call the Garig Board) first developed a formal management plan for the Park in 1987 (CPSB 1987), banteng were one of the pressing environmental issues recognized therein.

Yet these charismatic Asian bovids represent an unusual management “paradox” (Bowman 1992). For instance, banteng are listed as Endangered in their native range of Southeast Asia (IUCN 2004), and the GGBNP herd is now the world’s largest wild population of this species and a potential source of animals for future international conservation efforts (Bradshaw and others 2006). Further, commercial safari hunting provides traditional owners of GGBNP with important cash incomes. Currently, up to 40 trophy bulls may be taken annually at a fee of \$2,500 per head, with the money so earned returning directly to the traditional owners, who view this income as a long-standing and indispensable contribution to their economic and social well-being (Altman 1988). Impact of the banteng on the environment is poorly understood, although a comparative survey indicated the far greater detriment to vegetation and soils by feral pigs (*Sus scrofa*) than banteng (Bowman and Panton 1991).

Multiple Perspectives on Banteng

Banteng in northern Australia can be considered from the following, often conflicting perspectives: (1) A feral species, which has no place in a National Park because it is “unnatural” and may have negative im-

pacts on native flora and fauna. (2) A unique living connection to the first European settlement of northern Australia that should be conserved in a national park. (3) Equivalent to other species of cattle (e.g., *Bos taurus*) used in north Australian pastoral enterprises. (4) An *ex situ* refuge for the largest wild population of an Endangered species. (5) An Endangered species that can be used ethically for safari hunting. (6) A feral animal that, like swamp buffalo (*Bubalus bubalis*), has been incorporated into Aboriginal customary economies. Consequently, banteng can be considered from various economic perspectives such as: (1) an exploitable resource that can generate revenue through harvest or viewing fees; (2) a pest species that causes losses through the environmental damage it creates; or (3) fauna with an existence value to individuals and society, even if never directly experienced.

Existing management arrangements for the herd do not deal comprehensively with this mix of economic perceptions and the management issues they entail, a situation that the traditional owners (who hold a majority on the statutory Board of Management) and the responsible agency, the Parks and Wildlife Service of the Northern Territory, wish to correct. Clearly, the situation of the banteng is complex because despite being a land-management priority recognised by both the traditional land owners and the nature conservation agency, it is also an exotic species in a national park that may be causing some environmental degradation. In response to this policy vacuum, a multi-disciplinary research team was funded in part by the Parks and Wildlife Service and with the support of the Garig Board to explore possible management options. Of particular concern for the traditional owners were economic options for the sustainable harvest of the banteng and, for the park managers, options for managing the herd to prevent undesirable environmental change. The work of the research team is ongoing and no decisions have yet been reached regarding the management of banteng.

Reflections on the Role and Limitations of Ecological-Economic Modelling of Banteng

Bradshaw and Brook (2007) addressed the banteng management problem by using a population demographic model to undertake some economic analyses for the following six contrasting scenarios: (1) Maximise sustainable yield (MSY). This is effectively the least-capitalised form of cattle ranching where animals are mustered from the wild and then shipped to market. In the past, this approach was common practice in northern Australia and occurs on marginal pastoral properties elsewhere. It has also been used for the

harvest of feral buffalo from national parks and other Aboriginal lands (Robinson and Whitehead 2003); (2) Maximise harvest of trophy males. This form of use values a globally unique opportunity to shoot a rare bovid species in a wild, natural landscape that yields substantial fees to the traditional land owners (Bowman 1992); (3) Determine the upper limit of indigenous off-take. The resident population of traditional owners is small (ca. 20 adults) with a comparable number residing in nearby areas and visiting the region. Although not all the Aboriginal land owners seek banteng meat (deKoninck 2005), increasing resident human populations may result in banteng beef becoming more important as a food source in the future; (4) Suppress density or completely eradicate the population. This has been the goal of many national parks in the case of feral buffalo in northern Australia (Ridpath and Waithman 1988), although it has never been achieved because of the exponentially increasing cost of control once animal populations are reduced to low levels (Hone 1994). Moreover, this approach would seem to be undesirable from both indigenous and global conservation perspectives (Bowman and Robinson 2002); (5) Minimise risk of extinction whilst limiting range expansion. This approach would place emphasis on the inherent rarity and on indigenous and settler Australian cultural values (Bowman 1992); and (6) Scenarios incorporating two or more of the above options.

The modelling framework employed stochastic, density-regulated matrix population models with life-history parameters derived from (1) allometric relationships (for estimating maximum population growth [r_{max}], generation length, fecundity, and densities for a banteng-sized mammal) and (2) measured vital rates for wild and captive banteng and other *Bos* spp. For each management option, Bradshaw and Brook (2007) presented a simple economic analysis that incorporated estimated costs of management implementation and associated profits projected. Results demonstrate that revenue of > AU\$200,000 per annum is possible from meat production and safari hunting without compromising long-term population stability or the conservation status of this endangered feral bovid (Figure 1).

Zivin and others (2000) framed a bio-economic model in which feral pigs were considered both a pest and an economic resource. Using standard economic theory, they estimated steady-state populations under different management regimes. One had control (culling) costs met by the beneficiary of damage reduction, and the alternative offered direct returns (hunting fees) for animals killed, in addition to dam-

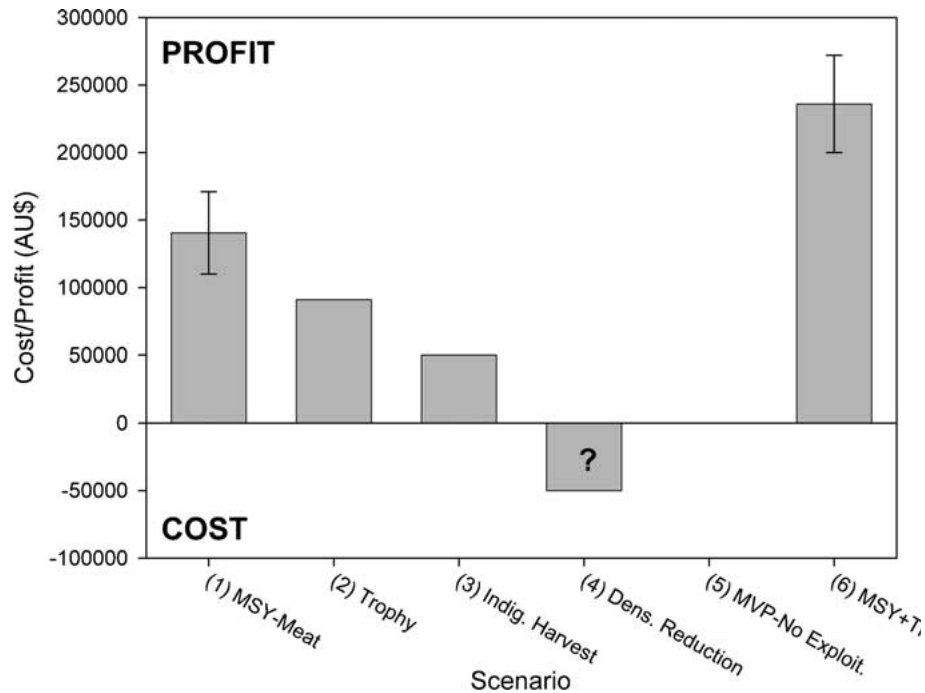


Figure 1. Summary of the cost/profit margins for the exploitation and management of banteng from Garig Gunak Barlu National Park, Northern Territory, Australia estimated from (Bradshaw and Brook 2007). (1) Profit from the maximum sustainable yield of 250 adults harvested/year for 30 years to be sold as beef within Australian cattle markets; (2) maximum profit from trophy fees received for the harvest of adult males (with demand-limitation function); (3) replacement value (profit) from the harvest of 16 adult banteng per year to supplement indigenous protein intake; (4) unestimated costs associated with density reductions (mean = 1100 animals culled/year for 5 years to reduce the population to 50% of the current population size; (5) minimum viable population size of 40 animals required to maintain the population in perpetuity, no exploitation (and no costs/profits) associated; and (6) a combination of meat production and safari trophy fee profits for an annual cull of 250 animals/year.

age mitigation. They found no single optimal solution because their modelling was so sensitive to assumptions (a feature also apparent in the modelling of Bradshaw and Brook, 2007). The latter modelling revealed that from an economic-ecology perspective, the optimal solution was a form of extensive cattle ranching that is substantially more profitable than other alternatives (Figure 1). However, such ultimately mechanistic findings ignore many fundamental aspects of the actual socio-political arena in which economic decisions are made (Endter-Wada and others 1998). Some Aboriginal economies in northern Australia have been described by Altman (2001) as a hybrid blend of subsistence, government payments in the form of employment programs and welfare, and local micro-enterprise, a situation that is clearly decoupled from mainstream market-based economies. Furthermore, this economic system cannot be described by models that assume independent rational actors, because the substantial asset of Aboriginal people—land—is held in communal and hereditary title and, therefore, can only be used to raise capital for enterprises via lease agreements that necessarily cede rights to the use of

the land to the leaseholder (in this case, the Northern Territory Parks and Wildlife Service). Furthermore, Territory and federal government regulation of land- and wildlife-use decisions, even on land owned by Aboriginal people, is a complex issue that is constantly evolving and strongly contested politically and legally (Hughes 1994). Such additional legislative controls on resource use reinforce the subordination of Aboriginal people as economic players in the decision-making process.

Bradshaw and Brook's (2007) analysis was necessarily incomplete because they were unable to quantify other forms of valuation beyond direct cash return from banteng exploitation. For example, a notable absence was the potential, yet unvalued "ecotourist experience" presented by this unique animal. Secondly, it ignores opportunity costs associated with the pursuit of the optimal economic strategy that may foreclose other alternative land-uses. For example, a safari enterprise may become unviable because overseas big game hunters are likely to be less inclined to hunt animals knowing that they are part of a pastoral enterprise even if they were managed to appear "wild."

This could perhaps have been attempted by modelling a reduction in prices for trophies for more-or-less domesticated herds owing to a lower demand for hunting, but the degree to which these intangibles are linked economically are difficult to measure or even guess. Thirdly, it is possible that the development of an extensive pastoral operation would, through market economic drivers, result in further capitalisation and intensification of the management of the banteng herd. The accoutrements of a pastoral enterprise would compete with many national park values, thereby undermining the tourist experience. This cost of pastoralism may be considerable even if the enterprise espoused a strong conservation ethos. The activities associated with more intensive pastoralism (e.g., stockyards, extensive fencing) could potentially degrade ecosystem services, the most valuable being the pristine waters that support a multi-million dollar pearl farming industry. On the other hand, formal recognition of the endangered status of Australia's introduced banteng and recognition of their recently discovered lack of genetic admixture with domestic breeds of cattle (Bradshaw and others 2006) could increase the level of government regulation of the exploitation of the herd, further increasing transaction costs (associated with the permitting and regulation of wildlife take under Federal and Territory Government regulations) and possibly stymieing the pursuit of cattle ranching or even safari hunting. Admittedly, once the regulation and *ex situ* conservation status of the banteng has been established by government authorities, the safari hunting experience may become more valuable given the "authenticity" of the safari experience, thereby increasing the revenue from the enterprise. These problems of making choices amongst competing economic activities (such as ranching versus safari) are thrown into sharp relief by the conflicting ways indigenous and non-indigenous Australians perceive and value feral species (Altman 1982; Robinson and Whitehead 2003; deKoninck 2005).

Decision-Making Context

Perhaps the most limiting aspect of the economic ecological model is the inability to tackle the political context of the decision-making process. Under current joint-management arrangements, natural and cultural resource management decisions are ultimately made by the Board of Management, which seeks to balance the aspirations of the traditional owners against societal expectation of government-regulated nature conservation (Press and Lawrence 1995; deKoninck 2005). The government bureaucracy's role is also counter-

balanced by representation of the Northern Land Council, a peak body representing Aboriginal land owners in the northern part of the Northern Territory. Furthermore, the traditional owners cannot be considered a politically unified block; rather, there are various cultural, familial, and political groupings that often have competing agendas. Thus, the Aboriginal representation on the Board of Management is more like a confederation rather than a united front of indigenous interests. While clans have defined geographic boundaries and hence spheres of influence over resources, the ownership rights to a mobile organism that can transgress clan boundaries is unresolved. It is possible that the various socio-political groups that own Cobourg Peninsula may opt for contrasting land management options. Whilst resulting in greater economic diversity for the area, such decisions may threaten ecological integrity through fragmentation of a large, intact natural landscape into smaller management parcels with different land uses.

Although it is clear that joint management is an institutional attempt to accommodate the multiple values placed on natural resources such as banteng, this form of governance and decision-making clearly results in substantial transaction costs. Regardless of the deliberations of the Board of Management, decisions regarding the exploitation of banteng are subjected to Northern Territory, national and international government regulation, and industry standards placing substantial compliance costs on economic exploitation of banteng (e.g., Whitehead 2000). For example, commercial use in addition to trophy hunting (e.g., of culled females for meat) could help offset costs of controlling herd size and management, yet markets for pet meat return low prices and access to more valuable markets for human consumption (e.g., game meats) depend on compliance with strict conditions on post-harvest management of carcasses. These conditions are not readily met for large animals with the infrastructure available to remote communities. Some Aboriginal communities, through various community-based organisations (e.g., the Bawinanga Aboriginal Corporation of Maningrida, Arnhem Land), have attempted to use buffalo to generate cash (trophy fees), employment (guiding fees), and non-cash income (meat) as elements of a hybrid economy (Altman 2001, BAC 2002). The concept of economic hybridity has yet to be subjected to a formal economic analysis. Any such study must resolve analytically the ambiguities, contradictions, and political tensions that are inherent in the confluence of kin-based and market economic and resource systems.

A pervasive idea amongst biologists is that adaptive management approaches (Walters 1986) provide the most reliable compass with which to navigate a path through a socio-politically contested terrain. However, such a view can presuppose the primacy of resource or species persistence with little consideration of qualitative real-world constraints. Quite simple ecological models, coupled with economic analyses incorporating the costs and benefits of population management, can certainly help extend the range of perspectives and issues brought to bear and, hence, provide an improved conduit to the difficult task of decision-making. Indeed, such an approach is necessary for the development of sustainable management in an arena of contested multiple-values and competing aspirations. But it should never be presented as providing a definitive solution.

In the case of Australian banteng, the crux of the problem rests with competing and in some cases mutually exclusive goals. A solution to this problem should include: (1) a formal resolution of the status of the banteng under Australian and international law (i.e., invasive feral animal versus conservation asset); (2) an identification of the points of agreement between indigenous and non-indigenous stakeholders; (3) continued monitoring of the herd and ecological research to understand their demographic and environmental impacts; and (4) the integration of points (2) and (3) in an adaptive management cycle (Walters 1986) by confronting conflicting goals with quantitative models such as those provided by Bradshaw and Brook (2007) and inviting stakeholders to update their opinions in the light of new knowledge.

Conclusions

We have “mapped” the inherent constraints in using quantitative ecological-economic models in natural resource decision-making but have avoided the temptation to propose an “optimal response” for managing an endangered Southeast Asian bovid in a national park that is co-managed by traditional aboriginal owners. Nonetheless, our research (Bradshaw and Brook 2007; Bradshaw and others 2006) supports the present cautious approach to management of the herd adopted by both the Garig Board and the Parks and Wildlife service by providing critical ecological and economic information. In particular, our analyses indicate that: (1) “Australian” banteng are of conservation value because they are genetically identical to the endangered taxon in Southeast Asia; (2) domestication and associated intensification of use of the herd may be inimical to the amenity value of the national park and undermine the

authenticity of the current safari industry; and (3) it provides a basis for ecologically-grounded planning to increase the profitability of safari hunting.

The banteng case study emphasises that although numerical approaches are essential tools for good decision-making in natural resource management, they may not provide unambiguous “solutions,” even when they integrate the perspectives and approaches of different disciplines (in this case, ecology and economics). Integrative approaches are essential for sustainable and socio-politically realistic natural resource management (Bammer and Land & Water Australia Integration Symposium Participants 2005), but many challenges remain to develop new tools and frameworks for their effective application.

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