

The cost of information: should black rhinos be immobilized?

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It is an axiom of science that, in order to measure a process, one ends up changing it in some way. This has been apparent to physicists for a long time but it is perhaps less apparent as a consideration in the biological literature. In many cases the degree to which one changes the process that is being measured is insignificant but there are exceptions. This problem becomes particularly difficult in wildlife biology when one is sometimes faced with gaining information from and protecting small populations of endangered animals. The combination of small sample size, and the high value of each individual to the population, mean that any interference could have negative consequences for the population. The resulting data from the study may have statistical characteristics that make it very difficult to use as a basis for conclusive results.

Nevertheless, in order to manage an endangered species it is essential to collect information and, in the case of some, it may be essential to take steps to actively protect individuals. Both these processes could result in active intervention. This is brought into sharp focus in the case of the black rhino, a species that has been brought close to extinction by human predation (Berger & Cunningham, 1994). Almost without question, this has been a species that has survived because of management intervention through a combination of translocation/recolonization and active protection. But this intervention also comes at a cost as suggested by Alibhai, Jewell & Towindo (2001). They described evidence that chemical immobilization of black rhinos could have affected the productivity of the population.

In response to this suggestion Atkinson *et al.* (2002) have provided a critique of the study conducted by Alibhai *et al.* (2001) highlighting the statistical problems associated with a data set that contains multiple observations from the same individuals. This is an important debate and, since the paper that stimulated the debate was originally published in the *Journal of Zoology*, the Editors considered that it was important to provide an opportunity for opposing views to be aired.

Although both Atkinson *et al.* (2002) and Alibhai & Jewell (2002) have raised valid points of detail, the central question in this debate concerns the extent to which it is reasonable to intervene in a population of endangered animals. The point being made by Alibhai *et al.* (2001) is that intervention can become too obtrusive especially if the purpose of the intervention (in this case it was often to allow the fitting of radio collars which had a tendency to fail, Alibhai & Jewell, 2001) fails to achieve the expected outcome. The criticism raised by Atkinson *et al.* (2002) is that it would be unfortunate if, on the basis of flimsy evidence, there was a backlash against some of the most important management techniques available for the black rhino.

There is, of course, a resolution to this debate. Management models for wildlife populations are becoming increasingly important to the development of management strategies. Examples of these approaches are already present in the literature for black rhinos (Hearne & Swart, 1991; Milner-Gulland *et al.*, 1992). The analysis of Alibhai *et al.* (2001) provides a foundation for introducing the negative effects of intervention into such a model together with the positive effects that can be gained from the protection measures that result from intervention, such as attaching radio collars. Moreover, these types of models can include the uncertainty in the observation process allowing one then to deal with the statistical uncertainties in the data.

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Response to Alibhai, Jewell and Towindo

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We have read with interest the paper by Alibhai, Jewell & Towindo: Effects of immobilization on fertility in female black rhino (*Diceros bicornis*) (*J. Zool. Lond.* (2001). **253**: 333–345). As conservation professionals who have devoted our careers to serving the needs of endangered species while employing only the highest standards of veterinary care, we feel it necessary to point out that Alibhai, Jewell & Towindo's experimental design, selection of data for analysis, and basic conclusions may be flawed in several critical ways.

Alibhai *et al.*, state, 'Kock and Atkinson (1993) and the Veterinary Unit (1995, 1996) have described the details of the procedures and drugs used in detail' and go on to specify that Large Animal Immobilon[®] was selected for use. This is incorrect. Immobilon[®] (a combination of etorphine and acepromazine) was not a standard drug used to immobilize black rhinoceros in Sinamatella and indeed, was never used in any of the several hundred immobilizations conducted on rhino throughout Zimbabwe by the Veterinary Unit (VU) between 1989 and 1996. The standard protocol used by the VU included pure etorphine HCL (M99[®]), mixed with a low dose sedative. The individual agents (alpha-2 adrenoceptor agonists) in the immobilization drug combinations used, were selected on the basis of their known effectiveness, safety and reversibility.

We also believe there were a number of important problems associated with Alibhai, Jewell and Towindo's analyses and experimental design. As an illustration we review one of their most important results: the claim that inter-calving interval (ICI) was significantly related to the immobilization rate and mean immobilization interval (IMI). Their model was designed with only 11 observations of ICI but 5 independent variables. Standard statistical guidelines suggest case/variable ratios of less than 5:1 are highly likely to yield meaningless results (Tabachnick & Fidell, 1989). In addition, in the same analysis they used repeated observations of two animals ('2' & '4' – their Table 1) thus violating the fundamental assumption of 'independent observations' (Kleinbaum *et al.*, 1988). The investigators dismiss the potential for problems based on the fact that they did not detect differences in ICI duration between individuals contributing 1 vs. 2 observations. However, they present no power calculations to substantiate this claim. In addition, even if the potential for type II errors was reasonably low, a comparison of mean ICI values does

not constitute an explicit test of independence. Finally, there is the concern that observations of association between ICI and immobilization history may reflect other, more fundamental factors (e.g. individual health, animal age). Is immobilization a cause or a correlate? The investigators conclude the paper by suggesting that the 'opportunistic' nature of the study dictated that 'data collection did not conform to classical experimental design'. We believe that rarity of data cannot justify the improper use of inferential models.

While we do not dispute the importance of the question raised, we do recognize that when data are limited, factual exactness and accuracy of the experimental protocol becomes essential. In the context of rhino conservation policy, it is also important to note that Alibhai *et al.* have not provided what we believe to be key information relating to the net effect of drug immobilizations on the Sinamatella rhino population as a whole. Their own monitoring reports from Sinamatella indicated an annual population growth rate of up to 10% per annum during the period of regular immobilizations. Since this is one of the fastest sustained growth rates to be recorded for natural rhino populations, we find it difficult to accept the statement by these authors that 'the intensive immobilization regime negatively impacted on black rhino fertility in the Sinamatella IPZ'.

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Response to Atkinson, du Toit, Radcliffe, Dooley and Kock

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We appreciate the concerns of Atkinson *et al.* regarding our paper (Alibhai, Jewell & Towindo, 2001), and will try to give reassurance that these are unfounded.

With regard to the drugs used, Atkinson *et al.* are incorrect in stating that all the agents used in combination with M99 were alpha-2 adrenoceptor agonists. Azaperone is a butyrophenone neuroleptic sedative (Hall, Clarke & Trim, 2001). Whether ACP or another sedative agent was used in combination with etorphine hydrochloride, the risks we have discussed remain valid since the most potent and potentially dangerous is the opioid etorphine, which is used for wildlife immobilization in a high dose to produce an anaesthetic rather than analgesic effect (Branson, Gross & Booth, 1995). The stresses involved in the capture circumstances are very likely to carry a further risk for the pregnant rhino.

Atkinson *et al.* incorrectly quote Tabachnick & Fidell (1989) as a reference for their argument concerning a minimum case/variable ratio of 5:1 for regression analyses. In fact the only reference to such a ratio is in chapter 7 which deals with multiway frequency analysis i.e. number of cases per cells in contingency tables. It does not apply to regression analysis. There are no standard statistical guidelines regarding a rigid case/variable ratio for multiple regression analysis and standard statistical texts (e.g. Searle, 1971; Seber, 1977; Montgomery & Peck, 1982; Neter, Wasserman & Kutner, 1990; Myers, 1990) make no reference to such a ratio. This is reflected in other studies where authors have used a case/variable ratio of less than 5:1 to derive meaningful results, e.g. Brett (1998) who examined the effects of different explanatory variables on the probability of individual survival and fighting mortality in translocated rhino.

We believe that our test for dealing with repeated observations was adequate. Atkinson *et al.* suggestion that other 'more fundamental factors' such as individual health and animal age may be involved is surprising since we refer to both these factors specifically in our paper (p. 341) and provide a convincing argument against these factors contributing significantly.

Is immobilization a cause or a correlate? This point can be aimed at any similar study, but we believe that we have provided enough evidence using both linear and non-linear models and comparing the different stages of the ICI to show that the immobilization regime did affect the ICI.

We must take particular issue with Atkinson *et al.* contention of 'rarity' of our data. Our initial analysis was based on 17 ICIs. We explained that our study was based on opportunistic data collection. Working with a highly endangered species it is unlikely that very large data sets within such a design will ever be a reality. This is also important in the context that, for many years, some important and far-reaching decisions about the safety of rhino immobilizations in Zimbabwe were based on anecdotal reports e.g. Veterinary Unit (VU) (1996) stated with regard to a black rhino immobilized at Sinamatella 'Cow No. 22 has produced three calves in the space of 5–6 years which refutes all suggestions that immobilisation, dehorning etc., effects (sic.) animal health'.

With regard to the annual growth rate of the population at Sinamatella we indicated that this was an estimate based on a sampled population over 4 years, and that 53% of births included in the analysis occurred before immobilizations began (Alibhai, Jewell & Towindo, 1996). We also stated that this was a relatively short period of time for an accurate assessment of annual growth rate for a species with an average ICI of about 30 months and an age of maturity of about five years (Alibhai & Jewell, 2001).

We agree that all of us who work with endangered species must employ the highest standards in our work, and that our principal responsibility is clearly to 'do no harm'. We also believe that an extremely important part of this responsibility is to ensure that management decisions are based on properly quantified data. As Atkinson *et al.* correctly state, several hundred immobilizations were carried out by the VU in Zimbabwe from 1989 to 1996 (and beyond, see Alibhai & Jewell, 2001). The VU itself expressed concerns on the possible effects of immobilization (VU, 1995). We would therefore urge that these data be made available for analysis and publication.

We re-emphasise the need for common guidelines for the immobilization of female black rhino under field conditions.

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