Deer and Boar of Bardiya National Park - concept note - November 3, 2017

The aim of the Himalaya Tiger Foundation (HTF) is the same as that of the Government of Nepal, namely, the doubling of the number of tigers by the year 2022. HTF has chosen to focus its attention on Bardiya National Park in the Terai of West Nepal. To enable this growth of these tiger numbers, the Park needs to harbour at least twice as many prey biomass unless one would accept depredation in the surrounding buffer zone areas. In Bardiya NP, Cervidae dominate the ungulate community. The deer community is diverse, as there are five different species, namely (in decreasing order of body mass) swamp deer (*barasingha*), sambar, spotted deer (*chital*), hog deer, and barking deer (*muntjac*). There is evidence form national parks in India where tiger went recently extinct, that this high species diversity is actually maintained by tiger depredation. Indeed, when tigers go extinct, the deer assemblage gets smaller and only 2-odd species survive (pers. comm. E. van de Pol). Apart from feeding on deer, the Bardiya tigers feed on wild boar. If deer (or ungulate) diversity is enhanced by tiger predation, than this is an exciting scientific issue, because two predictions follow from this, namely,

(a) diet overlap and niche overlap (sensu Pianka, thus measured as habitat overlap) between the ungulates will be higher than would be expected on basis of the mutual exclusion principle (Darwin 1878);
(b) the species packing (i.e., the number of species in a local assemblage) will be higher than predicted by Hutchinson's Rule (Prins & Ollf 1998; Olff et al. 2002).

Deer are encountered as the most abundant prey (more than 90% of the individual ungulates are deer in Bardiya). However, this dominance by deer is a reflection of the absence of other ungulate species (blackbuck, gaur, wild water buffalo (*arna*) or their rarity (nilgai and one-horned rhino), rather than great absolute abundance of deer. The density of deer is approximately 40 ungulates per km^2 (0.5 ind./ha) (Karki et al., 2016; van Lunenburg, Kral, & van Alphen, 2017). Wild boar and gaur (and possibly arna) may even be the most preferred prey species. Data on boar are not available.

For deer, Bardiya NP represents several challenges. Good quality forage is scarce and patchily distributed and competed for by several other predator species. Leopard and tiger pose a major predation risk. Moreover, there is considerable seasonal climatic variation. In spring, during which daily temperatures go up to over 40 ^{o}C, animals may suffer heat stress, during the monsoon they experience serious flooding, and in winter, when many plant species go dormant, the ungulates experience low food quality.

Preceding research has given first insights in aspects of social behaviour (from solitary to gregarious), breeding behaviour (timing of breeding and calving) and resource selection of deer in Bardiya NP (most deer in early successional stages., few deer in sal forest) (Dinerstein, 1980; Pokharel & Storch, 2016).

Yet, to understand what is limiting the deer and boar population sizes, we now need a study that aims at understanding the impacts of these factors on deer and boar survival, growth and reproduction. Ultimately, this should lead to an integration that pinpoints the main factors (K-factor analysis). With the understanding of the key factors (on basis of the K-factor analysis) that limit a population in its growth, one can devise management interactions. This leads to the following main question and sub-questions:

What factors limit population growth of deer and boar species in Bardiya National Park?

- **Resource use and competition**

  What is the resource use (habitat and diet) of different ungulate species?

  Methods: GPS readings, visual observation. DNA of plant species in faeces, micro-histological identification of plant epidermis fragments in ungulate dung,

  - To what extent do deer overlap in their resource use (habitat and diet).

  Methods: GPS readings, visual observations. Per species: where do species occur (i.e. local occupancy rates). Different micro-spatial use in areas where species overlap.

- **Nutrition**

  Do deer or boar have nutritional stress?

  Methods: Assess body condition of the different species through time and in different areas. Mineral / Trace elements composition of (Preferably fresh tissue, but antlers is also possible, although imperfect measure for soft tissue) Sex ratio (of course one would expect an equal sex ratio but under some circumstances this can deviate). Different body condition in different areas. Mineral and trace element measurement in selected food species over time.

- **Heat stress**

  How do deer adjust their behaviour to heat stress?

  Methods: GPS readings relative to habitat in which they are, visual observation. Taking into account: temperature, wind speed, humidity. Developing a model for a thermal landscape

- **Predation**

  What is the predation rate?

  Methods: Observation data with modelling. On basis of pick-up samples of jawbones and skulls, one can determine differential (predation) mortality. The first molar can reliably be used for determining age-at-death either based on photo-identification if executed elsewhere or though measuring growth rings in the dentine. Linked with natality and juvenile survival a reasonable life table can be constructed (which is needed for the K-factor analysis mentioned above).

  - What is perceived predation risk?

  Methods: Vigilance and the experimental determination of local (habitat specific) giving-up densities.

- **Density**

  Methods: Establishment of relative densities of the different species on basis of camera trapping data.

  Establishment of absolute density estimates on basis of best professional judgement of guides and military (Van der Hoeven et al. 2004)

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