Research description for Shailendra Yadav

Evidence-based Park Management: the facts behind tiger and deer counting

The Terai Arc is landscape lying between the Ganges Plain and the foothills of the Himalayas. Biogeographically it is the most northern part of the Oriental Kingdom, and zoologically it is characterised by a mixture of Tropical species, like the Indian Rhinoceros, the Indian Tiger, the Asian Elephant, the Gavials or Hornbills and Palearctic species, such as the many migratory bird species but also mammals such as Wolves and Wild Boar. Botanically, the Oriental Floral Kingdom is a mixture of Pan-Tropical species, and shares Ethiopian species with Africa and Indo-Malayan species with the tropical Far-East.

The Terai, which stretches from the area bordering Assam and Myanmar to the Punjab, was till recently nearly one hundred percent forested. Malaria eradication programmes in the 1960s enabled settlement by non-malaria resistant people, and the Terai quickly filled up with settlers from the foothills of the Himalayas to the North and from the Gangetic Plain to the South. This *landnam* resulted in a very fast deforestation of this stretch of land of some 1200 km E-W and 60 km N-S and now, in 2017, only little of the original vegetation still exists in a few isolated remnants which got legal protection as National Parks, both in India and Nepal.

In these ever-shrinking pieces of forest an ever-shrinking population of tigers occurred. At the start of the 21st century, the world-wide number of tiger remaining in the wild approached 2000 in total in the so-called 'range states' (e.g., Russia, Nepal, China, India, Malaysia, Indonesia). At a range state conference in St Petersburg the governments of these states decided to strive for a doubling of the word-wide but also country-wide 'doubling of the tigers' by the year 2022. This pledge by the Government of Nepal resulted in a major impetus for tiger conservation in Nepal, also in Bardiya National Park. Importantly, the Himalaya Tiger Foundation quickly realised that doubling the tiger implies doubling the prey so as to prevent the built-up tiger population start preying upon livestock outside the Park. The Nepali conservation authorities have embraced this now, and measures are underway to achieve this.

World-wide, the scientific community focussed on nature conservation recently arrived at the conclusion that too many management interventions are based on shaky foundations. Theory may even outstrip facts, thus leading to an urgent need for evidence-based evaluations of the facts and figures underlying population estimates. Indeed, without sound and correct estimates of population sizes, the verifications of theories that are based on population dynamics and predator-prey dynamics cannot take place. One then enters the realm of fact-free conservation!

Bardiya National Park is an interesting case-in-point. In the last years, a major transition in counting techniques of tiger took place. Prior, these were based on pug mark counting and identification of footprints of individual tigers by mainly local rangers. Now this is based on camera trapping. The first method suffered from lack of repeatability; the second method is heavily influenced by (statistical) assumptions. Both methods suffered from a lack of

independent verification procedures. Yet, the camera trapping data, that are collected consistently and according best practices developed for instance for parks in the USA, also comprise a unique data set, not only about tigers, but also about the prey of these tigers. Data are collected systematically over the whole Park, and already for a number of years.

The research should thus address the following issues:

1. What are the statistical assumptions underlying the method to arrive at a population estimate of tigers, and how sensitive is this outcome to errors in the estimation of the parameter values for these underlying assumptions? What is the error propagation model? How can errors be contained?
2. Does different software for pattern recognition (of the stripes of tigers) lead to the recognition of the same individuals? If different software leads to different outcomes, how then can we find a heuristic to choose what software is best?
3. Presently, the zero-poaching policy of the Government of Nepal – shored-up by the deployment of a full battalion of Army of Nepal for this 970 km^2 of Bardiya National Park (core area only; tigers do not occur in the buffer zones) – has reportedly led to an increase of the number of tiger from 37 to 55 (85 incl. sub-adults; 2016). A back-of-the-envelope calculation shows that a healthy tiger needs about 5 kg meat per day. An average chital (spotted deer) weighs about 35 kg. Of that chital about 15 kg can be eaten: a tiger has to kill about 2.5 chital a week. If, on the other hand, tigers would concentrate on the bigger sambar and barasingha, they would have to kill fewer of these 'sambar' since they weigh on average about 70 kg. Thus a population of 37 tigers had to kill every year some 4800 chital (and boar, and so on) or some 2400 'sambar'. A very healthy well-fed chital population can sustain an off-take of some 30%. In other words, Bardiya NP should have started its tiger increase at the beginning the 21st century with some 15,000 chital or some 7500 sambar. If it is true that in 2016 there are now 55 tigers, then that figure a number of years must have been even higher, because the present-day tiger population needs a sustainable chital population of 22,000 (or 11,000 'sambar'). These represent figures of about 22 chital.km^{-2} or 11 sambar.km^{-2}. The research question is thus (a) do the camera trapping data yield more or less identical density estimates? And (b) does the increasing tiger population started 'eating down the food chain'? In other words, are sambar and barasingha replaced by the smaller chital?
4. Theory predicts that tigers would distribute themselves over the landscape in a so-called 'ideal free distribution', meaning that the effort to catch its food (expressed as kg food.tiger-1) should be the same as that of the average effort for all tigers in the population. Because the cameras are spaced in a regular pattern all over the 970 km2 of core area, the data enable the testing of one of these central theorems of animal ecology. This would yield powerful insight into the understanding of tiger dispersal into the nearly vacant adjacent Banke National Park.
5. Finally, the candidate could consider comparing the density data on these large mammals that are collected by means of camera trapping to those that can be estimated based on pooled local expert opinion methodology.