Perspective

Recognising the power and limits of different forms of knowledge

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It has long been an adage that "knowledge is power" and therefore it is not surprising that there is often a conflict over knowledge, and whose knowledge should be given priority. Fortunately, we live in an era where many forms of science exist to provide robust empirical insights into natural and social processes, rather than forcing us to draw on superstition and mythology. However, there are often debates about the relative value of scientific knowledge versus more localised knowledge [1]. This essay aims to provide some perspectives on this debate and point to possible ways forward to better address this conflict.

There have been tremendous advances in the way that researchers study the complex relationships between large carnivores and humans. Three tools that have emerged during the last years of the 20th century and the first two decades of the 21st century have transformed the ability of researchers to study wildlife. Firstly, digital camera traps can be distributed in the field and left untended for months [2]. They patiently wait on standby and photograph any animal walking past. This allows us to see what would normally remain unseen, confirming the presence of shy, nocturnal and cryptic animals that would never show themselves to a human observer. Secondly, GPS collars allow us to remotely track the movement of individual animals for periods of months or years [3]. The collars collect location data day and night, in all weathers, in all seasons and in all terrain. The data allow us to study their reproduction and their deaths, their habitat choices, and their predatory behaviour, no matter how far they move. GPS-tracking is also used to study the movements and survival of free-ranging livestock. Thirdly, the incredible advances in genetic methods allow us to take a few hairs rubbed against a tree, or a scat dropped on a trail and confirm the species, the sex, and the individual identity of the animal that left these signs behind and even determine its diet [4].

These technological tools allow researchers to learn things that just three decades ago were almost unknowable. We can put numbers onto things that previously could not be quantified with certainty. Perhaps most importantly, these methods allow us to come to know large carnivores as individuals, attributing their movements, behaviours and fates to the identity of specific animals. This allows researchers to associate conflicts with both the overall size of the population of large carnivores and to the actions of individuals or groups, which is crucial information to design appropriate responses and interventions.

But the advances go beyond the realms of technology.

In fact, it would be possible to argue that the most important developments have simply brought us back to where we started: as humans that interact with each other. There has been a tremendous increase in the use of social science methods (such as psychology, sociology, anthropology, ethnography) to study the human perspective of our interactions with wildlife and with other groups in society that hold different views and have different objectives than our own [5]. By investing the time to listen to the diverse stakeholders that influence, or are influenced by, large carnivores, social scientists have been able to identify the diverse ways in which different groups of people experience the impacts associated with large carnivores (or in which they perceive positive values associated with their presence) that could possibly lead to conflicts with other interests or activities. These studies of people have been instrumental in shaping the way policies are developed and how we try to address conflicts [5]. For example, such studies have revealed that the concrete impacts associated with a wolf killing a sheep represent just the tip of the iceberg of the way conflicts are perceived by many rural residents [6]. Gaining insight into the full picture of conflicts requires understanding a far wider range of societal issues related to agricultural and rural policies, the history of specific areas, the power relations between different actors as well as the overall cultural setting.

Combining these modern research approaches from both the social and biological sciences can produce incredibly detailed, objective and accurate data allowing the empirical study of many aspects of the human–wildlife relationship. However, research projects are by definition limited in time and space whereas human–wildlife interactions are open-ended and conflicts relating to large carnivores are experienced across a large proportion of the European landscape in many different social, cultural and ecological circumstances.

Social science methods can also be used to collect insights into the behaviour and ecology of large carnivores. Rural people accumulate many observations of large carnivores (and other wildlife) and of their tracks and signs, as well as experiences of the consequences of their presence. Rural residents, especially those who spend significant time outdoors (e.g. hunters, foresters, livestock herders, outdoor recreationists, amateur naturalists) represent millions of eyes and ears that can potentially contribute with invaluable information about large carnivores on a scale that no researcher or research project could achieve [7]. Furthermore, in many areas that have had a continuous presence of large carnivores for centuries, a body of knowledge about how to adapt to their presence has accumulated over the generations. This local knowledge (also called lay-knowledge, or traditional ecological knowledge) can be collected through interviews and observations with rural people, as well as collected from indirect sources such as historical documents, books, films and social media.

However, there are some clear limitations to local knowledge and some potential pitfalls that must be avoided when using knowledge provided by the public or stakeholders in ecological studies. When conducting social science research, knowledge limitations are not important because the objective is to study the subjective perceptions of the people being interviewed or studied. But when using local knowledge in an ecological or agricultural context there is a need to distinguish between the subjective and the objective.

Firstly, not every member of the public is an experienced animal tracker or observer and many people may not be accurate when reporting observations of carnivores (that typically only appear as fleeting glimpses, often in dense forest) or of their tracks and signs. Such issues can be addressed through training and by requesting photo documentation, for example the Scandinavian Skandobs app for large carnivore monitoring (see below). However, it does require building an understanding that being sceptical and asking for verification is not an insult or a demonstration of distrust. This is simply how science works. Scientists are trained to be sceptical and to critically appraise the reliability of all information and its sources and to provide verifiable documentation where possible. In science, there should be no expert who cannot be questioned by colleagues or the public.

Secondly, it is important to realise that not all rural residents have direct experience with large carnivores (or livestock). Many modern rural lifestyles do not bring people into contact with shy, elusive species of wildlife. This is not to say that their opinions, perceptions and values are any more or less important than anyone else's, but it does limit the extent to which they can contribute objective knowledge or factual data to a research project or monitoring programme. Similarly, it is important to real-

An anaesthetised lynx equipped with a GPS collar in Finnmark, northern Norway, as part of a study investigating predation on semi-domestic reindeer (Photo: John Linnell).

ise that many parts of the world have not had a continuous exposure to large carnivores. This is especially pertinent in many parts of Europe that have recently experienced a dramatic return and expansion of the wolf. In these areas, the traditional knowledge, practices and adaptations of living with large carnivores may well have been lost through lack of continuity in the decades, or centuries, of predator absence.

Thirdly, there are some things that local people simply cannot know without all the technological tools available to professional scientists. For example, if a hunter finds two bear scats in his hunting area, there is no way that he can know if these come from the same bear or from two different bears. Likewise, if two shepherds living 10 km apart experience attacks on livestock by a lynx within a short period of time, they have no way to know if these were made by the same lynx or by two different individuals. An ecotourist can spend a whole day hiking in an area with wolves but not see any sign of them and mistakenly conclude that there are none there. However, using the modern tools of science, DNA analysis, GPS collars, or digital camera traps and statistical modelling, the professional scientist can actually establish if the scats came from one or two bears, or estimate the likelihood of the same lynx moving that distance between the sheep flocks, or determine how many wolves remained hidden from the hiker, maybe seeing him, but not being seen by him [8].

Finally, there is the issue of scale [9]. Most people working or recreating outdoors are limited to relatively small areas such as their hunting ground, their pasture, their farm or their hiking route. These areas are typically measured in hectares or a few square kilometres. While a person can acquire a good understanding of the local carnivore activity within such an area, there is a near universal challenge to communicate the scale at which large carnivores use the landscape. Virtually all individual wolves, lynx and bears that have been studied with modern scientific methods have been found to have home ranges or territories greater than 100 km², with many using areas measured in the thousands of square kilometres. Young animals in the dispersing stage of life can travel tens, hundreds or even thousands of kilometres, often crossing international borders, in very short periods of time [9]. This implies that local people only see a fraction of the area used by individual carnivores, so their experience of carnivore activity within their perceptional area does not embrace that of the carnivore. For example, five

neighbouring grazing areas may all experience the presence of a bear but it does not mean that they each have their own bear! In fact, the same bear is probably roaming through several different grazing areas.

The main message here is that all forms of knowledge gathering are subject to limitations and potential biases. The way forward is to openly recognise these and find ways to address them. It is also possible to find ways to combine different forms of knowledge generation that make the best of each. A good example here lies in the use of citizen science as an approach. Citizen science takes advantage of the fact that interested people are dispersed across the whole landscape and can potentially represent observers of issues on a scale impossible for any research team to operate on. By structuring the way that observations are collected, by introducing some validation procedures and subjecting observations to rigorous interpretation using the tools of modern ecological science, it is possible to collect incredibly rich data at very large scales efficiently and cost-effectively in order to better inform policy development and implementation. The massive growth in the use of mobile phones and associated apps has transformed citizen science in recent years, turning everybody into a potential observer. A second way forward lies through the co-generation of knowledge, where local people and key stakeholders are integrated into research projects, with local voices helping shape the way research is conducted and which questions are prioritised as well as taking part in field activities [7].

Norway provides an illustrative example of many of these issues. Although Norwegian large carnivore management is embroiled in constant controversy, there has been a massive investment in developing cutting-edge research and monitoring programmes which have always tried to build synergies between local- and research-based knowledge systems. For example, the monitoring of lynx depends almost entirely on the public reporting observations of tracks of lynx or other observations such as images from their private camera traps. These observations are submitted via an app (Skandobs[1]) and key observations that represent signs of reproduction are validated and form the basis of annual population estimates. In areas with poor coverage, camera traps are distributed to local experts, often hunters, who deploy them according to a standardised protocol which builds on their local knowledge of sites most likely to be used by lynx. When conducting field research that requires capturing animals to equip them with GPS collars, scientists and wildlife technicians are totally dependent on local experts to help them place traps in the right areas and then to follow the lynx once they have been collared, checking clusters to see what they prey on.

Partnerships with local people have been at the heart of how scientists study lynx for almost three decades and have allowed them to conduct large-scale research and monitoring projects which have transformed the species from a near mythological unknown to one of the best studied large mammals in Europe. This has not removed all conflicts, but it has provided a near common knowledge platform concerning the species and its relationship with people on which actions can be discussed. In effect, it has transformed the debate from conflicts over contested knowledge to conflicts over values (about how this knowledge should be used, or the goals that different people want to reach concerning large carnivores). This represents the core of the conflicts around these species and the ongoing process to identify how the future of coexistence should look.

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