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Short communication

Building public trust in compensation programs through accuracy assessments of damage verification protocols

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ABSTRACT

Reliable verification of damage claims is fundamental to create public trust in the legitimacy of compensation programs, and avoid fraud and moral hazards. However, after decades of using this tool, transparency in verification processes and availability of quantitative information on the accuracy and misidentification rates are unresolved issues. Accurate rules overcome several challenges facing compensation programs worldwide, such as the difficulty of proving claims, lack of compensation or insufficiency of community support. Here, we tested the accuracy of the verification protocol of damage claims used in Sweden for large carnivore depredations on sheep. In Sweden, verifiers (who will determine if a livestock owner is compensated or not after a suspected attack) uses rules grounded on typical bite marks from each predator species on animal carcasses. Contrasted with DNA salivary analysis, verifiers correctly identified wolf and lynx as the culprit species in 86% (n = 57) and 91% (n = 11) of cases tested, respectively, and the overall accuracy in identifying a predation event was 94%. We believe that rigorous tests of current damage verification protocols are essential to show people the frequency that predation results in compensation, as well as how often other causes of livestock death or injury are erroneously interpreted as being inflicted by large carnivores. The use of DNA salivary analysis to test the accuracy of damage verification protocols is transferable to any livestock-carnivore conflict scenario worldwide, as well as to other wildlife, such as ungulates browsing on forest plantations and crops.

1. Introduction

Livestock depredation is a central issue in most large carnivore management strategies worldwide. In order to mitigate this human-carnivore conflict, different compensation programs have been adopted since the 1970s to indemnify for livestock killed or injured by large carnivores, such as in the case of wolves *(Canis lupus)* (Boitani et al., 2010) or brown bears *(Ursus arctos)* (Bautista et al., 2017). Compensation programs aim to redress the unbalanced costs of sharing the landscape with large carnivores for those that have had livestock attacks. They are expected to alleviate the conflict, increasing tolerance towards carnivore presence and raising awareness about community concerns shifting economic responsibilities to the general public.

Compensation can take different forms, from indirect economic incentives to direct payments for conservation performance (Zabel and Roe, 2009), and ranging from ex-post compensation schemes, or insurances, to performance payments (Schwerdtner and Gruber, 2007; Zabel and Roe, 2009; Zabel et al., 2011). Irrespective whether the source of funding is public or private, the majority of existing compensation programs are all based on the same raw information: observations and interpretations of verifiers (i.e., field observers trained in identifying livestock attacks by large carnivores or conservation goals, such as carnivore reproduction events). Verification can thus take the form of certifying a livestock depredation event in ex-post compensation programs (Boitani et al., 2010) or a given conservation goal, such as reproduction events, in performance payments (Zabel et al., 2011). The main reason behind verification is to create public trust in the legitimacy of decisions and compensation programs, avoiding fraud and reassuring funders that compensation is targeting the right people (for example, those that actually have had attacks by large carnivores in the case of ex-post compensation programs).

Social trust (i.e., the willingness to rely on managing authorities, policy makers and those implementing interventions) is crucial to successfully implement management interventions (Cvetkovich and Winter, 2003; Stern, 2008), such as compensation programs. In ex-post compensation programs, the trust from livestock owners, funders,

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managers and the general public in relation to the decision adopted after verification (i.e., to confirm or reject a suspected attack event) is crucial for compensation programs to be considered legitimate and fair, and at least have the potential to be used as an effective conservation tool (Boitani et al., 2010; Redpath et al., 2013). Trust issues often arise due to the decisions taken by verifiers in relation to confirm or reject a suspected attack (Montag et al., 2003; Maheshwari et al., 2014). Such decisions will determine if a livestock owner will receive compensation or not, and owners, therefore, can exhibit distrust of government agencies and the persons responsible for verifying suspected attacks (Montag et al., 2003; Beeland, 2008). In the end, distrust in compensation programs and the decisions adopted by verifiers, can even influence the motivation of livestock owners to report suspected attacks.

We believe that testing the effectiveness of verifiers is important in order to create public trust in compensation programs and the legitimacy of decisions. Verification is implemented in different forms in the majority of current compensation programs (e.g., Montag et al., 2003; Schwerdtner and Gruber, 2007; Hazzah et al., 2009; MacLennan et al., 2009; Boitani et al., 2010; Maheshwari et al., 2014), but the field inspection of animal carcasses, the scene and necropsy of carcasses is the standard verification procedure in ex-post compensation programs (e.g., MacLennan et al., 2009; Boitani et al., 2010). However, we still, after five decades of use, find that public access to information on the accuracy, misidentification and transparency of damage verification processes is an unresolved issue. The scrutiny of verification processes is also supported by budgetary reasons, as the funders of predator compensation programs also demands a responsible use of funds.

Verification processes in ex-post compensation programs have to be evaluated with respect to how often the verifier arrives at the correct conclusion regarding, firstly, whether a large carnivore was involved or not in a suspected attack event, and secondly, the ability of verifiers to discriminate between bite marks from different carnivore species. Because the effectiveness and the criteria used in damage verification processes remains untested, decisions are being hold only by expert criteria. Here, using the verification system of large carnivore depredations on sheep (*Ovis aries*) in Sweden, and DNA salivary analysis from buccal traces on bite marks of dead animals, we evaluated the accuracy of the Swedish verification protocol for livestock predation events.

2. Methods

2.1. The Swedish verification system of large carnivore depredations on sheep

We focused on depredation by wolves and lynx (*Lynx lynx*) on sheep in south-central Sweden; where the potential carnivore species involved in livestock depredations apart from these species are: brown bear, red fox (*Vulpes vulpes*) and dog (*Canis lupus familiaris*). In Sweden, wolf and lynx predation on sheep are more common in the south-central region because this area has relatively high densities of sheep farms (Karlsson, 2013). Between 1997 and 2014, the annual number of attacks by wolves (verified) on sheep ranged between 5 and 90 attacks, whereas it ranged between 35 and 95 attacks for lynx (Frank et al., 2014). Regarding the number of heads, in 2014, wolves and lynx attacked 421 and 163 sheep, respectively (Frank et al., 2014). During the same time period, the total annual compensation for wolf and lynx attacks on sheep ranged from 15,600 to 200,000€ (the average over the past 5 years was 90,000 and 25,000€, respectively; Frank et al., 2014).

In Sweden, livestock owners have to check their animals once every day, following the Swedish Animal Welfare Act of 1988 (SFS 1988:534) and the European Council Directive 98/58/EC. After livestock owners detect sheep potentially attacked or killed by predators, they report suspected attacks to the Swedish County Administration Boards (Fig. 1). Before 24 h after the event, governmentally employed verifiers visit the area to skin and examine all carcasses found (Appendix A). Verifiers use simple rules to determine whether a carnivore has killed a sheep or not. When verifiers skin sheep carcasses, they check what parts of the carcasses (Fig. 2; Appendix B) have bleedings after bite marks, as well as look for claw marks (Levin et al., 2008). Then, they decide the most probable culprit species by considering what are rare, occurring or typical bite marks of the respective carnivore species (Appendix B). Trust is critical in this step for decisions made by verifiers to be considered legitimate and fair (Fig. 1). The verifiers report is the documentation used by the County Administration Board to decide whether compensation should be paid or not. In Sweden compensation is paid when verifiers attribute injury or death to predators. When verifiers confirm an attack event they also implement fast response interventions, such as fladry and portable electric fences, to prevent recurrent attacks. If verifiers cannot document an attack event, no further actions are adopted (Fig. 1).

Livestock owners are typically compensated within four weeks after the application for payment has been submitted. All sheep injured, killed, or missing after a verified attack by large carnivores are indemnified at a rate slightly higher than the market value (Fig. 1). The number of sheep attacked by large carnivores not reported is expected to be small for several reasons. First, according to the abovementioned Swedish Animal Welfare Act, sheep must be checked and counted on a daily basis. Second, farms in Sweden typically keep relatively small numbers of sheep (92% of sheep farms have less than 50 head; Statistics Sweden, 2012), and under the Swedish law, sheep cannot graze outside fenced pastures. Third, livestock owners are encouraged by authorities to report all cases of suspected carnivore attacks. All farms reporting suspected attacks are visited without costs by verifiers. Finally, no compensation is paid unless the verifiers attribute injury or death to large carnivores.

2.2. Using buccal DNA analyses to identify the culprit of a sheep attack

DNA salivary analysis may be useful to carry out accuracy assessments of damage verification protocols. We tested the accuracy of verifiers' decisions on 68 randomly selected sheep carcasses in central Sweden deemed to have been killed by wolves or lynx based on simple rules between 2007 and 2009 (Fig. 2; Appendix B & C) by contrasting such decisions with the results obtained from saliva collected from bite marks. After necropsies, we collected buccal swab samples from bite wounds (Appendix A). All buccal samples were collected from sheep killings that occurred less than 24 h after the attack.

Details on the molecular procedures used in this study are provided in Appendix D. We focused on the cytochrome *b* to identify the culprit species. To identify suitable regions with the cytochrome *b* gene we used already published sequences from the focal carnivore species (Appendix D). We designed 4 separate primer pairs (Table 1 in Appendix D) to identify sequences from the cytochrome *b* gene on canids (i.e., wolf and dog), brown bear, lynx and red fox. Since wolves and dogs carried identical sequences from the cytochrome *b*, we designed specific primers to amplify markers on control region of the mitochondrial DNA (Appendix D).

3. Results

Out of the 68 sheep depredations considered, where we determined the culprit species using buccal DNA analyses (Appendix E), wolf DNA was found in 57 cases, whereas lynx DNA was found in 11 cases. In 49 out of the 57 wolf kills, verifiers, after necropsy, reached the conclusion that wolves killed the sheep (Fig. 3). Verifiers thus correctly identified wolf as the culprit species in 86% of cases. In 10 out of the 11 lynx kills, verifiers, after necropsy, reached the same conclusion for lynx (correctly identifying the culprit species in 91% of cases; Fig. 3). The overall accuracy in identifying a depredation event was 94% (two cases were classified by verifiers as red fox, and two other cases were concluded as unknown; Appendix E), with the overall accuracy of identifying the real predator culprit being 87%. Finally, it is noteworthy that dogs were