Commentary

Tolerance of bearded vultures to human activities: response to Comor et al. (2019)

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Abstract: The bearded vulture (*Gypaetus barbatus*) is listed as vulnerable in Europe on the International Union for Conservation of Nature Red List because of population declines over multiple generations. Vulture population declines have been attributed to shooting, use of toxicants, and changes in land use, which have resulted in habitat degradation and increased anthropogenic disturbances. Concomitantly, conservation authorities have restricted practices deemed harmful to the species and have established protection buffers around occupied vulture breeding sites to mitigate the impacts of anthropogenic disturbances on breeding success. Comor et al. (2019) compared bearded vulture breeding success over 6 years within and outside areas with restricted activities in the western French Pyrenees and assessed distances between vultures and hunting parties. They concluded that hunting was not a threat to species conservation and may even benefit vultures by providing alternative food resource. We dispute the conclusions of Comor et al. (2019) and present concerns about the data used, the study design, and the inferences taken from some of the data presented. Herein we provide arguments and rationale to support our opinion.

Key words: bearded vulture, conservation, disturbance, French Pyrenees, *Gypaetus barbatus*, hunting, noise, rebuttal

Disturbance generated by human activities is one of the main factors affecting breeding success of wild bird species (Gill 2007). Anthropogenic disturbance can occur either indirectly through habitat modification or directly through the negative effects associated with responses to disturbance such as energetic cost resulting from escape flights and prolonged absences from nests (Madsen and Fox 1995, Brawn et al. 2001, Thiel et al. 2007). Among birds, raptors are particularly susceptible to disturbance close to their nests (González

Editor's note: We have been informed that because of logistical reasons the authors of Comor et al. (2019) were unable able to provide the answers requested by Duriez et al. (2020) regarding the protocols, the quantitative data, or the small and unbalanced sample sizes. At the authors' request, the article by Comor et al. published in *Human–Wildlife Interactions* 13(3) has been retracted.

et al. 2006, Zuberogoitia et al. 2008, Margalida et al. 2011, Moreno-Opo et al. 2013, Monti et al. 2018). Richardson and Miller (1997) reported that buffer zones can be effective tools to mitigate disturbance of raptors during the breeding season. Such measures have proven to be efficient to increase breeding success of endangered vulture species such as the Egyptian vulture (*Neophron percnopterus*) in northern Spain (Zuberogoitia et al. 2014).

The bearded vulture (*Gypaetus barbatus*) is listed as vulnerable in Europe on the International Union for Conservation of Nature (IUCN) Red List because of small and declining populations (BirdLife International 2015). The species decline has been attributed to changes in land use, which have resulted in habitat degradation, non-natural mortality factors, and increased anthropogenic disturbances (Arroyo and Razin 2006, Margalida et al. 2014, Arroyo et al. 2020). Arroyo and Razin (2006) reported the distances at which bearded vultures reacted to different human activities and showed a negative relationship between breeding success and the frequency of human activities (including hunting) in a nesting territory. To mitigate the effect of anthropogenic disturbances on bearded vultures, conservation authorities have designated protected areas around active bearded vulture nests.

In a recent paper, Comor et al. (2019) evaluated the efficiency of conservation policies restricting human activities on bearded vulture breeding success from 2011 to 2017 in the French Pyrenees. They compared breeding success between areas where human activities were "restricted" and "non-restricted" and included weather conditions as a covariate. They concluded that breeding success was similar in both types of areas but was negatively affected by rainfall. Additionally, they assessed the potential effects of hunting activities on bearded vulture behavior and found no evidence that hunting was perceived as a threat by vultures. They concluded that bearded vultures demonstrate some degree of tolerance to human activities (including hunting), which would therefore be assumed to have no detrimental impacts on the species, in contradiction with other studies on the species in the same area of the French Pyrenees (Arroyo and Razin 2006, Arroyo et al. 2020).

Comor et al. (2019) is now being quoted by certain parties seeking to change biodiversity protection policies regarding the restriction of human activities, including hunting, in important bearded vulture breeding areas. However, we argue that Comor et al. (2019) provided weak scientific evidence for supporting this change. Herein we provide arguments and rationale regarding the data used (i.e., the position and status of the nests), the study design, and inferences from some of the data presented to refute the conclusions of Comor et al. (2019).

Status of restricted and non-restricted areas

The study area in Comor et al. (2019) encompassed 27 monitored territories that they categorized as those with restricted human activities and those where human activities were permitted (non-restricted). The authors described restricted areas as zones where the minimal distance between an eyrie and human activities was 1.8 km. These zones in fact refer to those called in French "ZSM" ("Zones de Sensibilité Majeure," translated as "areas of major sensitivity"), which were established by French authorities in 2005 to enforce a national policy prohibiting any intentional disturbance toward bearded vultures (Arrêté du 12 décembre 2005 portant interdiction de la perturbation intentionnelle du gypaète barbu, (https://www.legifrance.gouv.fr/loda/id/LEGITEXT000027796456/2020-09-14/).

By identifying specific areas where bearded vultures nest, the ZSM designation is therefore an essential operational instrument for implementing the law by providing a transparent reference to warn all stakeholders about the location of restricted areas. Specifically, all human activities are restricted within 1.8 km of any bearded vulture nest benefiting from a ZSM from November 1 to August 15 (i.e., including hunting, which is practiced between November and February, as stated in Comor et al. 2019). In practice, the ZSM designation is revised annually and applies to all known active nests. The systematic identification of all nests actually used by vultures for breeding and around which the restriction perimeters is updated each year based on a coordinated monitoring network ("réseau Casseur d'Os") composed by >350 observers (including naturalist NGOs, public institutions, local hunting associations,

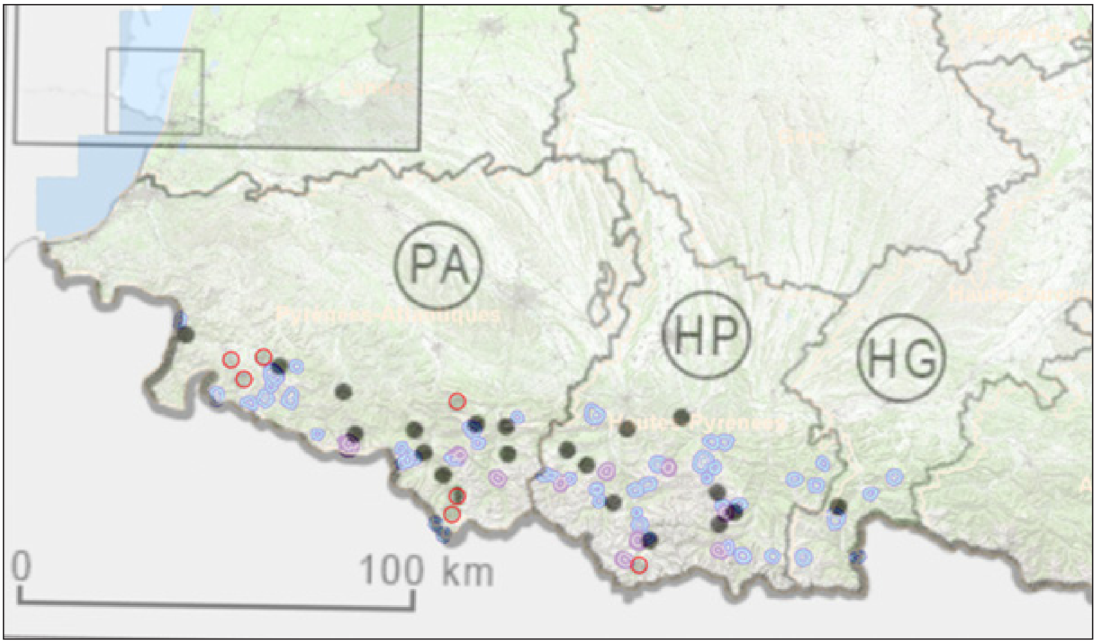

Figure 1. Map of "restricted nests" (grey dots with red contour) and "non-restricted nests" (black dots) considered in Comor et al. (2019), showing almost no overlap with the official locations of bearded vulture (*Gypaetus barbatus*) breeding sites and ZSM areas ("Zones de Sensibilité Majeure," translated as "areas of major sensitivity") either active in 2020 (in purple) and inactive but with a breeding attempt since 2010 (in blue). The letter codes encircled refer to 3 French departments (administrative units) in the French western Pyrenees (PA: Pyrenees-Atlantiques; HP: Hautes-Pyrenees; HG: Haute-Garonne).

and managers of protected areas; Arthur et al. 2010). Nests detected by this coordinated monitoring network are considered to represent >98% of existing nests in the French Pyrenees, according to results of an Integrated Population Model (Margalida et al. 2020).

Comor et al. (2019) reported that only 6 of the territories they monitored actually benefited from a ZSM, while 20 territories had unrestricted access, and an additional one was non-restricted the first study year, and restricted the 3 subsequent ones. This is highly unlikely because during the time frame of the study (2011–2017), all bearded vulture nests recorded as occupied benefited from the legal protection of a ZSM to fulfill the compliance to national policy regarding this protected species. Therefore, almost all—if not all—the territories considered in Comor et al. (2019) should have been under ZSM designation, and thus should have been considered as areas of "restricted human activity," preventing any comparison between restricted and unrestricted areas.

The total known breeding population of bearded vultures between 2011 and 2017 in the French Pyrenees (according to the monitoring program carried out by the "réseau Casseur d'Os" network) ranged between 33 and 44 pairs (annual census data available at http://rapaces.lpo.fr/gypaete-barbu/sensibilisation). Consequently, even assuming that all nests considered as "non-restricted" by Comor et al. (2019) were among the 2% that were not detected by the coordinated monitoring program each year, this means that at most 1 nest per year could be considered as "non restricted," giving a maximum of 7 nests over the whole study period. This number is far fewer than the 21 territories considered by Comor et al. (2019), which raises questions about the location of non-restricted nests in their study.

Nest locations

To further explore which nests Comor et al. (2019) considered as being within "non-restricted" areas, we compared the dot matrix shown in their Figure 2 (locations of bearded vulture nests) with all known vulture breeding sites obtained from the coordinated monitoring program (Arthur et al. 2010). We overlayed the official map of breeding sites and surrounding ZSM between 2010 and 2020 with Figure 2 of Comor et al. (2019; Figure 1). Surprisingly, even the "restricted eyries" considered by Comor et al. (2019) poorly matched the locations of breeding sites and ZSMs. With 33–44 pairs detected each year through the coordinated monitoring program, we would expect that a majority of nest locations should match those of Comor et al. (2019).

Given this concern, we urge Comor et al. (2019) to clarify the origin of the data and the reason of such possible mismatch to ensure the validity of their whole study. Ideally, nest location data should be published, even if with low precision (e.g., ±2 km, at the municipal scale) to prevent spreading highly sensitive information. In addition to allowing corroboration of the findings of their study, these locations may be precious for protecting the species by providing ZSM to nests that were not apparently detected by the coordinated monitoring network.

Breeding success

With respect to the assessment of effects of human activities on breeding success, we argue that the Comor et al. (2019) comparison of mean breeding success between the 2 groups may be over-simplistic. For example, the authors did not account for the age of the breeding birds or the duration of occupation of the nest/territory. The age of parents (as a proxy of their breeding experience) has been reported as a major factor explaining breeding success (defined as the number of fledglings per breeding pair) for the species, well beyond any climatic variable (Margalida et al. 2003, Arroyo et al. 2020). It is possible that birds in their restricted and unrestricted areas include birds of different ages, which may mask additive effects of human disturbance, particularly given the small dataset they use in their analyses.

Additionally, a comparison of "restricted" versus "non-restricted" areas includes an assumption that the frequency of human disturbances was homogeneous within the 2 groups and markedly different between them. Arroyo and Razin (2006) reported that breeding success was negatively correlated to the frequency of human activities in the territory. There may be a wide variation in the frequency of human activities within unrestricted areas, which may blur the effect of human disturbance when comparing means between groups from a relatively small dataset. To effectively demonstrate that breeding success was unrelated to human disturbance, the authors should provide quantitative evidence that the frequency of hunting actions (as well as of other human activities) was relatively homogeneous among all non-restricted areas and significantly larger than at restricted areas.

Distance to hunting parties as a surrogate for tolerance of disturbance?

Finally, Comor et al. (2019) compared the distances between hunters and bearded vultures observed during hunting parties in relation to whether there were firing actions during the hunting event (9 observations) or not (25 observations). They found that during hunting actions with shooting, the mean distance between bearded vultures and hunters did not differ from actions without shooting, although the mean was larger in the former (465 ± 60 m) than the latter (178 ± 55 m). Furthermore, they found that when bearded vultures were observed in hunting actions with shooting, the distance between birds and hunters was shorter when more shots were fired. Comor et al. (2019) interpreted these results as evidence that bearded vultures may have adapted to game hunting activities and tolerate them.

There are several reasons why we consider that such a conclusion from the above-mentioned data is misleading. First, the authors did not explain in their methods how distances to the flying birds were assessed (with a laser range finder or by sight; see the likely observer bias in Mateos et al. 2010) or at what moment (if the sample point was the "hunting action," was distance measured at the time of detection or was it an average of the distance during the whole observation?). Most importantly, they did not account for cases when firing occurred but no bird was observed. If no bird was detected, it does not mean that it was not present; it just means that it was not detected and that it could be elsewhere in its breeding territory at a further distance than human observers can possibly spot it (e.g., hidden by mountains or valleys, given that home ranges of territorial pairs commonly exceed 50 km^2; Gil et al. 2014, Margalida et al. 2016).

This is important from a biological point of view (as the effect of leaving an unattended nest for long periods will be stronger than that of short absences) as well as from a statistical point of view (MacKenzie et al. 2006). If the authors would have considered that a lack of observation of a bearded vulture in an occupied territory during a hunting party meant an arbitrary distance of >1 km, differences between birds and hunters between hunting actions with or without firings may have well been highly significant. More generally, beyond mentioning that larger sample sizes would be required, we think that more careful attention needs to be placed when analyzing data based on direct visual observations to tackle this question.

The best method to measure the response of tagged bearded vultures to hunting actions would probably be satellite telemetry, with a continuous and robust measurement of the distance bird/hunter at every moment (see Ferrand et al. 2013, McGowan et al. 2017). Beyond these issues, claiming that birds may have adapted to tolerate hunting activities based on 25 observations indicating shorter distances between hunters and birds and the frequency of shootings seems a bit far-fetched. Incidentally, the authors did not explain the behavior of the birds observed during hunting parties, beyond their distance to the hunters: were they attracted to them, flying away from them, or indifferent in their flying trajectory? This would have brought valuable information to support their interpretations and claims.

Conclusion

To ensure species conservation, it is imperative that management and conservation policies are based on sound science (Gill 2007, Sutherland 2007). Based on the concerns stated in our review, we contend that the conclusions presented in Comor et al. (2019) should be viewed with caution.

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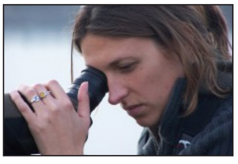

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