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METHODOLOGICAL PROPOSAL FOR THE INCLUSION OF FAUNA IN LANDSCAPE STUDIES. THE EXAMPLE OF CASASOLA BEACH, MALAGA (SPAIN)

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I. INTRODUCTION

Animals are an essential component of geographical landscape (Zonneveld, 2005; Swanwick et al., 2002; Bastian et al., 2006) in that they contribute to its ecological configuration, acting as geomorphic agents (Butler, 1995; Butler & Sawyer, 2012) with decisive effects on aspects such as vegetation (Vavra, 2007; Pietzsch et al., 2013) and soil (Hole, 1981; Evans, 1998). Animals also have a significant impact on the cultural dimension of the landscape, in terms of typical livestock breeds (Evans & Yarwood, 1995), place names (Sousa & García-Murillo, 2001; Moore, 2002), shepherd shelters (Corbera, 2006), etc. If we view landscape from a broader sensory approach that goes beyond its purely visual aspects, the sound, scent and feel of animals can also contribute to the way we perceive landscape (González, 1981).

Despite the importance of fauna in landscape, there are relatively few studies that present methodological procedures to assess its role (Gómez-Zotano & Riesco-Chueca, 2010). The emergence in recent decades of various international treaties to implement landscape policies (such as the European Landscape Convention) represents an opportunity for the inclusion of fauna in the methodological system for landscape analysis and assessment.

With this in mind, in this paper we present a methodology for evaluating the direct manifestations of animals (both wild and domestic) in the landscape and implementing the results in landscape studies. This methodology is tested in a Mediterranean coastal landscape in the province of Malaga (Andalusia, Spain).

II. STUDY AREA

The study area covers a coastal landscape in Estepona in the province of Malaga. It extends over 18 hectares of coastline, bounded to the south by the western side of Casasola beach. At the back of this stretch of beach is Matas Verdes, a line of sand dunes that juts 200 metres inland. The northern area includes the hind dunes, a residential area which began to be developed in the 1980s ("Urbanización El Presidente").

III. CONCEPTUAL AND METHODOLOGICAL FRAMEWORK

The conceptual framework is based on the definition of landscape established by the European Landscape Convention (ELC): "Landscape is an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors" (Council of Europe, 2000).

The methodological procedure includes the following phases:

1. Identification and characterization of existing faunal habitats in the study area (Lozano & Carracedo, 2010).
2. Drawing a line transect through the central area of each of the previously identified habitats (T-T`). We also set up four listening points (P1, P2, P3, P4), one for each habitat.
3. Reviewing and updating the list of animal species identified and inventoried in previous studies ("Catalogue of terrestrial vertebrates of Saladillo-Matas Verdes"; Gómez-Zotano, 2009). To this end, we carried out new sightings and listenings (two sightings and two listenings in each season, and at different times of the day), based on the line transect and on the previously established listening points. The process of identification of species was based on expert knowledge and various different wildlife identification guides (Hume, 2011).
4. Selection of the most relevant species in the landscape and assessment of the ways in which they manifest themselves according to the following order of tasks: a) Drawing up of a list of animal species (both vertebrates and invertebrates) that may be interesting from a landscape perspective, in terms of their tactile, visual and sonic manifestations (Farina, 2014); b) Interviews with different users with close links to the landscape of the study area (wildlife experts, gardeners, residents, walkers,...) to complete the list of the most significant species (Lozano & Meaza, 2003b). In this case 42 people linked with the different habitats were interviewed; c) Analysis of seasonal and daily changes in animal manifestations in the landscape. The sightings and listenings on the line transect were carried out in eight days of fieldwork, from February 2013 to March 2014, as were the interviews. Listenings were also conducted during the night to analyse the variability between day and night.
5. Correlation of the representative species in each habitat. As proposed by Lozano and Meaza (2003a), analysing the presence of each species observed in sightings and listenings allowed us to establish a certain correlation between the different species and habitats in the study area.

6. Analysis, comparison, interpretation and representation (landscape profile) of the information collected.

IV. RESULTS

IV.1. Faunal habitats

Four types of faunal habitat were identified in the study area (Fig. 2). Working from the coast inland, these were as follows: beaches, dunes, wooded area and residential developments.

The beaches and the embryonic and incipient dunes where the sand is less stable are characterized by a strong land-sea interaction. This habitat has low levels of organic matter, little fresh water and is strongly influenced by wind and salt water. The very limited vegetation consists mainly of herbaceous plants and subshrubs.

On the sands of the dune complex (stable dunes) there are different kinds of bushes, such as *Eryngium maritimum, Elymus farctus, Helychrysum stoechas, Ononis ramosissima,* etc. A faunal community characteristic of dunes is established in this habitat. Fresh water is in very limited supply.

Further inland on the hind dunes, there is a wooded area with various tree species, such as cork oaks (*Quercus suber*), kermes oaks (*Quercus coccifera*) and mastic trees (*Pistacia lentiscus*). There are also plantations of pine trees (*Pinus pinea* and *Pinus pinaster*) and eucalyptus (*Eucaliptus globulus*). In this habitat the soil has greater moisture retention capacity.

Finally, on the northern boundary of the study area, buildings and gardens are also the habitat of different animal species.

IV.2. Manifestation of fauna in landscape

For their scenic relevance, we selected a total of 48 animal species. Birds are the largest group (37), followed by invertebrates (8), mammals (2) and reptiles (1) (Tables 1, 2, 3 and 4).

As regards the different ways in which these animals were perceived in our experiments, the majority were perceived by the sounds they made (51.9%), closely followed by those perceived visually (45.6%), while a barely representative selection (2.5%) were perceived via their tactile interaction with humans (mosquitoes and sand fleas).

As regards the variability of faunal manifestation, we found that resident species predominate over migratory species, while diurnal animals were more frequently detected than nocturnal animals. However, there are four species which stand out for the frequency and intensity of their manifestations at night: scops owl (*Otus scops*), nightingale (*Luscinia megarhynchos*), dog (*Canis lupus familiaris*) and two-spotted cricket (*Gryllus bimaculatus*).

V. DISCUSSION

In this paper we propose a method for the analysis and evaluation of the direct manifestation of fauna in the landscape from a broad perceptual perspective. Nevertheless, this proposal does not incorporate other important variables such as population density, degree of endemism, singularity or special values that characterize fauna. These variables could be

incorporated into future research in that they provide interesting information about the abundance or rarity of the species and their importance in landscape assessment and conservation. On this question, it is worth mentioning the methodological procedure proposed by Lozano and Meaza (2003a) for zoogeographical evaluation by environmental units, in which they analysed the locational specialization of animal species and considered the quantitative and qualitative assessment of species diversity at the landscape scale.

The practical application of the methodology presented in this article confirms the important contribution of fauna to the sonic dimension of certain landscapes, as shown by different authors in the characterization of soundscape (Pijanowski et al., 2011a, 2011b; Farina, 2014),

In accordance with Lozano (2000) and Farina et al. (2011), we have seen how certain environmental factors (wind, rainfall, temperature, etc.) alter the frequency and intensity of the manifestation of different animal species in the landscape. In our study area, the human presence on the beach and in the residential area is another important factor, as are ethological factors relating to mating, lethargy or hibernation, which create specific seasonal or temporal patterns in the manifestation of the fauna in the landscape.

There are other types of animal species, which despite having an appreciable body size or a special ecological value, are not usually directly perceived at the landscape level. This may be due to their evasive behaviour, or because they are mainly nocturnal, as in the case of rabbits (*Oryctolagus cuniculus*), badgers (*Meles meles*) or foxes (*Vulpes vulpes*). However, all these species affect, to a greater or lesser extent, the ecological configuration of the landscape (herbivory, digging and burrowing, trampling, etc.).

VI. CONCLUSIONS

The methodology we propose offers an initial approach to the inclusion of fauna in landscape studies. This method must be contrasted and complemented with an analysis of the impact of fauna, both direct and indirect, on the other components of the landscape. The evaluation of animals as a scientific, educational or tourism resource of landscape could also be an interesting subject for future research.

The recent emergence of various international treaties such as the European Landscape Convention (ELC) represents a great opportunity for the inclusion of fauna in landscape studies, which can enhance the protection, management and planning of landscapes. An improved knowledge of the way animals interact with the landscape could also be a valuable tool for wildlife conservation.