Policy Analysis

The continued deficiency in environmental law enforcement illustrated by EU sanitary regulations for scavenger conservation

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Abstract

Enforcement is critical to guarantee the effectiveness of environmental laws for nature conservation. Erroneously assuming an equivalence between the formal implementation of environmental legislation on paper and its practical enforcement in reality can result in biased conclusions with potential to ill-inform conservation actions and influence stakeholder perceptions. Here, using as an illustrative example the implementation of European sanitary regulations EC 1069/2009 and EU 142/2011 to manage livestock carcasses for wildlife conservation in Spain and Portugal, we demonstrate how the legal implementation of these regulations does not mean effective enforcement and compliance in practice. When interviewed, more Portuguese farmers declared to leave carcasses in the field without official authorization, than their Spanish counterparts, who were legally allowed to do so. This unforeseen result was further supported by GPS-tracked vultures feeding on livestock carcasses available in the Portuguese countryside, contrasting to what would be expected considering the sanitary regulations approved at each country at the time of this study. Accordingly, while agreeing with the global trend for weak enforcement and compliance with environmental legislation, our results provide additional evidence against assuming that the formal implementation on paper of environmental laws equals their real implementation on the ground. We highlight the need to systematically assess (not assume) observance of and compliance with environmental legislation and propose some ways to improve enforcement using as an example the above referred sanitary regulations. Communication-based interventions to publicize the regulations, reducing bureaucratic burden, and on-ground monitoring to assess observance and compliance have strong potential to enhance enforcement. Overlooking implementation gaps can give rise to biased interpretations on the

46 effectiveness of these legal tools with consequences at both, the scientific and
47 conservation arenas.
48
49 **Keywords:** environmental rule of law, compliance, farmers, livestock carcass, vultures
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1. The Achilles' heel of conservation policies: Lack of enforcement

The increasing implementation of laws and policies dedicated to conservation in the last decades, − from 3 countries with environmental framework laws in 1972 to 176 in 2017 (UNEP, 2019) −, acknowledges the important role that environmental legislation plays in halting, slowing, and even reversing, nature degradation (Trouwborst et al., 2017; Lees and Viñuales, 2019). Worryingly, these legal frameworks often suffer from deficient enforcement (i.e., to compel observance of or compliance with legislation; UNEP, 2019), which jeopardizes their effectiveness as conservation tools. Enforcement failures identified so far include slow transposition of policies, poor administrative coordination among and within nations, under-resourcing, misfit between rules and traditions, lack of monitoring or deprioritizing legal obligations against economic gain (Markell and Glicksman, 2014; Treib, 2014; Chapron et al., 2017; López-Bao and Margalida, 2018; UNEP, 2019). From climate change or waste pollution (Barrett, 2008) to the effective protection of species and habitats (Mateo-Tomás et al., 2019a; Sazatornil et al., 2019), the implementation of conservation actions (López-Bao et al., 2018) or the fight against poaching and illegal wildlife trade (Milliken, 2014; Bennett, 2015; Linkie et al., 2015; Cooney et al., 2017; Hauenstein et al., 2019), additional efforts are still needed to tackle enforcement failures properly. To guarantee that environmental laws effectively address major conservation challenges, a critical step is to address the gap between the formal implementation of environmental legislation on paper and its practical enforcement in reality.

Several examples are available on the efforts carried out by authorities in charge of enforcing environmental laws. For example, exhaustive environmental controls are in place to approach commitments on greenhouse gas emissions or water pollution (e.g. Nkosi and Odeku, 2014), and increasing efforts are put in place to improve wildlife crime

persecution (UNODC, 2020). But noncompliance with regulations involves not only a deliberate violation of the norms, but also a lack of awareness of the implemented legislations,− identified as a major factor behind enforcement and compliance failures (OECD, 2000; Arias, 2015) −, as well as passive failures in enforcing the norms (Börzel, 2001). A worryingly scenario emerges when the lack of enforcement is overlooked, e.g., legal observance and compliance are assumed by default or ignored when inexistent or incomplete (Heyes, 2000). In this context, no actions are expected to fix the unnoticed drawbacks, with substantial consequences for conservation. Assuming a correct implementation of environmental legislation in this scenario can lead to misleading conclusions (Heyes, 2000), with potential to erode the legitimacy of the environmental policies, increase resistance and discontent among stakeholders and trigger distrust in managing authorities, ultimately, undermining the consecution of the legislation objectives (Meinzen-Dick and Pradhan, 2016).

Using as an illustrative example the implementation of European sanitary regulations EC 1069/2009 and EU 142/2011 (Official Journal of the European Union, 2009; 2011) to manage livestock carcasses for wildlife conservation, we show here how the legal implementation of these regulations on paper did not result in a generalized effective enforcement and compliance in practice. We call attention to the fact that erroneously assuming such equivalence can result in biased conclusions with potential to ill-inform conservation actions. We highlight the need to systematically assess (not assume) observance of and compliance with environmental legislation and propose some ways to improve enforcement using as an example the above referred sanitary regulations.

2. Implementation deficits of European sanitary regulations and their consequences for wildlife conservation

The outbreak of the Bovine Spongiform Encephalopathy (BSE), commonly known as "mad cow disease", in the late 1980s (Aldhous, 2000) forced the removal of livestock carcasses from the European countryside, following different EU regulations at the beginning of the 2000s (Commission Decision 2000/418/EC, Regulation EC 1774/2002 and Commission Decision 2003/322/EC; Fig. 1). At the same time, this decision aroused concerns on scavenger conservation in Europe (Tella, 2001). Several years later, the approval of EU regulations 1069/2009 and 142/2011 reversed the situation, by allowing carcasses of extensive livestock to be left in the field again for feeding wildlife outside collective fenced feeding stations previously authorized for avian scavengers only. These new regulations took into account therefore the natural consumption patterns of both avian and mammalian scavengers, which could feed on livestock carcasses left *in situ* within large natural areas called Scavenger Feeding Zones (SFZs) designated by the competent authorities (Fig. 1; Mateo-Tomás et al., 2019b). The implementation of these regulations has been outlined as a significant achievement for scavenger conservation in Europe (e.g., Margalida et al., 2012). Nonetheless, several implementation deficits, such as slow or uneven transposition across and within European countries, or insufficient monitoring of the implementation of the norms, have been highlighted as major issues with strong potential to compromise the effective consecution of the regulations' objectives, i.e. biodiversity conservation and public health (e.g., López-Bao and Margalida, 2018; Mateo-Tomás et al., 2018, 2019a, 2019b).

In the Iberian Peninsula, − home of >90 % of the vultures in Europe, 100 % of the Spanish imperial eagles *Aquila adalberti*, and important populations of large carnivores in western Europe, like wolves *Canis lupus* and bears *Ursus arctos* (Chapron et al., 2014;

125 BirdLife International, 2020) −, noticeable among-country (Spain *vs.* Portugal) and
126 within-country (e.g. among Spanish autonomous regions) differences exist in the
127 implementation of these regulations (Fig. 1; Mateo-Tomás et al., 2018; 2019b).
128 Regarding the among-country differences, although the Portuguese legislation has been
129 progressively adapted for allowing livestock carcasses to be left in the countryside
130 (Decree-Law 33/2017; Despacho 3844/2017, Diário da República, 2017a,b; DGAV,
131 2018; Despacho 7148/2019, Diário da República, 2019), the objective of establishing
132 SFZs has not been clearly defined until recently, when the Despacho 7148/2019 set the
133 goal of creating five SFZs for feeding scavengers outside feeding stations across the
134 country (Fig. 1; Diário da República, 2019). Therefore, at the time of this study, livestock
135 carcasses should be either collected or buried (i.e., the latter only allowed in remote areas,
136 such as our study area, previously declared by the competent authorities in Despacho
137 3844/2017; Diário da República, 2017b). Livestock carcasses can only be used to feed
138 avian scavengers under very restrictive conditions (e.g. within fenced feeding stations)
139 and upon approval of a specific plan for each facility (Decree-Law 33/2017; Despacho
140 3844/2017, Diário da República, 2017a,b; DGAV, 2018).

141 Contrastingly, most Spanish autonomous regions (15 out of 17) have already
142 designated large areas as SFZs where fallen livestock can be left uncollected to feeding
143 wildlife (Morales-Reyes et al., 2016; López-Bao and Margalida, 2018; BORM, 2019;
144 Mateo-Tomás et al., 2019b). The implementation of these laws is expected to provide
145 enough food for wildlife scavengers (Morales-Reyes et al., 2016). On the contrary, the
146 lack of implementation of the EU regulations allowing SFZs in neighboring Portugal is
147 considered as negatively influencing scavengers (e.g. through altering their foraging
148 patterns; Arrondo et al., 2018). These effects on scavenger conservation would be
149 expected outcomes of the uneven implementation of EU regulations across borders (e.g.

Mateo-Tomás et al., 2018; 2019b). However, a thoroughly assessment of the practical implementation of these regulations is lacking, agreeing with the less attention paid to enforcement and application issues of EU regulations (Treib, 2014; but see Börzel and Buzogány, 2018). Knowing the level of observance of and compliance with the legislation for managing livestock carcasses in each territory is a critical step to ascertain the real dimensions and potential consequences of the lack of homogeneous implementation on scavenger conservation and make robust recommendations accordingly.

3. Formal implementation does not mean real implementation

The continued deficiency in conservation law enforcement was illustrated by interviewing a total of 109 livestock farmers at the Portuguese-Spanish border in the Douro river in 2018-2019 (i.e. 61 in Portugal and 48 in Spain; see Appendix S1 and Gigante et al., 2021 for further details). Despite EU regulations EC 1069/2009 and EU 142/2011 being adopted more than a decade ago, we found a lack of observance of and compliance with these sanitary regulations in both countries (Fig. 2). Only 2 (4.2 %) of the Spanish farmers interviewed had adhered to regulations allowing them to leave livestock carcasses in SFZs. In contrast, leaving livestock carcasses in the countryside without any supervision was frequently acknowledged by Portuguese farmers (27.9 % of the interviewed farmers), even when recognizing this as a non-legal practice (Fig. 2). Only one Portuguese farmer (1.6 %) declared to have asked for an authorization for disposal of livestock carcasses to wildlife within the limits of his farm (instead of using collective feeding stations). Despite SFZs were designated in 2013 by the competent authority in the Spanish side (i.e. the autonomous region of Castilla y León; Decree 17/2013; BOCYL, 2013), allowing the abandonment of livestock carcasses to feed scavengers, most Spanish farmers (95.8 %) declared to use the collection system, which

takes livestock carcass away for incineration in authorized facilities. The high rates of nonobservance of and noncompliance with EU sanitary regulations recorded (Fig. 2) seems to respond to a high lack of knowledge of these sanitary legislations by farmers, paradoxically, the stakeholders ultimately affected by the norms. Indeed, only 11 farmers (8 in Spain and 3 in Portugal), i.e. 10.1 % out of the total farmers interviewed, declared to be aware of the regulations for managing livestock carcasses enforced in their respective countries (Fig. 1).

Interestingly, contrasting with previous expectations on the implementation of EU regulations in each country (e.g. higher livestock carcass availability in Spain than in Portugal; Morales-Reyes et al., 2016; Arrondo et al., 2018), four times more Portuguese farmers declared leaving carcasses *in situ* than their Spanish counterparts (27.9 vs. 6.3 %, respectively; Fig. 1). This could result in ~1.4 times more dead biomass from livestock left annually in the countryside by the Portuguese than by the Spanish farmers interviewed (i.e. 6.7 *vs.* 4.8 tons, respectively; see detailed calculations in Appendix S2). Considering the percentage of farmers who left dead livestock in the field at both sides of the border, numbers of livestock mortality declared by the interviewed farmers, and the 2018/2019 livestock censuses in the study area (Appendix S1), we estimated that 1.2 times more biomass from dead livestock could be left in the field in the Portuguese than in the Spanish side of the border, i.e. 43.6 *vs.* 35.6 tons, respectively (see Appendix S2 for detailed calculations).

The lack of enforcement of EU regulations in Spain may contribute to the rise of an emergent conflict between the farming sector and some scavenging species, as illustrated by the negative perception of farmers towards vultures that we have previously recorded in the Spanish side of the border (Gigante et al., 2021). We observed how almost half of the Spanish farmers interviewed (i.e. 45.8 %) related vulture attacks on livestock

200 with food shortages caused by the removal of carcasses from the field, a procedure that
201 they wrongly considered still mandatory (by 97.8 % of the interviewed farmers). Since
202 the perception of farmers towards scavengers improved for those leaving livestock
203 carcasses in the field, when compared with farmers using feeding stations or burying
204 carcasses (Gigante et al., 2021), not only the designation of SFZs but, overall, a better
205 enforcement of the existing legislation that allows leaving livestock carcasses in the field
206 may help to mitigate this emerging human-scavenger conflict. On the contrary, the lack
207 of observance of the current EU sanitary regulations could compromise the conservation
208 of these and other scavenging species in the long term (e.g., through retaliatory killing of
209 livestock predators; Woodroffe et al., 2005).
210
211 **4. Improving enforcement and compliance for effective biodiversity conservation**
212 While agreeing with the global trend for weak enforcement and compliance with
213 environmental legislation (UNEP, 2019), our results provide additional evidence against
214 assuming that the formal implementation on paper of environmental and conservation
215 laws means their real implementation in practice. Overlooking implementation gaps can
216 give rise to biased interpretations on the effectiveness of these legal tools at both,
217 scientific and management arenas.
218 In the particular case of the consequences of a deficient implementation of EU
219 sanitary regulations for scavenger conservation, the absence of SFZs in Portugal has been
220 previously related to altered foraging patterns of Spanish vultures, arguing that vultures
221 seem to prefer foraging at the Spanish side of the border, because of a much higher
222 availability of livestock carcasses (Arrondo et al., 2018). However, our results indicate
223 that livestock carcasses would be also available at the Portuguese side, and could be even
224 locally more abundant in Portugal than in Spain (Appendix S2). Similarly, our results

225 warn against assuming that the designation of SFZs in most Spanish regions would
226 guarantee carrion availability for wildlife (Morales-Reyes et al., 2016).
227 The level of nonobservance and/or noncompliance with EU sanitary regulations
228 among farmers should be therefore further considered when assessing the potential
229 impacts of this legislation on scavenger conservation. For example, in the concrete case
230 of the griffon vulture, − which feeds mainly on large ungulate carcasses, such as those of
231 livestock −, although food shortages due to the mandatory collection of livestock
232 carcasses could have negatively affected some vulture populations at local scale (Camiña
233 and Montelío, 2006), overall, the Iberian populations have shown increasing trends in the
234 last decades, including the period of food shortage associated with the BSE outbreak (Del
235 Moral and Molina, 2018). Concretely, the griffon vulture population in Spain has
236 increased from 2,283 breeding pairs in 1979, to 7,519 in 1989, 17,337 in 1999, 24,609 in
237 2008 and 30,945 in 2018, i.e., a 26 % increase in the last decade (Del Moral and Molina,
238 2018). Both the speed of increase and the breeding parameters seem to have decreased
239 since the first census carried out in 1979 (i.e. from 0.65 to 0.56 fledglings per breeding
240 pair; Del Moral and Molina, 2018). Besides several census limitations, such as incomplete
241 coverage or delayed visits, the observed slowdown in vulture population growth could be
242 attributed to the species reaching the carrying capacity of the environment in several areas
243 (e.g., Navarra, Burgos or Teruel provinces, which account for the 8.7, 7.0 and 4.5 % of
244 the total griffon population in Spain, respectively; Del Moral and Molina, 2018). To
245 ascertain to what extend EU sanitary regulations have contributed to the observed vulture
246 population trends needs to consider the level of enforcement and compliance with the
247 successive legislations implemented after the BSE outbreak (Mateo-Tomás et al., 2019a).
248 Our results detect a lack of compliance with EU sanitary regulations banning
249 carcass disposal in the field. This could especially occur in remote areas such as, for

example, our study area in Portugal, where burial by farmers instead of mandatory collection by an external service could facilitate carcass abandonment, or in mountainous ranges where carcasses would be hard to locate (Mateo-Tomás, 2009). In this regard, the interviewed Spanish farmers could have over-reported compliance with the former regulations of carcass disposal to "save face" (Pollnac et al., 2010). Nonetheless, even under this scenario, such over-reporting would not have affected one major result of our work, i.e. the lack of awareness of Spanish farmers regarding the current legislation that allows them to leave livestock carcasses in the field.

Existing recommendations to counteract the lack of enforcement of environmental laws include publicizing rules and regulations as a first step for building a culture of compliance (UNEP, 2019). Aligned with this, the noticeable lack of knowledge of farmers on the EU regulations enacted in Spain and Portugal for managing livestock carcasses highlights the need of communication-based interventions to enhance enforcement (Leisher et al., 2012); especially considering that most people tend to comply when informed (Winter and May, 2001; UNEP, 2019). Previous results from our study area showed that those farmers who leave carcass *in situ* have a more positive perception towards vultures, compared to those farmers using other methods for livestock carcass disposal (Gigante et al., 2021). Considering this, and that leaving carcass *in situ* was highly preferred by both, Spanish and Portuguese farmers (33.3 and 31.0 %, respectively; Fig. 2), improving communication of the current norms among farmers would be a major step towards the effective consecution of the objective of wildlife conservation under EU regulations EC 1069/2009 and EU 142/2011. In this line, a common claim of the few Spanish farmers aware of these new regulations was to reduce the bureaucracy burden to be authorized to leave their fallen livestock within SFZs. The veterinary units or equivalent competent authorities in charge of *in situ* surveillance of livestock health issues

should act as information points to publicize the regulation among farmers, and assist them with the bureaucracy needed for inclusion into SFZs, while tracking enforcement and compliance through, for example, on-ground monitoring (Mateo-Tomás et al., 2019a).

Effectively counteracting weak enforcement and compliance requires accurate information on, for example, the type of noncompliance activities, where and why they occur and who is involved (Solomon et al., 2015). This information will increase the chances of success by guiding the selection of the interventions that best addresses enforcement failures in each particular case (Solomon et al., 2015). Besides improved communication with farmers about the implemented EU sanitary regulations (see above), we urge to implement a program to monitor the presence and consumption of livestock carcasses on the ground (Mateo-Tomás et al., 2019a). On-ground monitoring of livestock carcass consumption has been previously recommended to assess the achievement of EU regulation objectives regarding both biodiversity conservation (through food provisioning for scavengers) and public health (by minimizing the presence of unconsumed carcasses in the field; Mateo-Tomás et al., 2019a). On-ground carcass monitoring will contribute to assess the real implementation of these laws instead of assuming their effective enforcement, while contrasting the information provided by farmers regarding carcass management (Pollnac et al., 2010). Furthermore, on-ground monitoring will inform the regulations in line with the current strategies of the European Commission of amending existing legislation, instead of set new laws, to enforce compliance (Börzel and Buzogány, 2018).

Several ways exist in which this monitoring could be performed, from camera trapping of livestock carcasses (e.g. Life Feeding Scavengers, 2019; Mateo-Tomás et al., 2019a) to on-ground monitoring of the feeding activities of GPS-tracked vultures (Pérez-

300 Rodríguez, 2020). For example, current vulture GPS tracking activities have allowed us
301 to confirm that, as declared when interviewed, Portuguese farmers leave livestock
302 carcasses *in situ* in our study area even when they were not authorized to do so (Fig. 3a,
303 b and c). Although we acknowledge that this situation may differ along the entire border,
304 the long-distance movements of GPS-tracked vultures from northern Spain to southern
305 Portugal, presumably to feed into areas with abundant extensive livestock (Fig. 3d;
306 authors, direct observation), suggests that livestock carcasses could be available
307 elsewhere in the country.

308 Regular assessment and monitoring are key to strengthen the environmental rule
309 of law (Lyons et al., 2010; Solomon et al., 2015; UNEP, 2019). The lack of accurate data
310 on the drivers of enforcement and compliance can give rise to erroneous assumptions on
311 the effective implementation of environmental legislations. In the concrete case of EU
312 sanitary regulations, this can result in misleading conservation recommendations such as,
313 for example, establishing supplementary feeding points in places where low carcass
314 availability is wrongly suspected, or limiting the number of carcasses authorized to be
315 left in the countryside on the basis of complete compliance with existing regulations,
316 which may also trigger human-scavenger conflicts.

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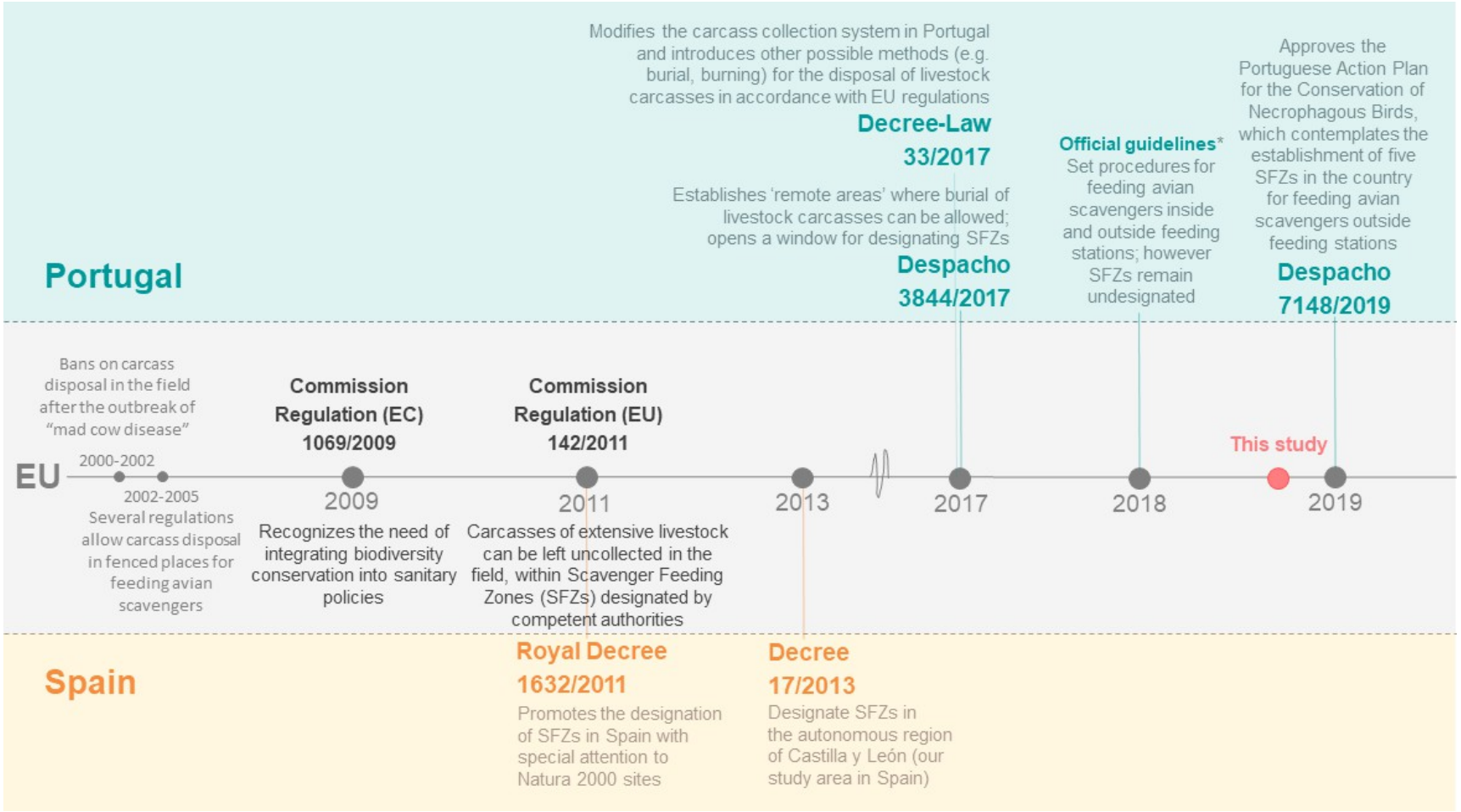
477 **Figure 1.** Timeline showing the main legislation on livestock carcass management for scavenger conservation implemented in Portugal (green
478 background at the top) and Spain (orange background at the bottom) after EU sanitary regulations EC 1069/2009 and EU 142/2011 (center grey
479 background), which allow carcasses of extensive livestock to remain uncollected in the field for feeding wildlife. Previous EU regulations restricted
480 carcass disposal in the field after the outbreak of the Bovine Spongiform Encephalopathy (BSE) or "mad cow disease". The red point indicates the
481 time when this study was conducted.
482


Portugal
Modifies the carcass collection system in Portugal and introduces other possible methods (e.g. burial, burning) for the disposal of livestock carcasses in accordance with EU regulations
Decree-Law 33/2017
Establishes 'remote areas' where burial of livestock carcasses can be allowed; opens a window for designating SFZs
Despacho 3844/2017
Official guidelines* Set procedures for feeding avian scavengers inside and outside feeding stations; however SFZs remain undesignated
Approves the Portuguese Action Plan for the Conservation of Necrophagous Birds, which contemplates the establishment of five SFZs in the country for feeding avian scavengers outside feeding stations
Despacho 7148/2019
EU
Bans on carcass disposal in the field after the outbreak of "mad cow disease"
2000-2002
2002-2005
Several regulations allow carcass disposal in fenced places for feeding avian scavengers
Commission Regulation (EC) 1069/2009
2009
Recognizes the need of integrating biodiversity conservation into sanitary policies
Commission Regulation (EU) 142/2011
2011
Carcasses of extensive livestock can be left uncollected in the field, within Scavenger Feeding Zones (SFZs) designated by competent authorities
2013
2017
2018
This study
2019
Spain
Royal Decree 1632/2011
Promotes the designation of SFZs in Spain with special attention to Natura 2000 sites
Decree 17/2013
Designate SFZs in the autonomous region of Castilla y León (our study area in Spain)

483

484

485 **Figure 2.** Results of the methods used (left panel) and preferred (right panel) for livestock carcass disposal by 61 Portuguese (solid bars) and 48
486 Spanish (striped bars) farmers interviewed illustrate a lack of enforcement (i.e. negative values) of the EU regulations aiming at harmonizing public
487 health and biodiversity conservation through designation of Scavenger Feeding Zones (SFZs; positive values). Despite the fact that the law in force
488 in their country allows (tick sign) livestock carcasses to be either collected or left in the field for wildlife, most Spanish farmers used the carcass
489 collection system, showing therefore a large lack of observance of the enforced legislation (yellow tick); even one out of the three Spanish farmers
490 who declared to leave carcasses in the field was not aware of this law allowing him to do it, showing also a lack of observance with the norm.
491 Contrastingly, in Portugal, more than one quarter of the farmers left carcasses in the field without any official supervision, exhibiting noncompliance
492 (wrong sign) with the current national legislation compelling them to bury or collect livestock carcasses (feeding of necrophagous birds is only
493 possible but under very restrictive rules). Enforcement of both, the legislation currently in force in Spain and the last norm providing for the
494 establishment of SFZs in Portugal, will better match farmers' preferences (right panel), reducing the levels of nonobservance and noncompliance
495 with regulations.
496

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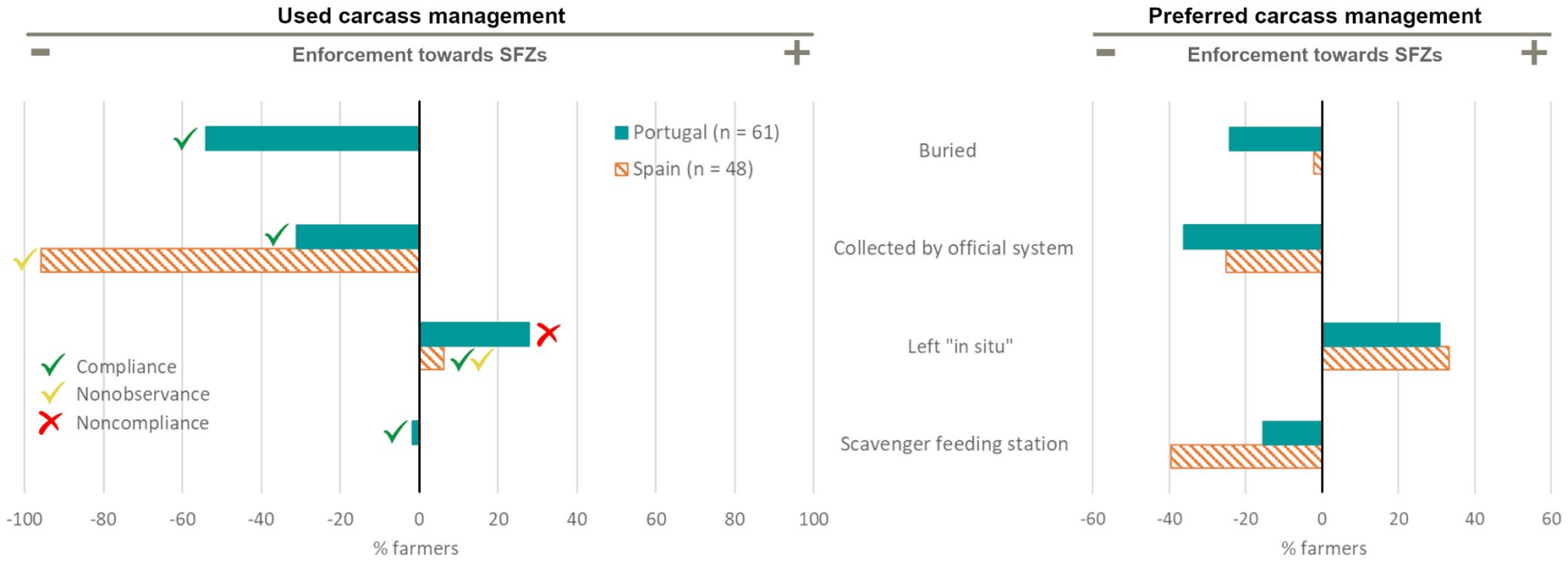

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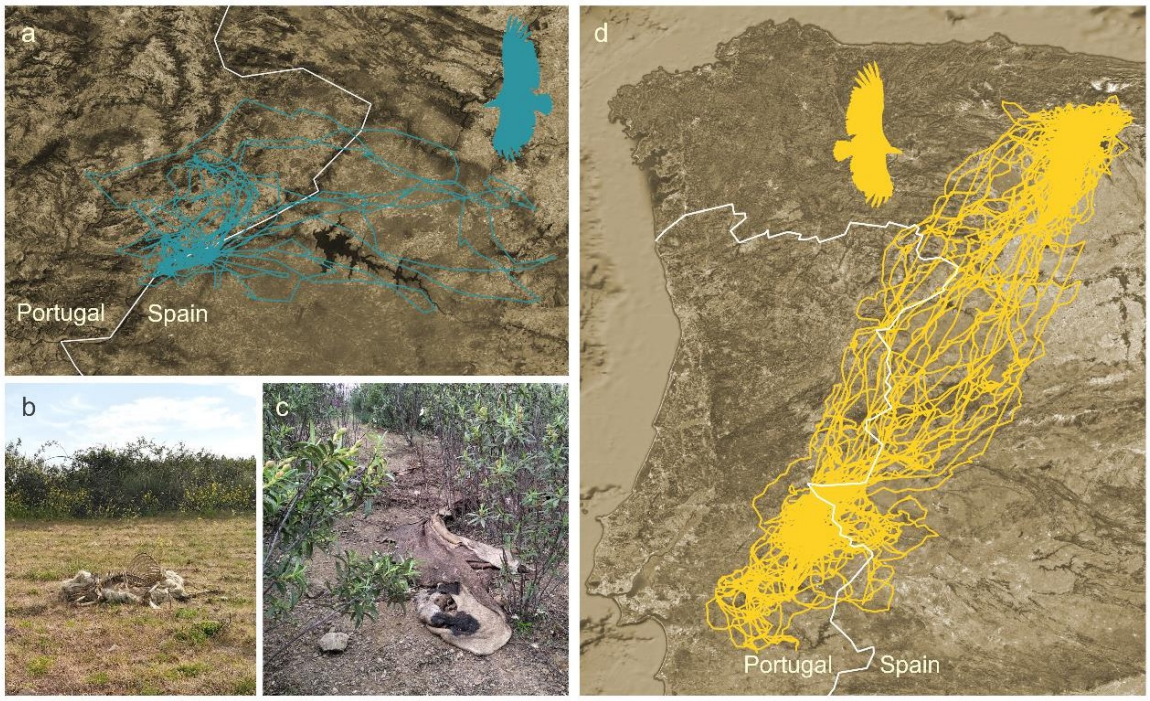
Figure 3a. Griffon vultures tracked with GPS in Spain and Portugal have allowed us to detect livestock carcasses of sheep (**b**) and cow (**c**) available in the Portuguese countryside. **d.** Periodic long-distance movements of one GPS-tracked vulture from northern Spain to central-southern Portugal have been also registered, presumably to feed into areas with extensive livestock, where long stays with on-ground locations have been registered. Photo credits: João P.V. Santos and Iván Gutiérrez.



The continued deficiency in environmental law enforcement illustrated by EU sanitary regulations for scavenger conservation

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The authors declare no conflict of interest.

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Author statement

P.M.T. conceived the initial idea and led the writing. P.M.T. and J.V.L.B. conceptualized the paper. F.D.G, J.P.V.S., P.M.T. and J.V.L.B. did fieldwork. F.D.G. and P.M.T. did the analyses. All authors contributed to the further discussion and writing of the manuscript.

Supplementary material for:

Farmers' perceptions towards scavengers are influenced by implementation deficits of EU sanitary policies

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Appendix S1. Number of livestock units owned by the farmers interviewed at each local entity according to 2018-2019 official censuses (Spanish census: "Datos Abiertos de Castilla y León", 2018; Portuguese census: ADS/OPP personal communication). The numbers in brackets are the percentages from the total censed per major local entity (Portuguese municipality and Spanish province). ADS or "Agrupamentos de Defesa Sanitária" and OPP or "Organizações de Produtores Pecuários" are associations responsible for implementing the animal health surveillance programs approved by the Portuguese National Authority for Animal Health (DGAV – Direção-Geral de Alimentação e Veterinária). The proportion of cattle and sheep breeders did not differ between countries, with significant differences retrieved only for goats (G test = 7.70, P = 0.021). Livestock farmers owning goats were not interviewed in Figueira de Castelo Rodrigo (Portugal) and Salamanca (Spain) because they were out of the study area, developed intensive livestock farming or were not found. Nonetheless, goats in these two regions represented 0.19 % and 0.23 % of the total livestock, respectively.

Portugal

Municipality	Cattle	Sheep	Goats	**Total**
Miranda do Douro	435 (10.4)	1,148 (9.6)	183 (27.7)	1,766 (10.5)
Mogadouro	491 (17.6)	1,527 (15.0)	396 (15.6)	2,414 (15.6)
Freixo de Espada à Cinta	25 (24.8)	915 (34.8)	121 (30.2)	1,061 (33.9)
Figueira de Castelo Rodrigo	200 (7.8)	1,199 (13.3)	0 (0.0)[a]	1,399 (12.0)
Total	1,151 (11.9)	4,789 (14.2)	700 (19.0)	**6,640 (14.1)**

Spain

Province	Cattle	Sheep	Goats	**Total**
Zamora	374 (10.1)	5,457 (8.1)	119 (12.2)	5,950 (8.3)
Salamanca	1,974 (11.3)	5,289 (13.4)	0 (0.0)[a]	7,263 (12.7)
Total	2,348 (11.1)	10,746 (10.1)	119 (9.0)	**13,213 (10.2)**

[a] Not interviews conducted because the farms were intensive, were out of the study area and/or no farmers were found.

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Appendix S2. International, national and subnational regulations enforced regarding the management of livestock carcasses in the study area.

Scope	Legislation	Territory	Main measures
International	Commission Regulation (EC) 1069/2009	European Union	Recognizes the need of integrating biodiversity conservation into sanitary policies, considering *"the natural consumption patterns of the species concerned"* as well as *"community objectives for the promotion of biodiversity, as referred to in the communication entitled 'Halting the loss of biodiversity by 2010 – and beyond' from the Commission of 22 May 2006".*
	Commission Regulation (EU) 142/2011		Provides guidance for implementing Commission Regulation (EC) 1069/2009. Accordingly, carcasses of extensive livestock can be left uncollected in concrete areas designated by the competent authorities, i.e. Scavenger Feeding Zones (SFZs). Food supply from livestock to up to 51 vertebrate species (including facultative and obligate scavengers) is guaranteed (Mateo-Tomás *et al.,* 2019). It also includes a list of priority countries for implementation, including Spain and Portugal.
National	Royal Decree 1632/2011	Spain	Transposes Commission Regulation (EU) 142/2011 into national legislation, acknowledging the importance of Spain for the conservation of scavengers at European level and promoting the designation of SFZs with special attention to Natura 2000 sites. It tries to homogenize the implementation criteria across Spanish autonomous regions.
Sub-national	Decree 17/2013	Castilla y León (Spain)	Enhances the application of the Royal Decree 1632/2011 and therefore also the application of the Commission Regulation (EU) 142/2011 in the autonomous region of Castilla y León. It also establishes the assumptions, conditions and areas for the potential use of extensive livestock carcasses for the feeding scavengers.
National	Decree-Law 33/2017	Portugal	Ensures enforcement and compliance with Commission Regulations (EC) 1069/2009 and (EU) 142/2011. It establishes the rules of funding and functioning of the Portuguese livestock carcass collection system, i.e. *Sistema de Recolha de Cadáveres de Animais Mortos na Exploração* (SIRCA). It also refers to the possibility of establishing 'remote areas' where the burial or burning of animal by-products (including livestock carcasses) can be allowed, as well as other forms of carcass disposal upon approval of a plan by the competent authorities and in accordance with the rules laid down in EU regulations.
	Despacho 3844/2017		Establishes and lists 'remote areas' where the burial of livestock carcasses and other forms of carcass disposal are allowed under supervision. It also states that *"[…] the feeding of avian scavengers using animal by-products is allowed if the rules and procedures established regarding the feeding of necrophagous birds and other species living in their natural habitat are followed […]"*, thus opening a window for designating Scavenger Feeding Zones (SFZs). The conditions and procedures for feeding avian scavengers inside and outside feeding stations were subsequently published in official guidelines (DGAV, 2018; updated in 2019).
	Despacho 7148/2019*		Approves the Portuguese Action Plan for the Conservation of Necrophagous Birds. Based on the changes made in the Despacho No 3844/2017 regarding the non-removal of extensive livestock carcasses in 'remote areas', which can be used in benefit of the conservation of avian scavengers, it contemplates the implementation of SFZs.

*The Portuguese Despacho 7148/2019 had not yet been published when the interviews for this study were conducted.

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Appendix S3. Population estimates in the study area of the scavenging species considered in this study. Protection status according to the national legislation in Portugal and Spain and national and global conservation status according to IUCN criteria are also shown. [a]Join number of breeding pairs at both sides of the border (only data from complete bird censuses are shown; no data available for red kite in Portugal). [b]Unknown population estimates but common species in the study area. [c]Estimated number of wolf packs at both sides of the border, four in Portugal and one in Spain. [d]Join number of wintering animals at both sides of the border; wintering red kites in Portugal, i.e. 115, correspond to the total figures in Guarda and Bragança districts, including, but not only, our study area (Alonso et al., 2019). [e]In Portugal, the wolf is strictly protected through European (EU Habitats Directive) and national Law 90/88, 13th August, and Decree-Law 54/2016, 25th August.

Species	**Population in the study area**	**Portugal**		**Spain**		**IUCN global category** (IUCN, 2020)
		Protection status (Decree-Law 140/99)	**IUCN national category** (Cabral et al., 2005)	**Protection status** (Royal Decree 139/2011)	**IUCN national category** (Madroño et al., 2004; Palomo et al., 2007)	
Griffon vulture *(Gyps fulvus)*	1,676[a]	Protected	Near Threatened	Special Protection	Not evaluated	Least Concern
Cinereous vulture *(Aegypius monachus)*	2[a]	Priority species	Critically Endangered	Vulnerable	Vulnerable	Near Threatened
Egyptian vulture *(Neophron percnopterus)*	118-123[a]	Protected	Endangered	Vulnerable	Vulnerable	Endangered
Red fox *(Vulpes vulpes)*	Unknown[b]	Not listed	Least Concern	Not listed	Least Concern	Least Concern
Wolf *(Canis lupus)*	5[c]	Strictly protected[e]	Endangered	Not listed*	Near Threatened	Least Concern
Wild boar *(Sus scrofa)*	Unknown[b]	Not listed	Least Concern	Not listed	Least Concern	Least Concern
Golden eagle *(Aquila chrysaetos)*	28-30[a]	Protected	Endangered	Special Protection	Near Threatened	Least Concern
Red kite *(Milvus milvus)*	102[a] / 467[d]	Protected	Critically Endangered (breeding) / Vulnerable (wintering)	Endangered	Endangered	Near threatened
Common raven *(Corvus corax)*	Unknown[b]	Not listed	Near Threatened	Not listed	Not Evaluated	Least Concern
Beech marten *(Martes foina)*	Unknown[b]	Not listed	Least Concern	Not listed	Least Concern	Least Concern

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Appendix S4. Response and explanatory variables considered in order to assess the main factors affecting farmers' perceptions towards scavengers in the cross-border region of the Douro/Duero River Valley (northwestern Iberian Peninsula).

Response variables

Variable	Description
Species	Individual farmers' perception, on a Likert scale from 'very harmful' (1) to 'very beneficial' (5), of each one of the vertebrate scavenger species considered, i.e. griffon, Egyptian and cinereous vultures, red kite, common raven, red fox, wild boar, beech marten, golden eagle and wolf.
Scavengers	Averaged farmers' perception of all the species together, excluding those correctly identified by <15% of the interviewed farmers in each country (i.e. red kite and beech marten).
Vultures	Averaged farmers' perception of the three vulture species, i.e. griffon, Egyptian and cinereous vultures.
Generalists	Averaged farmers' perception of the generalist species, i.e. common raven, red fox and wild boar.

Explanatory variables

Variable	Description	Main hypothesis
Country	Spain / Portugal	Uneven implementation of EU regulations on carcass disposal between Spain and Portugal can result in different perceptions towards scavengers. Although societies in this transboundary area share many cultural and ecological characteristics, social and cultural differences among countries could result also in different perceptions.
Regulation knowledge and compliance		
Legislation knowledge	Yes (1) / No (0)	Legislation knowledge and/or compliance can trigger positive perceptions of farmers towards scavengers where carcass disposal for feeding wildlife is allowed, e.g. in Spain, where SFZs are designated since 2013, with the opposite occurring in Portugal, with SFZs still under way.
Legislation use	Yes (1) / No (0)	
Carcass management		
Carcass management method used	Carcass management method used by farmers: (1) Leaving *in situ* / (2) Scavenger feeding station / (3) Burial / (4) Carcass collection / (5) Mixed methods	Carcass management methods can trigger positive perceptions of farmers towards scavengers where carcass disposal for feeding wildlife is allowed. Since the method allowed for carcass disposal is determined by the enforced legislation, these variables also allow us to ascertain the potential effect of the uneven implementation of sanitary regulations on farmers' perceptions towards scavengers.
Carcass management method preferred	Carcass management method that farmers would prefer to use: (1) Leaving *in situ* / (2) Scavenger feeding station / (3) Burial / (4) Carcass collection / (5) Mixed methods	
Coincidence carcass management method used and preferred	Yes (1) / No (0)	
Carcass management value	From (1) Very unsuitable to (5) Very suitable	
Farmer characteristics		
Age	Age of the farmer	Factors like age, sex and/or educational level has been previously related to difference valuation of scavengers and the ecosystem services they provide (Morales-Reyes et al., 2018).
Gender	Male (0) / Female (1)	
Studies	No studies (0) / Primary studies (1) / Secondary studies (2) / Baccalaureate (3) / Vocational training (4) / University studies (5)	

Table 1 (cont.)

Main activity	Livestock farming (1) / Other (0)	Farmers dedicated full time to livestock breeding would have a better perception of scavenger species since they are more familiar with the species.
Farm characteristics		
Number of cows	Total number of animals in the farm	Farmers owning a higher number of animals could have a more positive perception of scavengers, since we would expect the harm coming from wildlife attacks to be relatively lower.
Number of sheep		
Number of goats		
Dead Animals	Total number of dead animals in 2018	Higher amounts of dead animals in the farm during a year can lead to more negative perceptions of scavengers (due to their potential role as predators).
Wildlife impacts		
Wildlife attacks	His/her livestock has suffered a wildlife attack in the last year (2018): Yes (1) / No (0)	Higher wildlife impacts on the farms or higher perception of risk (i.e. perceived possibility of suffering wildlife impacts) can lead to more negative perceptions of scavengers (Miller et al., 2016; Kushnir and Packer, 2019)
Vulture attack	His/her livestock has suffered a vulture attack in the last year (2018): Yes (1) / No (0)	
Neighbour wildlife attacks	Neighbors' livestock has suffered a wildlife attack in the last year (2018): Yes (1) / No (0)	
Neighbour vulture attack	Neighbors' livestock has suffered a vulture attack in the last year (2018): Yes (1) / No (0)	
Risk perception	Perceived risk of suffering a wildlife attacks on him/her livestock, from 1 (none) to 10 (maximum)	
Neighbour risk perception	Perceived risk of his/her neighbors suffering a wildlife attacks on their livestock, from 1 (none) to 10 (maximum)	
Wildlife as problem	Wildlife is considered among the three major issues of the farm: Yes (1) / No (0)	
Vulture as harmful	Vultures are considered among the three most harmful species for the farm: Yes (1) / No (0)	

Appendix S5. Results of univariate Cumulative Link Mixed Models (CLMMs) showing significant differences in farmers' perceptions towards all scavengers, vultures, and generalists' groups between countries (i.e. Spain and Portugal) in the transboundary study area. At species level, significant differences were recorded for the griffon and cinereous vultures, the wild boar and the common raven. Major local entities (i.e. Portuguese municipalities and Spanish provinces) were considered as random factor in all the models, except for the wild boar for which minor local entities nested within major local entities gave the best adjustment. *Spain as reference level. **Mean farmers' valuation on a 1 to 5 Likert scale. See Appendix S6 for the remaining results.

Do farmers' perceptions towards scavengers differ between Spain and Portugal? YES						
Response variable	Country*	Mean**	Estimate*	Std. Error	z value	*P*
All Scavengers	Portugal Spain	3 (2.84) 2 (2.25)	2.520	0.463	5.444	**< 0.001**
Vultures	Portugal Spain	4 (3.96) 3 (2.66)	2.524	0.751	3.358	**< 0.001**
Generalists	Portugal Spain	3 (2.84) 2 (2.17)	2.796	0.934	2.994	**0.003**
Species level						
Griffon vulture *(Gyps fulvus)*	Portugal Spain	4 (4.04) 3 (2.64)	2.465	0.748	3.297	**< 0.001**
Cinereous vulture *(Aegypius monachus)*	Portugal Spain	4 (4.40) 3 (3.21)	2.852	1.210	2.358	**0.018**
Wild boar *(Sus scrofa)*	Portugal Spain	3 (2.69) 2 (1.83)	2.310	0.426	5.399	**< 0.001**
Common raven *(Corvus corax)*	Portugal Spain	3 (3.04) 3 (2.57)	2.444	0.845	2.892	**0.004**

Appendix S6. CLMMs obtained to explain farmers' perceptions of scavengers that were not included in the text and/or main figures because they are less relevant and/or are not significant.

Do farmers' perceptions towards scavengers differ between Spain and Portugal? NO, for the following species. See Table 2 for the species showing significant differences.

Response variable	Country	Mean	Estimate	Std. Error	z value	*P*
Species level						
Egyptian vulture (*Neophron percnopterus*)	Portugal	4 (3.58)	1.481	0.890	1.665	0.096
	Spain	3 (3.04)				
Wolf (*Canis lupus*)	Portugal	1 (1.54)	0.522	0.522	1.000	0.317
	Spain	1 (1.38)				
Red fox (*Vulpes vulpes*)	Portugal	3 (2.62)	1.013	0.571	1.773	0.076
	Spain	2 (2.25)				

[a]NA: *Aquila chrysaetos* model did not properly adjust.

Do Portuguese and Spanish farmers perceive differently wildlife in general and vultures in particular as problematic for livestock farming? YES

Response variable	Country	Mean	Estimate	Std. Error	z value	*P*
Wildlife as problem	Portugal	0.05	-2.184	0.909	-2.402	**0.016**
	Spain	0.27				
Vulture as harmful	Portugal	0.07	-2.075	0.723	-2.868	**0.004**
	Spain	0.40				

Does the knowledge or compliance with the regulations affect farmers' perceptions of scavengers? NO

Response variable	Explanatory variable	Estimate	Std. Error	z value	*P*
Grouping variables					
Generalists	Legislation Knowledge	0.054	0.707	0.077	0.939
	Country	2.801	0.951	2.952	**0.003**
	Legislation Use	-0.486	1.158	-0.419	0.675
	Country	2.765	0.916	3.017	**0.002**
Species level					
Egyptian vulture	Legislation Knowledge	-0.917	0.902	-1.016	0.310
	Country	1.376	0.943	1.459	0.144
	Legislation Use	0.140	1.374	1.102	0.919
	Country	1.505	0.923	1.630	0.103
Wild boar	Legislation Knowledge	-1.395	0.668	-2.090	**0.036**
	Country	2.490	0.589	4.230	**< 0.001**
	Legislation Use	-2.153	1.394	-1.545	0.122
	Country	2.540	0.590	4.302	**< 0.001**
Wolf	Legislation Knowledge	1.265	0.719	1.7597	0.078
	Country	0.768	0.584	1.314	0.189
	Legislation Use	1.148	1.411	0.814	0.416
	Country	0.584	0.526	1.109	0.267
Red fox	Legislation Knowledge	0.070	0.667	0.106	0.915
	Country	1.024	0.587	1.745	0.081
	Legislation Use	0.249	1.102	0.226	0.821
	Country	1.028	0.586	1.752	0.080
Common raven	Legislation Knowledge	0.217	0.847	0.256	0.798
	Country	2.482	0.866	2.866	**0.004**

Does the coincidence between the preferred and the used carcass management method affect farmers' perceptions of scavengers? NO

Response variable	Explanatory variable	Estimate	Std. Error	z value	*P*
Grouping variables					
All Scavengers	Coincidence	0.294	0.209	1.406	0.160
	Country	2.590	0.477	5.424	**< 0.001**
Vultures	Coincidence	0.130	0.168	0.775	0.438
	Country	0.507	0.729	3.441	**< 0.001**
Generalists	Coincidence	0.196	0.208	0.943	0.346
	Country	3.004	1.128	2.662	**0.008**
Species level					
Griffon vulture	Coincidence	0.118	0.169	0.696	0.486
	Country	2.443	0.736	3.319	**< 0.001**
Cinereous vulture	Coincidence	0.153	0.426	0.360	0.719
	Country	2.801	1.153	2.429	0.015
Egyptian vulture	Coincidence	0.195	0.235	0.830	0.407
	Country	1.504	0.895	1.681	0.093
Wild boar	Coincidence	0.093	0.183	0.511	0.609
	Country	2.295	0.429	5.355	**< 0.001**
Wolf	Coincidence	-0.123	0.183	-0.721	0.471
	Country	0.535	0.520	1.030	0.303
Red fox	Coincidence	0.008	0.176	0.045	0.964
	Country	0.995	0.595	1.670	0.095
Common raven	Coincidence	0.305	0.260	1.175	0.240
	Country	2.492	0.885	2.815	**0.005**

Do the values farmers give to the carcass management method used affect farmers' perceptions of scavengers? NO

Response variable	Explanatory variable	Estimate	Std. Error	z value	*P*
Grouping variables					
All Scavengers	Carcass Management Value	0.325	0.474	0.686	0.493
	Country	2.518	0.474	5.312	**< 0.001**
Vultures	Carcass Management Value	0.379	0.389	0.972	0.331
	Country	2.382	0.670	3.555	**< 0.001**
Generalists	Carcass Management Value	-0.180	0.472	-0.382	0.703
	Country	2.940	1.054	2.789	**0.005**
Species level					
Griffon vulture	Carcass Management Value	0.375	0.393	0.956	0.339
	Country	2.314	0.678	3.413	**< 0.001**
Cinereous vulture	Carcass Management Value	-0.728	0.947	-0.768	0.442
	Country	3.134	1.477	2.124	**0.034**
Egyptian vulture	Carcass Management Value	-0.017	0.648	-0.026	0.979
	Country	1.481	0.889	1.666	0.096
Wild boar	Carcass Management Value	0.325	0.459	0.707	0.479
	Country	2.266	0.468	4.842	**< 0.001**
Wolf	Carcass Management Value	-0.249	0.445	-0.559	0.576
	Country	0.606	0.440	1.376	0.169
Red fox	Carcass Management Value	-0.410	0.405	-1.012	0.312
	Country	1.031	0.570	1.810	0.070
Common raven	Carcass Management Value	-0.403	0.568	-0.710	0.478
	Country	2.894	0.971	2.982	**0.003**

Are there other factors significantly affecting farmers' perceptions of scavengers? YES

Response variable	Explanatory variable	Estimate	Std. Error	z value	*P*
Grouping variables					
Generalists	Dead Animals	-0.021	0.010	-2.158	**0.031**
	Country	2.638	1.123	2.348	**0.020**
Species level					
Cinereous vulture	Dead Animals	-0.021	0.010	-2.158	**0.031**
	Country	2.638	1.123	2.348	**0.020**
	Neighbour vulture attack	-2.694	1.296	-2.078	**0.038**
	Country	1.842	1.032	1.784	0.074
Wolf	Age	- 0.034	0.017	-1.965	**0.049**
	Country	0.651	0.547	1.190	0.234
	Studies	0.324	0.146	2.214	**0.027**
	Country	0.547	0.576	0.951	0.342
	Risk perception	-0.318	0.100	-3.175	**0.001**
	Country	-0.589	0.727	-0.810	0.418
Common raven	Number of sheep	-0.004	0.002	-2.394	**0.017**
	Country	1.618	0.804	2.012	**0.044**

Appendix S7. Test of differences in perceptions of scavengers, vultures and griffon vulture between major local entities (i.e. Portuguese municipalities and Spanish provinces), and veterinary associations. Note that the level of reference against which comparing the rest of levels (i.e. administrative and veterinary units) was changed to show the maximum number of comparisons possible among them.

Are differences of farmers' perceptions of scavengers between Portugal and Spain consistent when comparisons are made between administrative units? YES

Variable	Estimate	Std. Error	z value	*P*
Veterinary associations (ADS)				
Bermillo de Sayago as reference level				
Lumbrales	-0.080	1.195	-0.067	0.946
Vitigudino	0.211	0.736	0.287	0.774
Mogadouro	3.258	0.829	3.930	**< 0.001**
Torre de Moncorvo	2.813	1.126	2.498	**0.012**
Almeida	3.082	1.043	2.956	**0.003**
Miranda do Douro	1.692	0.794	2.132	**0.033**
Lumbrales as reference level				
Vitigudino	0.291	1.114	0.261	0.794
Mogadouro	3.338	1.178	2.834	**0.004**
Torre de Moncorvo	2.893	1.402	2.063	**0.039**
Almeida	3.162	1.337	2.366	**0.018**
Miranda do Douro	1.772	1.153	1.537	0.124
Vitigudino as reference level				
Mogadouro	3.047	0.703	4.335	**< 0.001**
Torre de Moncorvo	2.602	1.037	2.510	**0.012**
Almeida	2.871	0.945	3.037	**0.002**
Miranda do Douro	1.481	0.661	2.241	**0.025**
Mogadouro as reference level				
Torre de Moncorvo	-1.390	0.983	-1.414	0.157
Almeida	0.176	0.978	0.180	0.857
Miranda do Douro	-0.269	1.254	-0.215	0.830
Torre de Moncorvo as reference level				
Almeida	0.269	1.254	0.215	0.830
Miranda do Douro	-1.121	1.072	-1.045	0.296
Almeida as reference level				
Miranda do Douro	-1.390	0.983	-1.414	0.157

Cont.				
Major entities				
Miranda do Douro as reference level				
Mogadouro	1.566	0.752	2.082	**0.037**
Freixo de Espada à Cinta	1.121	1.072	1.045	0.296
Figueira de Castelo Rodrigo	1.390	0.983	1.414	0.157
Zamora	-1.692	0.794	-2.132	**0.033**
Salamanca	-1.524	0.642	-2.374	**0.017**
Mogadouro as reference level				
Freixo de Espada à Cinta	-0.445	1.078	-0.413	0.680
Figueira de Castelo Rodrigo	-0.176	0.978	-0.180	0.857
Zamora	-3.257	0.829	-3.929	**< 0.001**
Salamanca	-3.090	0.685	-4.510	**< 0.001**
Freixo de Espada à Cinta as reference level				
Figueira de Castelo Rodrigo	0.269	1.254	0.215	0.830
Zamora	-2.813	1.126	-2.498	**0.012**
Salamanca	-2.645	1.025	-2.582	**0.010**
Figueira de Castelo Rodrigo as reference level				
Zamora	-3.082	1.043	-2.956	**0.003**
Salamanca	-2.914	0.932	-3.126	**0.002**
Zamora as reference level				
Salamanca	0.167	0.718	0.233	0.816

Are differences of farmers' perceptions of vultures between Portugal and Spain consistent when comparisons are made between administrative units? YES				
Variable	Estimate	Std. Error	z value	*P*
Veterinary associations (ADS)				
Bermillo de Sayago as reference level				
Lumbrales	-1.468	1.004	-1.462	0.144
Vitigudino	-1.112	0.608	-1.827	0.068
Mogadouro	1.388	0.584	2.375	**0.017**
Torre de Moncorvo	2.660	0.847	3.140	**0.002**
Almeida	0.717	0.731	0.980	0.327
Miranda do Douro	3.537	0.870	4.067	**< 0.001**
Lumbrales as reference level				
Vitigudino	0.357	0.958	0.373	0.709
Mogadouro	2.857	0.982	2.910	**0.004**
Torre de Moncorvo	4.128	1.162	3.553	**< 0.001**
Almeida	2.185	1.070	2.042	**0.041**
Miranda do Douro	5.005	1.179	4.245	**<0.001**
Vitigudino as reference level				
Mogadouro	2.500	0.565	4.428	**< 0.001**
Torre de Moncorvo	3.771	0.838	4.502	**< 0.001**
Almeida	1.828	0.710	2.579	**0.01**
Miranda do Douro	4.648	0.861	5.340	**< 0.001**
Mogadouro as reference level				
Torre de Moncorvo	1.272	0.762	1.668	0.095
Almeida	-0.672	0.664	-1.012	0.312
Miranda do Douro	2.148	0.782	2.745	**0.006**
Torre de Moncorvo as reference level				
Almeida	-1.943	0.897	-2.167	**0.030**
Miranda do Douro	0.877	0.951	0.921	0.357
Almeida as reference level				
Miranda do Douro	2.820	0.916	3.078	**0.002**
Major entities				
Miranda do Douro as reference level				
Mogadouro	-2.148	0.782	-2.745	**0.006**
Freixo de Espada à Cinta	-0.877	0.951	-0.921	0.357
Figueira de Castelo Rodrigo	-2.819	0.916	-3.077	**0.002**
Zamora	-3.535	0.869	-4.065	**< 0.001**
Salamanca	-4.702	0.850	-5.534	**< 0.001**

Cont.				
Mogadouro as reference level				
Freixo de Espada à Cinta	1.271	0.762	1.667	0.095
Figueira de Castelo Rodrigo	-0.671	0.664	-1.011	0.312
Zamora	-1.387	0.584	-2.374	**0.018**
Salamanca	-2.554	0.547	4.673	**< 0.001**
Freixo de Espada à Cinta as reference level				
Figueira de Castelo Rodrigo	-1.942	0.897	-2.166	**0.030**
Zamora	-2.658	0.847	-3.138	**0.001**
Salamanca	-3.825	0.826	-4.630	**< 0.001**
Salamanca as reference level				
Zamora	1.167	0.590	1.977	0.05
Figueira de Castelo Rodrigo	1.883	0.694	2.712	**0.007**
Zamora as reference level				
Figueira de Castelo Rodrigo	0.716	NaN	NaN	NA

Are differences of farmers' perceptions of the griffon vulture between Portugal and Spain consistent when comparisons are made between administrative units? YES

Variable	Estimate	Std. Error	z value	*P*
Veterinary associations (ADS)				
Bermillo de Sayago a reference level				
Lumbrales	-1.376	0.960	-1.432	0.152
Vitigudino	-1.331	0.611	-2.176	**0.029**
Mogadouro	1.068	0.583	1.833	0.067
Torre de Moncorvo	3.042	0.964	3.156	**0.001**
Almeida	0.769	0.733	1.047	0.294
Miranda do Douro	2.943	0.851	3.457	**< 0.001**
Lumbrales as reference level				
Vitigudino	0.045	0.905	0.050	0.960
Mogadouro	2.444	0.926	2.640	**0.008**
Torre de Moncorvo	4.418	1.210	3.651	**< 0.001**
Almeida	2.145	1.025	2.093	**0.036**
Miranda do Douro	4.319	1.122	3.848	**< 0.001**
Vitigudino as reference level				
Mogadouro	2.399	0.553	4.335	**< 0.001**
Torre de Moncorvo	4.373	0.954	4.585	**< 0.001**
Almeida	2.010	0.707	2.970	**0.003**
Miranda do Douro	4.274	0.840	5.088	**< 0.001**

Cont.

Mogadouro as reference level				
Torre de Moncorvo	1.974	0.896	2.203	**0.027**
Almeida	-0.299	0.658	-0.454	0.649
Miranda do Douro	1.875	0.773	2.426	**0.015**
Torre de Moncorvo as reference level				
Almeida	-2.273	1.003	-2.266	**0.023**
Miranda do Douro	-0.099	1.057	-0.093	0.926
Almeida as reference level				
Miranda do Douro	-2.273	1.003	-2.266	**0.023**

Major entities

Mogadouro as reference level				
Miranda do Douro	1.8875	0.773	2.425	**0.015**
Freixo de Espada à Cinta	1.974	0.896	2.203	**0.027**
Figueira de Castelo Rodrigo	-0.299	0.658	-0.454	0.649
Zamora	-1.068	0.583	-1.833	0.067
Salamanca	-2.406	0.533	-4.513	**< 0.001**
Freixo de Espada à Cinta as reference level				
Miranda do Douro	-0.099	1.058	-0.093	0.926
Figueira de Castelo Rodrigo	-2.273	1.003	-2.266	**0.023**
Zamora	-3.042	0.964	-3.156	**0.001**
Salamanca	-4.380	0.942	-4.647	**< 0.001**
Zamora as reference level				
Figueira de Castelo Rodrigo	0.769	0.733	1.048	0.294
Miranda do Douro	2.943	0.851	3.457	**< 0.001**
Salamanca	-1.338	0.593	-2.257	**0.024**
Salamanca as reference level				
Figueira de Castelo Rodrigo	2.107	0.691	3.048	**0.002**
Miranda do Douro	4.281	0.827	5.175	**< 0.001**
Figueira de Castelo Rodrigo as reference level				
Miranda do Douro	2.174	NaN	NaN	NA