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European Union single species recovery plan for the Western Palearctic population of Bearded Vulture (*Gypaetus barbatus barbatus*)

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European Union single species recovery plan for the Palearctic population of Bearded Vulture (Gypaetus barbatus)

The present action plan was commissioned by the European Commission in the framework of the LIFE EuroSAP Project (LIFE14 PRE/UK/000002) and prepared by the Vulture Conservation Foundation (VCF).

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Lifespan of plan: 2018 - 2028

This plan should be reviewed and updated every ten years. An emergency review will be undertaken if sudden major environmental changes, liable to affect occur within the range of the species.

Milestones in the production of the plan

1st International workshop to update the Bearded Vulture European SAP
23-24 November 2015
1st draft: April 2017

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TABLE OF CONTENT

1. BASIC DATA

• Taxonomy and biogeographic populations

There are two subspecies currently recognized for the species: *Gypaetus barbatus barbatus*, distributed through NW Africa (mostly Morocco and the High Atlas,) and SW Europe (Pyrenees, Corsica) through SE Europe (Balkan region, where it's virtually extinct), Crete, Turkey, the Caucasus, Egypt, Middle East (also in SW Arabia), Iran and Afghanistan to E Kazakhstan, Russian Altai, N & W Mongolia and NW China, Pakistan, the Tibetan Plateau, Himalayas and C China, and in the last decades reintroduced populations in the Alps, S Spain and C France. The second subspecies, *G. b. meridionalis* is more restricted on its distribution, occurring locally in NE & E Africa, E South Africa and Lesotho. Duty

Within Europe, the Bearded Vulture currently breeds in Andorra, Armenia, Austria, Azerbaijan, France, Georgia, Greece (Crete), Italy, Russia (Caucasus), Spain, Switzerland and Turkey. Despite recent increases in the Alpine and the Pyrenean populations, the overall trend in Europe is mostly considered stable, although declining in some important areas such as Turkey. Unfortunately, there's little data available for this country, which most probably still sustains one of the largest populations in Europe. The species has completely disappeared from the Balkan Peninsula since the beginning of the 21st century, when the last pairs disappeared from the region of the Macedonia-Greece, Bulgaria-Greece (2004 in Greece mainland, 2006 Macedonia; Andevski, 2013).

• Principal Range States covered by the Action Plan

Table 1: Range states for the species in the Palearctic region. Countries covered by the Actin Plan in bold

Country	Status	Breeding pairs	Quality	Year(s) of estimate	Breeding Population trend in the last 10 years	Quality
Albania	**extinct**					
Andorra	**breeding**	**1**	**G**	**2016**	**stable**	**G**
Armenia	breeding	11-12	M	2007-2009	stable	M
Austria	**breeding**	**3**	**G**	**2015**	**small increase**	**G**
Azerbaijan	breeding	20-100	P	2000-2016	stable	P
Bosnia and Herzegovina	**extinct**					
Bulgaria	**extinct**	**0**	**G**	**2016**		
Egypt	breeding	2-3	M	2015		
France	**breeding**	**46 (61*)**	**G**	**2016**	**small increase**	**G**
Georgia	breeding	20-25	M	2001-2012	small increase	M
Greece	**breeding**	**6(8*)**	**G**	**2016**	**moderate**	**G**
Iran	breeding		P			
Iraq	breeding	20	M	2013		
Israel	extinct		G	2016		
Italy	**breeding**	**12**	**G**	**2016**	**large increase**	**G**

Jordan	extinct		M	1995		
Kazakhstan	breeding	50-100	M	2012	stable	M
Mongolia	breeding	500-1000	P	2016	small increase	P
Palestine	extinct		P			
Portugal	**extinct**		**G**	**2005**		
Romania	**extinct**					
Russia(Caucasus)	**breeding**	**181-237**	**G**	**2008**	**moderate**	**G**
Russia (Altai-Sayan)	breeding	55-75	G	2016	stable	G
Saudi Arabia	extinct		M	2010		
Syria	extinct		M			
Serbia	**extinct**		**G**	**2016**		
Spain	**breeding**	**115 (137*)**	**G**	**2015**	**moderate**	**G/M**
Switzerland	**breeding**	**14**	**G**	**2016**	**large increase**	**G**
Syrian Arab Republic	extinct		M	2008		
Tajikistan	breeding	100s	P			P
The FYR of Macedonia	extinct		G	2015		
Turkey	**breeding**	**160-200**	**M**	**2013**	**decline**	**M**
Turkmenistan	breeding					
Uzbekistan	breeding	50-70	M	2009	stable	P
Yemen	breeding					

Data missing
Extinct

Q – Data quality (P= poor, M= medium, G= good)
*Territorial pairs

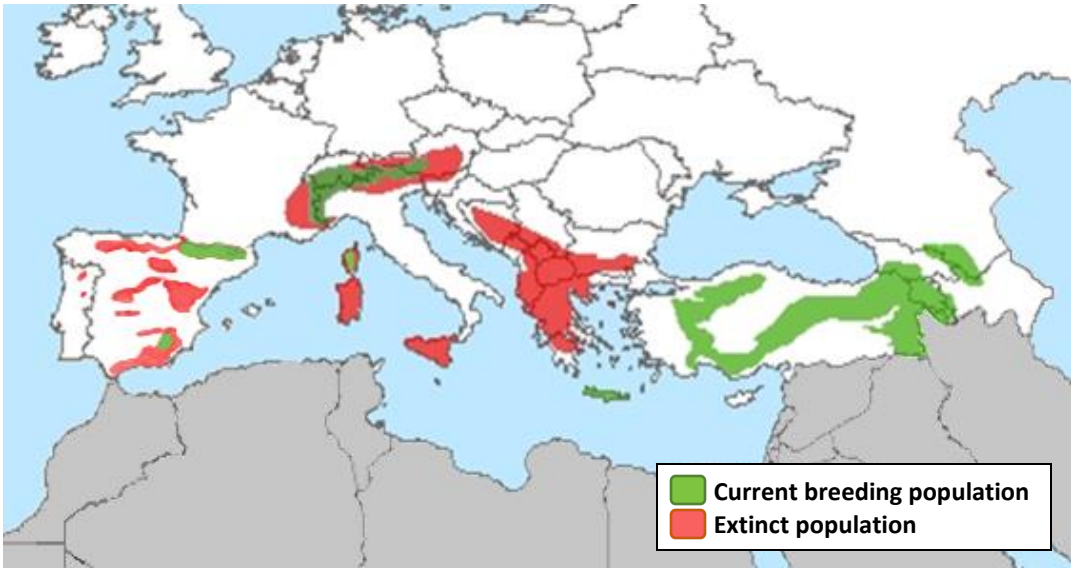


Figure 1: Population of Bearded Vulture in the focal range

- ***Global, Regional and sub-regional Red List status***

Despite the relatively positive trend in Western Europe, Bearded vulture populations in other regions of its distribution range have suffered a dramatic decline, notably in the southern Africa populations (Krüger et al., 2014) and in Nepal (Acharya et al., 2010). Even in some parts of Europe the species is still declining. In Corsica the species decreased from ten territories in 2006 to five in 2014, and from eight laying pairs in 2000 to two in 2015 (Parc Naturel Régional de Corse data) with extremely low breeding success, whereas in Morocco only three pairs seem to survive in the highest reaches of the Atlas (Alfonso Godino pers. comm.). For all these reasons, the species was uplisted from Least Concern to Near Threatened in the 2014 update of the global IUCN Red List (Birdlife International, 2016).

- ***International legal status***

The species is listed as Vulnerable (SPEC 3) under criteria C1 and C2a(i) in the European IUCN Red List (BirdLife International, 2016), and is listed in Annex I of the EU Council Directive on the Conservation of Wild Birds (79/409/EEC, 'Birds Directive'), in Appendix II of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention), in Appendix II of the CMS and in Appendix II of CITES. The species is legally protected in all European range states covered by the Plan. Besides the European directives, each country has its own national legislation for the protection of the species.

Table 2: International conservation status

IUCN Global Red List	Vulnerable	www.iucnredlist.org (last accessed 8th April 2017)
European Red List	Vulnerable	Under criteria C1 and C2a(i) BirdLife International (2016)

Table 3: International and European protection policy and legislation

Instrument	Relevant section	Reference and notes
Bonn Convention/CMS	Appendix II	http://www.cms.int/en/species/gypaetus-barbatus (last accessed 8th April 2017)
CITES	Appendix II	https://cites.org/eng/app/appendices.php (last accessed 8th April 2017)
Bern Convention	Appendix II	https://www.coe.int/en/web/conventions/full-list/-/conventions/treaty/104 (last accessed 8th April 2017)
EU Birds Directive 79/409/EEC	Annex I	http://ec.europa.eu/environment/nature/conservation/wildbirds/threatened/index_en.htm (last accessed 8th April 2017)

		The Bearded Vulture is listed on Annex I of the EU Birds Directive, including "species in danger of extinction; vulnerable to specific changes in their habitat; considered rare because of small populations or restricted local distribution; requiring particular attention for reasons of the specific nature of habitat".
Commission Regulation (EU) 1320/2014 of 1 December 2014 amending Council Regulation (EC) 338/97 on the protection of species of wild fauna and flora by regulating trade therein	Annex A	http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R1320&from=EN (last accessed 8th April 2017)
Directive 2009/147/EC considered as "Priority for funding under LIFE"	Annex I	http://ec.europa.eu/environment/nature/conservation/wildbirds/action_plans/docs/list_annex1.pdf (last accessed 8th April 2017)

There are other EU policies that indirectly affect Bearded vultures, although they are not specifically aimed at the species, such as the Habitats Directive/Natura 2000, EU Directive 2004/35/EC on Environmental Liability, Common Agricultural Policy, etc.

Table 4: National status according to the National Red List of Endangered Species (2016)

Country/Territory	National Red List status (where known)
Spain	Endangered
France	Vulnerable
Switzerland	Critically Endangered
Italy	Critically Endangered
Austria	Regionally Extinct
Greece	Critically Endangered
Turkey	Data missing
Russia (Caucasus)	Endangered
Andorra	Endangered
Albania	Extinct
Bosnia and Herzegovina	Extinct
Portugal	Extinct
Romania	Extinct
Serbia	Extinct
Bulgaria	Extinct

- ***Implementation of former Action Plan***

The first SAP for the Bearded vulture in Europe (*European Union Species Action Plan for the Lammergeier (Gypaetus barbatus)*) was first published in 1999 and updated in 2001. This SAP was reviewed in 2011 by BirdLife International (Barov & Derhé, 2011) and more recently by the Vulture Conservation Foundation (VCF) as a preliminary stage of the preparatory actions for the current EuroSAP (Izquierdo & Llopis, 2017 in press.).

The progress achieved in the former Action Plan, was calculated using two indexes: National Implementation Score (NIS, see figure 2) to show the advancement on each Member State included in that plan, and Average Implementation Score (AIS, see figure 3) that illustrates the progress of each of the actions defined in the plan. Both indexes range from 1 (little or no implementation) to 4 (full implementation).

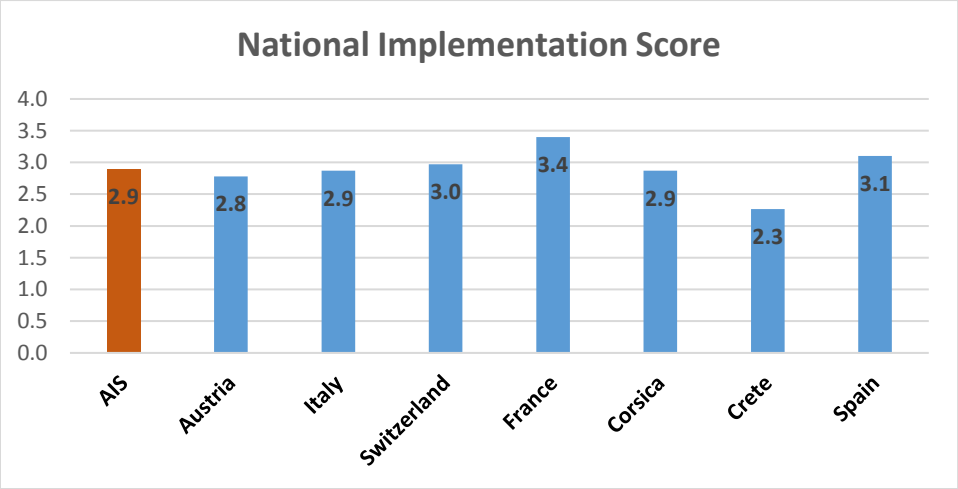


Figure 2: National Implementation Score (NIS) for each Member State, and the overall average score across all States (AIS)

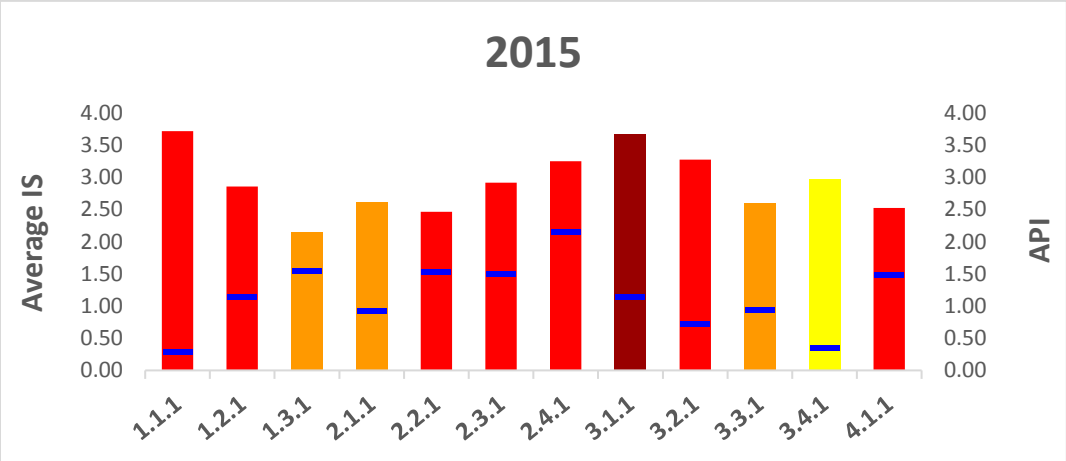


Figure 3: Average Implementation Score (AIS) for each action within the old Action Plan, across all Member States.

The implementation of the Action Plan has improved since 2010's review, from an overall AIS of 2.6 in 2010 to 2.9 in 2015. Out of the 7 EU countries where the species occurs, France and Spain are the countries where more specific actions for the protection and conservation of the species have taken place (National Implementation Score, NIS, of 3.4 and 3.1 respectively, see figure 2). Crete, in Greece, is the country with the lowest score (NIS=2.3) which is nevertheless still relatively adequate in terms of conservation.

2. *FRAMEWORK FOR ACTION*

- ***Goal***

This Action Plan aims to restore the Palearctic subpopulations of Bearded vulture to numbers prior the population crash in the 20th century, and improve its conservation status to the category of Least Concern (lost in 2014) (Birdlife International, 2016).

- ***Purpose***

The Purpose is to increase the population size, viability and breeding range of the species, and connect currently isolated populations into a meta-population. In order to achieve this, the plan's main objectives are:

I. Maintain or increase productivity of breeding populations sufficient to warrant up-listing in the European IUCN Red List,

II. Preserve and protect breeding sites and to manage sufficient habitat to accommodate population growth, and

III. Tackle population threats and decrease mortality throughout the distribution range.

- ***Results and actions***

Threat assessment	Priority	Action timescale
Critical - causing or likely to cause very rapid declines and/or extinction	**Essential**	**Immediate** - to commence within the next year
High - causing or likely to cause rapid decline leading to depletion	**High**	**Short** - to commence within the next 3 years
Medium - causing or likely to cause relatively slow, but significant, declines	**Medium**	**Medium** - to commence within the next 5 years
Low - causing or likely to cause fluctuations or minimal change	**Low**	**Long** - to commence within the next 10 years
Local - causing or likely to cause negligible declines in small parts of the population		**Ongoing** - currently implemented and should continue
Unknown - likely to affect the species, but extent unknown		**Completed** - completed during preparation of the Action Plan

Objective 1: Reduce significantly the mortality of Bearded vultures caused by the unintentional exposition to toxic substances used in the control of predators				
Threat – Illegal poisoning (locally critical)				
Result	**Action**	**Priority**	**Timescale**	**Organisations responsible**
1.1 Improved understanding of the conflict human-predators, detection techniques and regulations	1.1.1 Develop and implement more advanced response protocols and poison detection techniques (e.g. the use of canine units specialized in detection of poisoned baits), both in the fields and in the laboratory.	**Essential**	**Immediate**	NGOs, Universities and research institutions , Government
	1.1.2 Review current legislations for the control and regulation of the possession and usage of toxic substances used illegally against wildlife, increase penalties and update the list of such substances	**Essential**	**Immediate**	NGOs, Government
	1.1.3 Investigate and promote vulture-safe protocols and guidelines for the control of predators and other conflictive vertebrates, as well as traditional practices (e.g. use of guard dogs, shepherds, fences, etc.)	**High**	**Short**	NGOs, Universities, Research Institutions, Government, farmers community
	1.1.4 Review compensation and/or livestock insurance schemes for local communities in response to predation of livestock by wildlife when necessary	**Essential**	**Immediate**	NGOs, Government, farmers community
	1.1.5 Create an international database of all known poisoning cases registered within the EU	**High**	**Ongoing**	NGOs, Government
1.2 Positive public and private sector support against the use of poison	1.2.1 Implement sensitivity campaigns to awake awareness on the impact to non-target species (such as vultures), ineffectiveness of poisoning as a control measure against problematic species, promoting legal alternatives to mitigate conflicts with wildlife, etc.	**Essential**	**Immediate**	NGOs, Government, farmers community, mass media
	1.2.2 Promote campaigns on the positive role of scavengers, potential for eco-tourism, etc.	**Essential**	**Immediate**	NGOs, Government, farmers community, mass media

Objective 2: Develop and Implement policies to ensure the phase-out of lead ammunition throughout the species' distribution range				
Threat – Lead poisoning (High, potentially critical)				
Result	**Action**	**Priority**	**Timescale**	**Organisations responsible**
2.1 Implement mitigation measures to reduce the impact of lead poisoning on vultures	2.1.1 Develop and implement effective saturnism detection and response protocols both in the fields and in the laboratory	**Essential**	**Immediate**	NGOs, Universities, research institutions and Government
	2.1.2 Advocate for adequate policies and legislation to reduce known risks of lead poisoning to humans and wildlife	**Essential**	**Immediate**	NGOs, Government
2.2 Increase public awareness pressure against the use of lead ammunition	2.2.1 Raise awareness among relevant stakeholders (e.g. hunting community), decision makers and general public through public relations campaigns (e.g. the appointment of "champions against lead" in the hunting community)	**High**	**Short**	NGOs, Government, Stakeholders
	2.2.2 Active support of lead-free alternatives using field tests and supportive research, aimed particularly at conservative groups	**High**	**Short**	NGOs, Universities, research institutions, Government, hunting community
	2.2.3 Promote the partial and total ban of lead ammunition, voluntary initially and eventually compulsory, throughout the EU range	**Essential**	**Immediate**	NGOs, Government, hunting community, mass media

Objective 3: To prevent or reduce vulture mortality caused by collisions and electrocution with overhead cables or energy transmission and generation infrastructure				
Threat – Collision against artificial structures (Medium/unknown)				
Result	**Action**	**Priority**	**Timescale**	**Organisations responsible**
3.1 Understand the impact of powerlines and wind turbines on Bearded vulture, including the effect on populations, hotspots and upgraded designs	3.1.1 Conduct surveys and monitoring to determine the impact of collisions with artificial infrastructure in Bearded vulture populations using standardized protocols	**High**	**ongoing**	NGOs, Universities, Research Institutions
	3.1.2 Study the impact of artificial structures in relation to flying patterns and biology of the species, mapping mortality hotspots and how to decrease their effect	**High**	**immediate**	NGOs, Universities, Research Institutions
	3.1.3 Facilitate the exploration of more effective designs (e.g. buried lines), construction and placement sites in collaboration with national and local Electricity distribution companies	**High**	**immediate**	NGOs, Universities, Research Institutions, Government, Private sector
3.2 Ensure the support from public and private sectors in order to promote and adopt vulture-friendly energy infrastructure	3.2.1 Increase collaboration with Public and private sectors for better planning in developing future actions and constructions	**Medium**	**Medium**	NGOs, Government, Private sector
	3.2.2 Promote positive reinforcement and benefits (e.g. improved public image, economic benefits, etc.) for adaptation of old lines	**Medium**	**Medium**	NGOs, Government, Private sector

Objective 4: To decrease the impact of human disturbances and direct persecution, affecting negatively the population (lower productivity and adult mortality)				
Threat – Direct persecution (shooting) and disturbance (Medium)				
Result	**Action**	**Priority**	**Timescale**	**Organisations responsible**
4.1 Decrease occurrence of shooting to be virtually non-existing	4.1.1 Control and/or implement adequate regulations on the use of guns for eradication of wildlife and domestic livestock	**Medium**	**Medium**	NGOs, Government
	4.1.2 Legally prosecute actions like sport killing, specimens collection, and promote the partial and total ban of taxidermy, particularly of endangered species	**High**	**Immediate**	NGOs, Government
4.2 Decrease disturbances to the minimum	4.2.1 Define sensitivity zones near breeding cliffs and establish clear protocols and guidelines for observations (e.g. 800m far on ground, 1km by air)	**High**	**Short**	NGOs, Universities, Government and research institutions
	4.2.2 Control human actions in the area like forestry, controlled fires and infrastructure constructions (roads, dams, etc.)	**High**	**Short**	NGOs, Government
	4.2.3 Control activities in the area (outdoor sports, photography, birding, group hunting, etc.) and the presence of flying artefacts (military, hobby)	**High**	**Short**	NGOs, Government
4.3 Increase legislative and public awareness pressure for hunting and disturbance	4.3.1 Develop better legislations, and improve capacities and enforcement to meet existing ones to improve security around breeding sites and increase protected areas	**Essential**	**Immediate**	NGOs, Government
	4.3.2 Increase education and public awareness campaigns on the matter (both hunting and disturbance)	**High**	**Short**	NGOs, Government, hunting community, mass media

Objective 5: Guarantee the long-term provision of sufficient food resources to maintain and increase a sustainable population of Bearded vultures through specific actions				
Threat – Lack of freely-available food and use of inappropriate feeding practices (medium / locally high)				
Result	**Action**	**Priority**	**Timescale**	**Organisations responsible**
5.1 Reverse the decline of freely-available grazing species (livestock and wild ungulates)	5.1.1 Undertake specific reinforcement and reintroduction strategies for wild ungulates following IUCN criteria where needed	**Medium**	**Medium**	NGOs, Universities and research institutions, Government
	5.1.2 Review hunting management policies to ensure sustainable harvest and avoid overhunting of wild species	**Low**	**Long**	NGOs, Government, hunting community
	5.1.3 Provide EU support for extensive farming and traditional activities to ensure sufficient food where wild ungulates are scarce, and avoid reforestation and loss of mountain pastures	**High**	**short**	NGOs, Government, farmers community
	5.1.4 Monitor and counteract the outbreak of diseases transmitted between wild and domestic ungulate species	**Medium**	**Medium**	NGOs, Universities and research institutions, veterinary authorities
5.2 Improve practices in the management of available carcasses	5.2.1 Promote collaboration with farmers and authorities to emphasize the economic benefits of vultures in free waste disposal	**High**	**Short**	NGOs, Government, farmers community
	5.2.2 Apply or develop vulture-friendly regulations on carcass disposal considering health risks (e.g. food without pesticides and NSAIDs)	**Medium**	**Ongoing**	NGOs, Government, veterinary authorities
	5.2.3 Promote carcass disposal practices suitable for the biology of the species (e.g. avoid gathering of food, support that dead stock is left on spot for vultures, etc.)	**High**	**Medium**	NGOs, Universities and research institutions
5.3 Optimize the use of feeding practices for increased survival and sustainability of Bearded vulture populations	5.3.1 Improve communication, collaboration and capacity building among organizations to optimize feeding practices	**Medium**	**Medium**	NGOs, Government, farmers community
	5.3.2 Develop clear goals and science-based guidance and methods to support any feeding strategies (unless necessary, in principle such practices should be aimed at emulating time and spatial unpredictability to avoid dependence on feeding sites)	**Medium**	**Short**	NGOs, Universities and research institutions, Government

	5.3.3 When planning, clearly discriminate between feeding sites for carcass disposal (low cost, sustainable) and circumstantial support feeding sites (high cost), and ensure sufficient funds for the second type for 5-10 years	**High**	**Short**	NGOs, Government
	5.3.4 Research the potentially negative effects of large systematic feeding sites in Bearded vulture populations (e.g. density-dependent low productivity, intraspecific competition, lower dispersion etc.)	**Medium**	**Ongoing**	NGOs, Universities and research institutions

Objective 6: Understand and decrease the potential mortality caused by NSAIDs on Bearded vulture populations				
Threat – NSAIDS (Unknown)				
Result	**Action**	**Priority**	**Timescale**	**Organisations responsible**
6.1 Attain adequate knowledge on the potential impact of NSAIDs on wild Bearded vulture populations	6.1.1 Create a list of available NSAIDs, in the EU market, and the local and national legislations on distribution and usage	**Medium**	**Short**	NGOs, veterinary authorities, Government
	6.1.2 Research the potential exposure risk, availability and toxicity of veterinary products	**Medium**	**Medium**	NGOs, Universities and research institutions, veterinary authorities
6.2 Increase legislative and public awareness and pressure for sensitive and vulture-friendly usage of NSAIDs	6.2.1 Advocate for adequate policies and legislation to reduce known risks of NSAIDs for wildlife	**High**	**Short**	NGOs, Government
	6.2.2 Increase awareness of the dangers of illegal and inadequate use of NSAIDs on life-stock treatment	**High**	**Medium**	NGOs, veterinary authorities, farmers community
	6.2.3 Ban the use of vet diclofenac for the treatment of livestock and substitute it with readily available safe alternatives (e.g. meloxicam) throughout the EU range	**Essential**	**Immediate**	NGOs, Government, veterinary authorities

Objective 7: Recover and increase genetic diversity in both reintroduced and remaining populations, and facilitate connectivity among populations to create a Pan-European meta-population				
Threat – Low genetic diversity (unknown/locally critical)				
Result	**Action**	**Priority**	**Timescale**	**Organisations responsible**
7.1 Increase and retain genetic diversity and decrease subsequent population risks (e.g. inbreeding depression, low adaptability, vulnerability, etc.)	7.1.1 Exercise an strict control over pairings in the breeding stock to avoid founder effect and inbreeding in reintroduced populations	**High**	**Ongoing**	EEP, NGOs, Universities and research institutions Government
	7.1.2 Create a captive genetic reservoir including uncommon genetic lines in the breeding network from unrecoverable wild individuals	**High**	**Ongoing**	EEP, Universities and research institutions
	7.1.3 Increase heterozygosity in reintroduced populations by releasing individuals with underrepresented genotypes in “safe zones” (with lower mortality)	**Medium**	**Ongoing**	EEP, Universities and research institutions, NGOs, Government
7.2 Facilitate connectivity among populations	7.2.1 Monitor and study dispersion patterns to develop adequate strategies	**Medium**	**Ongoing**	NGOs, Universities and research institutions, Government
	7.2.2 Establish new Bearded vultures release sites in between extant populations to facilitate exchange of individuals	**Medium**	**Ongoing**	NGOs, Universities and research institutions, Government
	7.2.3 Ensure the existence of safe habitat corridors in between populations	**High**	**Medium**	NGOs, Universities and research institutions, Government

3. *ANNEX 1 - BIOLOGICAL ASSESSMENT*

• Distribution throughout the annual cycle

The species is listed as non-migratory in most of its distribution range, and resident all year round once they establish their territory when they reach the sub-adult or adult stage (4-6 years). However, there are evidences of vertical seasonal movements suggesting that Bearded vultures stay at higher altitudes during warmer months, and descend to lower elevations when snow covers higher grounds (Bogliani et al., 2011). This pattern corresponded to the seasonal movements of alpine ungulates (ibex *Capra ibex* and chamois *Rupicapra rupicapra*).

• Habitat requirements

Bearded vultures are long-lived scavengers which specialize in the consumption of bones of medium-sized wild and domestic ungulates (Ferguson-Lees & Christie, 2001). These large vultures are sparsely distributed across mountain ranges inhabiting areas with low forest cover, steep cliffs and low human presence (Hiraldo et al., 1979; Donázar et al., 1993; Margalida et al., 2008). They usually live near plateaus and high alpine pastures, with healthy populations of ungulates (mostly ibex and sheep, secondarily chamois) and predators where they can find the bones left after the flesh has been consumed by other scavengers. Bearded Vultures prefer ridge tops and higher slopes, but unlike other large scavenger, this species flies predominantly (over 62% of the time) less than 100 m above ground level (Rushworth & Krüger, 2013). Several studies across the distribution range of the species have shown that habitat selection varies with age (González et al., 2006; Morrison & Wood, 2009; Krüger et al., 2014b; Milanesi et al., 2016); immature individuals are less selective with their habitat requirements during the dispersal phase (also referred to as prospecting phase) and select their habitat based on feeding requirements. This changes when they reach maturity (sub-adult and adult) and enter the settling phase, when they choose their territory based on nesting sites availability, suitable topography for their *ossuaries* (bone-breaking sites) and/or thermal conditions. All these characteristics make limestone ranges the most suitable geologic formations for the species (Hirzel et al., 2004). Bearded vultures are highly mobile during the juvenile dispersal phase, particularly the 1st and 2nd calendar year, decreasing up to the 4th year when they enter the sub-adult stage.

• Survival and productivity

In long-lived species, population growth is highly sensitive to variations in the survival rate of adults (Lebreton & Clobert 1991). This is the case of Bearded vulture populations (Bustamante, 1998; Bretagnolle et al. 2004; Schaub et al., 2009). Schaub et al. (2009) studied the survival probabilities of free-ranging Bearded vultures in the Alpine reintroduced population and found out that the probability of mortality is slightly higher within the first year (12%) than thereafter (4%). Likewise, Brown (1990) studied the survival rate of Bearded vultures in South Africa and though he found similar probabilities for adults birds, his

estimates of mortality for immature birds up to 4 years was significantly higher (up to 40%). Both studies agree the small sample size and the difficulty of properly monitoring survival of all age classes make their estimations incomplete. Currently, there's a new revision of Schaub's work on Bearded vulture survival nearly completed to be published by the end of 2017 or 2018 (VCF data).

Bearded vultures are classic k- selected species, and thus display belated maturity and age of first reproduction, extensive parental investment, low prolificacy, low mortality rate, and a high offspring survival rate (Ferguson-Lees & Christie, 2001; Margalida & Heredia, 2005; Antor et al., 2007; Oro et al., 2008; Schaub et al., 2009; etc.). Antor et al. (2007) and afterwards López-López et al. (2017) studied the age of first breeding, natal dispersal and philopatry among other parameters for the Pyrenean population. In their work they determined that Bearded vultures first settle at the age of 6.5 ± 1.62 years (Antor et al., 2007) and 7.6 ± 3.0 (López-López et al., 2017), although there are recorded cases of individuals in other populations (such as the reintroduced population in Andalusia) that settled down earlier on, at 4 years of age (Gypaetus Foundation pers. comm.). In terms of age of first breeding attempt, Antor et al. (2007) assessed that Bearded vultures start breeding at an average of 8.1 ± 1.79 years, and produce their first chick at 11.4 ± 3.91, whereas López-López et al. (2017) estimated that they would start breeding later on at 10.0 ± 3.1, but produce their first successful offspring earlier on at 10.4 ± 2.2. Although López-López et al. (2017) propose their prediction is more accurate given their larger sample size, the overall increase in most parameters might be a consequence of the habitat saturation that affects the Pyrenean population in some areas.

This species presents one of the longest breeding cycles known in raptors, lasting up to 6 months a year (Margalida et al., 2003). Clutch size varies between 1-2 eggs laid in a single clutch (Brown, 1990; Barrau et al., 1997). Despite producing up to two eggs naturally only one chick survives from an early stage; obligatory siblicide (known as *cainism*) is suspected, although it isn't yet clear whether sibling mortality could be due to indirect starvation or aggression (Thaler & Pechlaner 1980, Margalida et al., 2004). Productivity in central Europe varies among populations, ranging from 0.58 in the Alps (increasing), 0.33 in the Pyrenees (slowly decreasing), to the alarming current 0.0 in Corsica. Low genetic variability and inbreeding (the mean number of alleles per locus is much lower than in larger historic and recent populations, and also than in other island populations like the historic Sardinian or the recent Crete population). Decreased productivity can be due to disturbance and eventually mortality due to anthropomorphic reasons (shooting, poison, lead intoxication, etc.), lack of food resources, and stochastic demographic events due to very low number of individuals.

- **Population size and trend**

The global population of Bearded Vultures is estimated to number between 2000 – 10000 individuals (BirdLife International, 2016), 65% of which (~1300 – 6700) are of mature age. Only in the Western Palearctic region were the population size has been more thoroughly assessed, the number of breeding pairs ranges from 591 – 774 (excluding non-breeding

territorial pairs). The European population (207 pairs) is intensively monitored and several actions have been undertaken to conserve and increase the numbers. There is little information about the populations in the Caucasus and Turkey, although it is still considered these regions sustain about half of the Western Palearctic breeding pairs.

- **Main population threats**

Anthropogenic factors are the prime reason that lead to the current endangered status of Bearded vulture populations (Arroyo & Razin, 2006). The main causes of mortality affecting the species in Europe vary significantly among countries, as a result of the diverse socio-economic circumstances across the region. Nevertheless, the most significant threat throughout the Western Palearctic range is still poisoning, both directed and undirected, that has even increased in some areas such as the Iberian Peninsula (Margalida, 2008), in response to the increase of other scavenger species and their conflict with farmers and other residents affected by them. Another significant yet underestimated threat for the species is saturnism (lead poisoning) that can be a major hindrance against the viability of reintroduced vulture species (Fry et al., 2009), and affects the population in all levels, from productivity to adult survival. Direct persecution (shooting) and disturbance are also major threats; whereas shooting was one of the main causes that lead to the decline and extinction of the species in several areas, it has decreased since. Disturbance, on the other hand, is on the rise as a result of the improvement of accessibility and usage of mountain sites. Habitat degradation, food availability and changes in livestock-rearing practices are also affecting the species in some areas, such as Turkey or the Caucasus. In the last decade, new threats have emerged such as the collision with powerlines, already a significant cause of mortality in some areas such as the Alpine range, and wind turbines, which hasn't yet been documented as lethal for Bearded Vultures but has a high impact in other large scavengers such as Griffon Vultures (*Gyps fulvus*) (A. Camiña pers. comm.). Small isolated populations like the island sub-populations of Corsica and Crete are vulnerable to problems derived from genetic isolation (low genetic variability) and stochastic demographic events as a consequence of the low number of individuals (Seguin et al., 2010). The use of veterinary drugs in domestic cattle also affects the population of Bearded vultures (Blanco & Lemus, 2010), and just recently the use of the NSAID (nonsteroidal anti-inflammatory drug) *diclofenac*, which led to the collapse of 95% of vulture populations in the Indian sub-continent, has been approved for commercialization in Spain, with unknown but potentially devastating effects on European vultures.

- **List of critical and important threats**

Table 6: Current level of importance[1] of threats for the species in European countries[2]

	General	Austria	France		Greece (Crete)	Italy	Spain		Switzerland
			Corsica	Continent			Andalusia	Pyrenees	
Poisoning	Critical	L	C	M	C	L	C	M	L
Lead poisoning	High/Critical	H	H/C	H	L	H	H	H	H
Collisions	High	M	M	M	H	M	M	M	M
Wind farms	Unknown	U	C	U	C	U	U	U	U
Disturbance	Medium/High	M	L	M	M	M	M	M	M
Shooting	Medium	M	L	L	L	L	L	L	L
Availability of food & habitat	Medium	L	C	L	M	M	M	M/H	L
Intoxication by NSAIDs	Medium	L	L	L	H	L	M	L	L
Low genetic diversity	Unknown	U	C	U	C	U	U	U	U

- **Poisoning**

Importance: Critical

Several species of raptors, and particularly vultures and other scavenging birds, are often unintentional victims of the use of poisons intended to eradicate undesirable mammal species, ranging from small rodents to large carnivores (Choisy, 2013). Since the 1990s and principally since 2001, intentional and unintentional poisoning has become the most critical source of Bearded vulture mortality in Europe (Margalida et al., 2008b). Although there have been no records of intentional poisoning directed against the species in decades, they are highly susceptible to indirect poisoning when they feed on poisoned carcasses or baits aimed for large carnivores or other predators (Margalida, 2012; Margalida et al., 2013). Although the use of poison has decreased in Europe in the last decade, the persistence in key distribution areas, severe impact on the population and the struggle to stop its usage make it of critical priority for the conservation of the species in Europe. Berny et al. (2015) studied the impact of poison on scavengers (Bearded vultures, Griffon vultures, Egyptian vultures and Red kites) in the Spanish Pyrenees from 2005 to 2012, and found out that poisoning

[1] L= Low; M = Medium; H = High; C = Critical; U = Unknown.

[2] Information on threats facing the Bearded vulture for each country was provided by: E. Bassi (Italy), R. Moreno-Opo (Spain), H. Frey (Austria), S. Xirouchakis (Greece), R. Néouze, M. Heuret & JF. Seguin (France) and D. Hegglin (Switzerland)

accounts for over 22-37% of mortality cases. Only in Spain, two different LIFE projects against the use of poison have been started since 2010 (LIFE08 NAT/E/000062, LIFE09 NAT/E/000533), aiming for the fight against poisoning in several aspects of the problem, including the enforcement and upgrading of legislations, education, research and improvement of detection methodology, among others. Likewise, Italy is implementing two other LIFE projects with similar goals (LIFE13 NAT/IT/000311, LIFE14 NAT/IT/000484), and one more in France (LIFE13 NAT/FR/000093). Moreover, there are several examples of cross-border collaborations between European countries, such an Italian-Spanish LIFE project (LIFE07 NAT/IT/000436) and several protocols and regulations implemented within the EU. National action protocols have also been developed, such is the case in France. No specific plans have been developed in Austria or Switzerland to our knowledge. However, although the amount of work in this aspect has increased significantly, it is still of top priority to increase the work, especially across borders.

- **Saturnism (Lead poisoning)**

Importance: High

Lead (Pb) is a highly noxious heavy metal that affects all body systems as a non-specific poison (Pain, 1996). Saturnism (or lead poisoning) is the result of the ingestion or absorption of lead, which affects the brain (mobility, equilibrium), produces anaemia, affects blood and digestive systems, etc. It can be presented in both acute and chronic forms. It is well documented that the ingestion of high levels of lead is a widespread problem which affects large birds of prey that feed on un-retrieved shot game specimens or on their discarded remains which still contain lead ammunition (Clark & Scheuhammer, 2003). Bearded vultures and other raptors are particularly sensitive to lead intoxication due to a very low gastric pH, which dissolves lead and releases it in the bloodstream and often results in death (Fisher et al., 2006; García-Fernández et al., 2005). Lead poisoning can be a crucial factor determining the viability of reintroduced vulture species (Fry et al., 2009), and it's considered of high priority in practically every European country where Bearded vultures occur. At the moment, the impact of lead poisoning on wild population is being assessed, and the primary results confirm the severe effect in the demography of the species in several areas (Hernández & Margalida, 2009).

Since 2011, several programmes on detection of saturnism in recaptured or dead birds have been taking place, mostly in the Alps. Since 2012, a coordinated monitoring and sampling protocol has been in place in the Alps, and the results of these years of study are now starting to be published. The main action projected against lead intoxication is to ban the use of lead ammunition at least in protected areas; although some countries (e.g. Spain, France, etc.) have already started implementing these actions, it has met a strong resistance from the hunting community so it's still far from accomplished. Other countries like Switzerland are testing the use of led-free ammo and have achieved positive acceptance so far (Daniel

Hegglin pers. comm.). In Spain a specific plan to promote the use of lead free ammunition for big game in the reintroduction areas by means of targeting cooperatives (hunter associations, hunting environmental officers, etc) has achieved some success. Part of the LIFE project GypHelp (LIFE13 NAT/FR/000093) also aims to identify lead sources in the French Alps.

- **Collisions & wind farms**

Importance: High

Bearded vultures are susceptible to collisions with overhead structures considering their distribution (open landscapes, upper slopes and overlaps with since they spend up to 62% of their flying time at less than 100m of height (Rushworth & Krüger, 2013) In addition to the area and flying height conflict, recent findings suggest that vultures sight doesn't cover the direction of travel forward, as their field of view focuses downwards when looking for food (Martin et al., 2012)

Since the beginning of the reintroduction project in the Alps, 37.5% of all registered mortality cases (N=16) have been by collision with overhead powerlines and ski-lift cables (VCF data), but it is expected that this problem affects more individuals than what can be found. In the whole of Europe, it accounts for 18% of all registered cases (Margalida et al., 2008b). This is a threat that although localised and difficult to quantify, is considered of medium to high importance in all European countries. Since 2014, a new LIFE project (LIFE GypHelp, LIFE13 NAT/FR/000093) has been started to tackle some of the anthropological threats that affect the Bearded vulture and how to mitigate them. Collision is one of the main problems targeted by this project.

Despite the benefits of wind power as a renewable source of energy, incorrectly placed wind farms can have severe environmental consequences, particular affecting large raptors and vulture species, threatening the survival of these populations through disturbance, behavioural changes and eventually mortality through collision with the turbine blades (Carrete et al., 2009; Dahl et al., 2012; Martínez-Abrain et al., 2012; de Lucas et al., 2012; Bellebaum et al., 2013). In South Africa, Reid et al. (2015) studied the potential impact of projected wind farms for the population of Bearded vultures and found out that 55-60 % (respectively mature and immature birds) flew at heights considered "of risk". Moreover, they also showed that the construction plan would not only pose a severe threat for the species, but actually be built in the most dangerous location when overlapping the site with the flying pattern of the studied birds. Up to date, no cases of Bearded vulture mortality by wind turbines have been recorded in Europe, so it is unclear how the expansion of wind farms will affect the species there. At the moment the risk in most areas is deemed low, since the presence of windfarms in Bearded vulture distribution areas is marginal. However, if we

consider the biology of the species (a large scavenger with low reproduction rate that flies long distances in search of food), and the known impact on other large raptors and vulture species (such as Griffon vultures in Spain, with an estimated 1000 casualties per year, Álvaro Camiña pers. comm.) this might become an important threat in the future. The risk has been assessed as particularly high and even critical in the island populations of Crete and Corsica, as well as Switzerland, as a response to the recent announcement of future plans for the development of wind parks in areas near Bearded vulture territories. In the year 2009 the European Bearded vulture experts agreed upon a resolution to mitigate the risks caused by wind turbines, although no further actions have been undertaken. Bearded vultures live in low densities and have a very slow reproductive rate, so the accumulative mortality the impact on the population across large areas should be considered when producing national plans to develop wind power farms. More studies on the flying behaviour of the species might be necessary.

- **Disturbance**

Importance: High

Impacts related to human disturbance are important restraints for the distribution patterns of Bearded Vulture and other vultures, affecting population densities, feeding areas and breeding ranges among others (Donázar et al., 2002; Bautista et al., 2004; Hirzel et al., 2004; Gavashelishivili & McGrady, 2006; Margalida et al., 2007; Krüger et al., 2015).

In Spain, the species' breeding grounds are regulated and monitored (for hunting, sports, forestry, etc.) between 1 December and 15 May. In the Italian regional Deliberazione Giunta Regionale N. 8/6648, the Lombardia Administration lists a set of activities that should be avoided for the conservation of the Bearded Vulture (including free climbing, fly-overs by airplanes, hand- and paragliding, etc.). In the proximity of the breeding cliffs it is forbidden to build new powerlines and it is a legal requirement to provide mitigation actions on existing powerlines. Breeding sites are thoroughly monitored within the International Bearded Vulture Monitoring carried out in the entire Alpine range. In Greece (Crete), regular patrolling and warding of the species nesting areas is carried out during the most critical stages of its breeding cycle.

The reintroduced Andalusian population of Bearded Vultures reproduced in the wild for the first time in 2015. The viability study for the Reintroduction Project in Andalusia showed that cliffs with high probability to be occupied by the species coincide with the areas where the species occurred in the past. Additionally these mountains, with places suitable for nesting, correspond largely with protected natural areas that are part of the RENPA (Hernández et al., 2005). This guarantees that all needed protection measurements for survival and breeding success will be applied in the future.

Enforcing avoidance of disturbance and warning of unsuccessful breeding pairs in Switzerland has been implemented by the Foundation for the Bearded Vultures in collaboration with the regional authorities.

- **Shooting**

Importance: High

Direct persecution and shooting, both legal and illegally, was one of the main reasons that lead to the extinction of Bearded vultures in most of the species' former distribution range in the past century (Mingozzi & Estève, 1997; Schaub et al., 2009). In 2008, Margalida and his colleagues calculated that shooting represented up to 31% of all registered mortality cases from 1986 to 2006 (Margalida et al., 2008b). Although shooting was arguably the main threat back then, they also proved that the impact of shooting had decreased ostensibly in the last decade, thanks to the work done since. Although it is now forbidden all across Europe, poaching is still taking place in several of the countries where the species is present. According to official records, only 2 cases of mortality by shooting have been confirmed in Europe since 2011. However, there are several reports of birds recovered dead or alive that have been non-mortally shot and still carried the pellets in their bodies, suggesting a higher risk that what can be assessed simply by counting mortal cases. In Austria, there are unofficial reports supported by data pointing out to shooting as one of the main reasons underlying the slow colonisation rate in this area of the Alps in comparison to other countries within the range in the past. Nevertheless, the occurrence of shooting has decreased overall in the last decade as a result of the implementation in the first decade of the century of several measurements, such as the declaration of non-hunting areas from the 1st of December to the end of the hunting season in Spain, improved monitoring of breeding grounds, etc. No specific plans on shooting have been undertaken in the last 5 years, but the general increase of awareness in conservation issues has had a positive impact in decreasing shooting.

- **Availability of food & habitat conservation**

Importance: High

Both wild and reintroduced populations should be self-sustaining in terms of food resources in the long term for the viability of the species. Unlike other vulture species in other regions of the world, European vultures are generally strongly associated to, and even dependent of, human resources for their survival. Thus, food availability is largely reliant on wild ungulates and domestic livestock, but also on feeding points in areas where free-ranging ungulates cannot sustain the vulture population. This is for instance the case of the French and Spanish Pyrenees, where Bearded vultures are dependent on specific supplementary feeding due to the insufficient amount of free-ranging ungulates. The reintroduced Alpine and Andalusian populations of Bearded vultures are able to feed on wild ungulates and can subsist without

artificial feeding due to the low concentration in these areas. Lack of food is considered the main reason underlying the low productivity in some certain areas, such as the island population of Corsica.

The impact of predictable feeding sites in populations has been thoroughly studied in the Pyrenees, and it's been proven that although it plays an important role in decreasing pre-adult mortality (Oro et al., 2008), it has the opposite effect in adult birds as well as decreasing productivity. Moreover, it's been proven that the presence of this type of feeding sites has a negative impact in juvenile dispersive potential, which in time might affect the population (Margalida et al., 2013b). However, the use of artificial feeding sites is the main conservation actions being implemented in isolated island populations such as Corsica and Crete, where specific feeding plans are being implemented and developed.

After the outbreak of BSE (Bovine Spongiform Encephalopathy) in the early 2000s, the European Commission changed the regulations on carcasses disposal in order to decrease the risks of infection. However, the EU reverted to less strict regulations once the risk was deemed low. Nowadays, EU regulations are quite open on the matter, which have important implications for European populations such as the case in France. In Spain, these regulations were not accepted nationally until 2011, but the implementation of these regulations is still diverse across the country.

The distribution/density of Ibex (*Capra ibex*) and a combination of spacious pastures in close proximity to steep cliffs (preferably limestone) have been found to be key factors when modelling Bearded Vulture habitat in the Alps (Hirzel et al., 2004; Zink, 2006). Conserving the species' habitat and ensuring the implementation of effective habitat protection policy has received a good level of implementation, with the exception of Turkey, where work has been limited.

The Andalusian Environmental Government environmentally assesses and reports every project inside the Natural Protected Areas (including Natura 2000 Network). Additionally, the Andalusian Gypaetus Foundation assesses projects that potentially affect the Bearded Vulture in the foreseen reintroduction areas. These reports are issued to the environmental authorities in order to have Bearded vulture-specific assessment to evaluate the projects. A "Manual for the Preventive conservation of the Bearded Vulture and its Habitat" in Spain have been published by the Gypaetus Foundation.

- **Intoxication by NSAIDs**

Importance: Medium

The negative impact that non-steroidal anti-inflammatory drugs (NSAIDs) on avian scavengers has been thoroughly documented. However, very little actual monitoring has been done regarding occurrence of veterinary drugs in the environment and the potential risk it poses for higher wildlife (Mateo et al., 2015). Mateo et al. (2015) studied, among other things, the persistence of human-administered antiparasitics in the food provided to Bearded vulture-specific feeding point in the Spanish Pyrenees, and found out that 71,4% (up to 95% in some areas) of samples had residues of the drugs. Although the effect these will have in the short or long term are still poorly studied, there are several empiric examples of how they can affect motility, cause sub-lethal toxicity, produce changes in feeding behaviour or depress the immune system (Blanco & Lemus, 2010; Mateo et al., 2015)

The NSAID diclofenac is highly toxic for vultures that feed upon carcasses of domesticated ungulates that have been treated with the drug shortly before death (Oaks et al., 2004; Green et al., 2006). The critical role that this drug played in the near global extinction of at least three species of Old World Gyps vultures has been thoroughly studied, and it's estimated that it's responsible of the disappearance of up to 95% of these species in the last two decades (Oaks et al., 2004; Taggart et al., 2009; Cuthbert et al., 2014). In spite of all we've learned about Diclofenac and its enormous impact on vultures, the drug has been allowed to be marketed in 5 European countries (Italy, Estonia, Czech Republic, Latvia and Spain). In Spain (that houses 95% of the European vulture populations) diclofenac was approved for administration in 2013, disregarding all the data gathered from the Asian vulture crisis in. Green et al. (2016) estimated that diclofenac would kill 715–6389 Griffon vultures per year only in Spain, and suggested the ban of diclofenac and the substitution by meloxicam, an NSAID with similar effect but low impact on vultures. Moreover, Zorrilla et al. (2015) also identified (in southern Spain) a suspected case of a Griffon vulture being poisoned by Flunixin, another anti-inflammatory drug used in livestock. These cases emphasise the pressing need for improving the current monitoring of the impact of pharmacologic substances and the need for better understanding of their characteristics and activity (Shore et al., 2014).

- **Low genetic diversity**

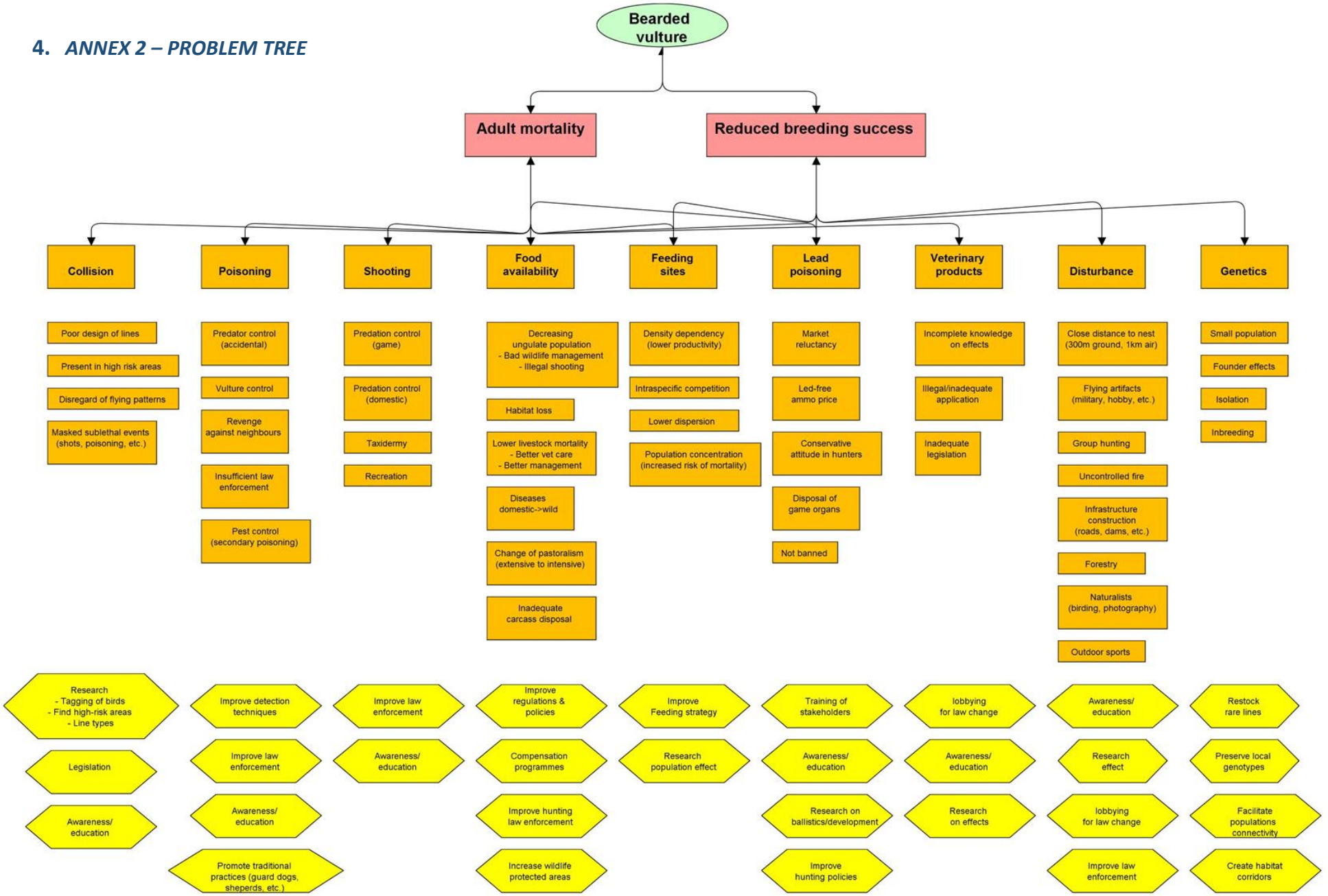
Importance: Medium

The reintroduction of species has become one of the most commonly and most widely used actions in conservation efforts (Armstrong & Seddon, 2008). When reintroducing endangered species, quite often the number of individuals available for release into the wild is too small to produce a long-term viable population (Jamieson, 2011). Small populations,

both natural and reintroduced, are often subjected to bottlenecks, which leads to loss of genetic diversity, lower adaptability and increased rates of inbreeding (and thus inbreeding depression), both of which can reduce the fitness of a population and lead to their extinction (Frankham et al., 2009). This is for instance the case of Bearded vulture island populations (e.g. Corsica), where the small number of individual and the isolation from other populations have produced a marked decrease in their heterozygosity (genetic variation both within an individual) (VCF data). Reverting this situation is vital for the survival of the population, and there is already a "genetic rescue" programme underway between Corsica and the VCF. In the Pyrenees, the largest remaining natural population in Europe, although the genetic variability is still relatively high, there are reasons to believe the population might suffer from a decrease in genetic diversity if no new lines are included (García et al., 2012). Breeding strategies for the management of captive populations are designed to minimize inbreeding and loss of genetic variation (Lacy, 1993). The Bearded vulture EEP (European Endangered species Programme), was created with this aim, and exerts a strict control over the reintroduced individuals. It was suggested that releasing more individuals into the Alps might not be necessary anymore for demographic reasons (Schaub et al., 2009), but it's also been said that it will be necessary to continue releasing individuals of rarer genetic lines to increase heterozygosis in the population (Lörcher et al., 2013).

The most perseverant effects of low genetic diversity are exacerbated by the isolation of populations, which prevents immigration and gene flow. This could be avoided in the wild by facilitating the genetic flow among populations and creating a meta-population. Without gene flow, the mean level of inbreeding will increase over time leading to a loss of genetic diversity and population fitness (Frankham et al., 2002). In order to achieve connectivity between the Alpine and Pyrenean population, there are some specific programmes in place, such as the LIFE GYPCONNECT (LIFE14 NAT/FR/000050), which aims to create a stepping stone for the expansion of the population.

4. *ANNEX 2 – PROBLEM TREE*



5. ANNEX 3 - JUSTIFICATION OF CONSERVATION OBJECTIVES

This annex gives a more in depth overview of the current situation of all European Bearded vulture subpopulations, highlighting the main threats for their survival and suggesting which actions would be more suitable for each region in order to ensure their long-term existence.

- **Business-as-usual scenario (no recovery or control measures taken)**

Bearded vulture populations are widely distributed across the Palearctic, Afrotropical and Indomalayan regions, associated to landscapes traditionally exposed to low anthropogenic pressure. Likewise, this is a species that, by its unique ecology – only osteophagic bird worldwide – should not be faced with the same human-wildlife conflicts that other large raptors and even some species of vultures are subjected to. Therefore, it could be expected that populations should at the very least remain constant throughout the distribution range, despite regional fluctuations caused by localized threats. However, the tendency worldwide is rather the opposite, having suffered from acute declines of 25-29% over three generations (BirdLife International, 2016) in most countries where the species occurs, except on those where specific actions for the preservation of the species or its habitat are being implemented. There is a global tendency of specialist species towards decline, due to direct and indirect disturbances such as habitat destruction or degradation, as well as extinction risk for those specialist unable to adapt to a changing environment (Clavel et al., 2010). Bearded vultures are highly specialized raptors, so it seems essential to establish a management plan for the species in order to revert this negative tendency.

In Europe, all current extant subpopulations, both natural and reintroduced, require the implementation of specific conservation measures regardless of their status. Only some populations in Western Europe show a positive/stable growth rate, whereas elsewhere the populations are suffering severe declines and almost facing extinction in several areas. One problem that is shared by all populations is the genetic isolation between them; there is currently no genetic exchange among populations that could help alleviate the long-term consequences of inbreeding, or help increase the distribution range of the species by naturally creating stepping stones between populations. At the moment, genetic exchange is only taking place through artificial actions, such as the reintroductions in the Alps and more recently Southern Spain and the Massif Central in France, reinforcement of extant populations (e.g. Corsica), and specific plans for connectivity among populations (e.g. LIFE project GypConnect). Another threat common to practically every population in Europe, yet largely disregarded as not critical till recent years, is lead poisoning. The impact of this relatively little known hazard on wild population is currently being assessed, and the primary results confirm the severe effect in the demography of the species in several areas.

If we look more into detail on the situation of each subpopulation we can get a better picture of the situation of Bearded vultures in Europe:

Baetic Cordillera sub-population unit (Andalusia)

Historically, the Baetic System served as a bridge between North Africa (where a small population still occurs in Morocco) and the rest of Europe through the Pyrenees. The release

of the first Bearded vultures in Andalusia started in 2006, exactly 20 years after the last wild individual disappeared from the region in 1986. The first successful breeding took place in 2015. Although the population has been increasing in a decade thanks to the continuous releases, the project has suffered several loses for a number of reasons, being paramount of all illegal poisoning.

The use of poisoned baits aimed at large carnivores or other predators has had a great impact on the survival of the released Bearded vultures, which are unintentionally affected by this practice. If no further releases were to take place, it is believed the damage caused by poison in the population would be irreparable and lead to the disappearance of the population once again.

Pyrenean sub-population unit (France & Spain)

The Pyrenean Bearded vulture population is the largest remaining population of Western Europe. Moreover, it's the only population that showed a positive growth by the end of the 20th and beginning of the 21st centuries. Like happened in the rest of Europe, this population was declining until reaching its lowest density by the 70s (40 occupied territories). Since the middle of the 80s, the population started growing again thanks to some specific actions that were implemented, such as the usage of feeding sites or improved protection status, increasing almost 4x since then. However, in spite of the increase in numbers and occupied territories, other factors that indicate the health of a population decreased instead of rising. Thus, productivity fell from 0.8 (1978) to 0.37 (2002), a tendency that remained more or less constant until today. Likewise, there is very little evidence of natural recolonization, only to recover lost territories within the Pyrenees but no further from that, with birds moving short distances from their fledging site, a lot less than what has been observed in other populations such as the reintroduced one in Andalusia and the Alps (Margalida et al. 2013b). In light of these figures, it is expected that the positive growth rate cannot be sustained on the long-term, as the prime areas are taken by pairs while floaters remain in the area, increasing disturbance and further reducing productivity. The lack of dispersal will eventually lead to a great loss on genetic diversity, producing inbreeding depression and reducing plasticity for adaptation to a changing environment.

Mortality risks affecting this population vary from illegal shooting to collision with lines, although poisoning remains as the main cause of death in this population. Another factor affecting the Pyrenean population, particularly in the Southern areas, is the decline in extensive livestock farming, which although it doesn't necessarily lead to mortality due to the existence of an extensive network of feeding sites, it means the population couldn't be self-sustainable without human management.

Corsica Island sub-population unit (France)

The Bearded vulture population of Corsica is the last surviving genetic pool of a former meta-population which included Sicily, Sardinia, Corsica and the Alps. This is probably the most threatened extant population in Europe, and deemed to disappear in less than a decade. Between 1981 and 2008, the number of fledglings per year of the whole group was between 0-2 (Seguin et al., 2010), which further decreased until nowadays to 0-1 individuals per year. Likewise, the number of occupied territories has decreased from 10 to 6 in just 4 years, and only laying pairs are currently active. There are 4 main causes that affect the survival of this population: Anthropogenic factors (poisoning, shooting, lead poisoning, etc.), stochasticity,

low genetic diversity and lack of suitable food. The impact of the first 2 factors is highly unknown, but due to the low numbers, they could have a huge impact. The genetic diversity was studied by Loercher (2013), who found that there were strong evidences of inbreeding and a very low genetic diversity, although couldn't be directly linked to the low productivity. The main threat for this population is however the lack of suitable food; since middle of the last century, the reduction of sheep and goat farming, combined with the low numbers of wild ungulates, lead to low availability of food for the species, which might explain the low productivity.

The Corsican sub-population is now on the verge of extinction, and it would be necessary to implement decisive actions to redress the dramatic decrease and secure the surviving of this unique genetic pool.

Alpine and Massif Central sub-population unit (Austria, France, Italy, Switzerland)

Historically this population served as bridge between the Western and Eastern European sub-populations, but it went extinct at the end of the 19th – beginning of 20th centuries as a consequence of direct persecution. In 1986, the first birds were released back into the wild, which has been done every year until this day, being thus the oldest reintroduced population of Bearded vultures in Europe. Since 1997, when the first successful breeding took place, the population has been steadily growing, surpassing the 40 territories in 2016. The total number of individuals and territories has been increasing unremittingly, and so has the productivity of the population, averaging 0.56 in the last 10 years. The large area covered by the Alpine range with prime habitats and low disturbance impact, suggests the population can still grow to cover optimal territories. However, due to the origin of the released birds (captive breeding) the effective population size was estimated at only 28 individuals (Loercher et al., 2013), and considering the lack of genetic exchange with neighbouring populations, the lack of genetic diversity will in all likelihood lead to a population crash.

Despite the little recovery rate of dead individuals, it seems collision with overhead cables and shooting (especially in the Eastern Alps) are the main threats overall, as well as poisoning and more prominently, lead poisoning. It is important to keep monitoring this, and in fact every other, population, as new threats could arise unexpectedly and turn the positive trend into a negative one. This could be the case in Switzerland, where the planning of constructing wind farms in the Alps could potentially jeopardize the population there.

Crete Island sub-population unit (Greece)

The Bearded Vulture autochthonous island population of Crete is the last surviving genetic pool of the former Balkan meta-population. Like in the rest of the continent, the species was in the verge of extinction in the 90s, but unlike others, this population survived and its numbers starting increasing by the turning of the century. Therefore, the population has remained practically unchanged for over a decade, with 5 laying couples these days. Although the Crete population still retains a large genetic diversity, its isolation and small size make this population extremely vulnerable.

Nowadays, the main issue affecting survival of the species in Crete is the destruction of the habitat, caused among other reasons by the building of new wind farms (Xirouchakis, 2013).. By the turn of the century, the main reasons for mortality were poisoning and shooting;

shooting was halted thanks to the 4 LIFE projects that focussed in this island, but poisoning still remains a problem of unknown consequences.

Caucasia sub-population unit (Russia, Georgia, Armenia & Azerbaijan)

Although the information coming from these regions is often incomplete or outdated due to the lack of observers and the large remote areas of difficult access, it is possible to give an estimation based on published data. Thus, in Georgia the population has remained stable for over 40 years (Abuladze, 2013). Similar results could be seen in neighbouring countries Russia, Azerbaijan and Armenia (Abuladze & Shergalin, 1998).

The main cause of mortality (over 50%) was the use of bait traps for large mammals, as well as poisoning and shooting, followed by other human actions (egg collection, taxidermy, etc.). The most recent and severe threat for the species in these lands is the lack of food caused by changes in traditional usage of the land and livestock practices, as well as decreases in the populations of wild ungulates.

- **Action Plan implementation scenario**

As it has been shown before, at the moment all European subpopulations require of specific management measures to ensure their short- and/or long-term survival. When looking at each population:

Baetic Cordillera sub-population unit (Andalusia)

Besides continuing with the current releases the main actions to be implemented would be focused on the fight against poisoning and education to minimize the impact of human activities. A specific strategy against the use of poison is already being implemented, and though the results are promising, this is a complicated issue that should be tackled on a national level.

Pyrenean sub-population unit (France & Spain)

The management of the feeding sites should be adapted to more specific planning. The problems associated to large predictable feeding sites in the Southern slope could be alleviated by adjusting the scheme to a similar plan like what's being used in the Northern slope. Poisoning is also quite present, particularly outside managed areas, but it has a severe impact on the population. If the feeding scheme changes, it is expected that more individuals would venture further from the monitored areas and thus be exposed to other mortality causes. This, as well as other factors such as food availability should be taken into consideration beforehand. Considering the genetic isolation, there is already a LIFE project in place focused on connectivity between populations, and there are plans to start a new reintroduction project in the Sierra of Maestrazgo that aims to connect the Southern and Northern Spanish populations.

Corsica Island sub-population unit (France)

The implementation of conservation measurements is critical for this population. Since 2015, there is a reinforcement project in place, releasing young Bearded vultures provided by the EEP through hacking, in order to increase the genetic diversity of the population while trying to keep the Corsican line safe. Together with this, there's a specific feeding plan, aimed overall at breeding couples by supplying the necessary type of food for raising the chicks, as well as

actions to reduce the impact of lead poisoning. There are plans to develop further actions in the island in order to secure this unique population.

Alpine and Massif Central sub-population unit (Austria, France, Italy, Switzerland)

The Alpine and Massif Central's artificial sub-population is the best monitored population in Europe. The situation of most breeding couples and whereabouts of over 60% of released birds is well known thanks to an effective and diverse network of monitoring tools. This helps keep a closer look at possible outbreaks of mortality or the apparition of new threats. At the moment there are 2 active LIFE projects focused on the species in this population, as well as several national and local monitoring projects, coordinated by the International Bearded vulture Monitoring (IBM). Most actions identified are ongoing or envisioned for the close future.

Crete Island sub-population unit (Greece)

As it happens with Corsica, Crete still holds a unique reservoir of some of the original genetic lines that would be extremely valuable for the future of the species. However, being a small island isolated population entails several risks, as can be seen in Corsica. There are moreover new hazards incoming, such as the construction of wind farms, which could pose a potential threat for the species. 4 LIFE projects were implemented in this island, and though some of the problems were solved, others remain. Although there is some certain stability in this population, it will be necessary to develop more specific management plans and the application of this SAP in order to ensure the future of the population.

Caucasia sub-population unit (Russia, Georgia, Armenia & Azerbaijan)

Since there is so little information about the real situation of many of these sub-populations, the first step, which is already undergoing, would be the survey of the local and national status of the species. Once this has been studied, more specific actions can be applied, particularly focusing on decreasing human-cause mortality while increasing food availability.

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