



BONELLI'S EAGLE'S LIFE PROJECTS

SCIENTIFIC MANIFESTO

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*Tribute to Matteo Griggio (R.I.P.),
who proposed this manifesto
and prepared its first draft*

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Summary

Our aim is the development of a shared “Manifesto”, whose purpose is to organize, develop and promote future scientific studies on the biology of the Bonelli’s eagle and to provide scientific support to the LIFE projects targeting the conservation of this raptor. The study issues proposed in the Manifesto make full use of data, information and experience directly originating from these LIFE projects activities and aim at providing new insights into several aspects of the biology and ecology of the species as well as to propose possible targets of future research and conservation efforts. The ultimate aim of the Manifesto is to collect robust research data that will foster sound conservation actions.

Each study issue is divided into two parts: 1. ‘Brief description’ (10-15 lines): gives basic information (so also scientists from different fields can understand the topic) and summarizes the main study questions/hypotheses. 2. ‘Goals’: describes the main scientific and practical results we would like to obtain for the project.

The list of study issues listed is considered as non-exhaustive and it is open to future implementations by further researchers and conservationists.



LIFE Projects involved in the Manifesto:

- ✓ AQUILA a LIFE (LIFE16 NAT/ES/000235): promoted and prepared the Manifesto
- ✓ LIFE BONELLI (LIFE12 NAT/ES000701): data provided by this previous project is available.
- ✓ LIFE ConRaSi (LIFE14 NAT/IT/001017): supporting project
- ✓ LIFE BONELLI EstMed (LIFE17 NAT/GR/000514): supporting project

Study issues

1. Mortality factors

Brief description: Mortality is a key issue in any reintroduction or restocking program and it is the first parameter that can be calculated to evaluate the efficacy of such programs. Identifying mortality factors allows addressing or readdressing reintroduction actions undertaken within the project in a feedback-based process as well as undertaking measures to minimize these mortality causes. An analysis of which are the proportional impact of different mortality factors (e.g. diseases, electrocution, impacts, shooting, poisoning, aggression by other birds, etc.) and whether these correlate with both individual features (e.g. age, sex, body mass, personality, tracking technique) and parameters than can be adjusted in the releasing program (e.g. age at release, the time elapsed from release, the season of release, landscape, bird conditions at release) is therefore urgent and should be considered as a priority.

Goals: 1. Identification of mortality factors and main covariates in order to maximize the survival of released birds over the short and long-term. 2. Comparison of mortality causes of GPS-tracked birds with other sources of information (e.g., admission to rehabilitation centres or field surveys).

2. Prey availability, prey selection and hunting behaviour

Brief description: The high number of radio-tagged birds provided by the projects offers a unique opportunity to investigate hunting behaviour. Specifically, an analysis of accelerometer and magnetometer data could provide information on the



proportion of hunting time spent in the two main strategies: ambush hunting (sit-and-wait strategy) vs active search hunting and whether this time budget differs among birds of different age or living in different habitats.

Indeed, birds introduced in different areas may face radically different prey communities. A robust knowledge of the potential prey availability and selected prey (use vs availability approach) would foster fundamental data about the adaptive capacity of the species to colonize or re-colonize the releasing areas. Furthermore, prey selection may change over the biological cycle of the introduced birds and its study may provide very useful information on both the general biology of the species and about the mechanisms that determine the installation and the size of the new territories. Ideally, prey availability data should be collected both inside and outside the territories/settlement areas to allow for effective comparisons.

Goals: 1. Identification of main ambush sites in different habitats and releasing areas; correlates of hunting behaviour time-budget with internal and external drivers (age, season, landscape, habitat, prey abundance, main target prey), hunting success concerning hunting strategy. 2. Evaluation of prey selection (availability vs use) at the individual level and comparison among releasing areas of prey abundance indexes inside and outside of the settlement areas.

3. Pair formation and pair bond: a life-history approach

Brief description: The breeding pair is a basic unit on which biological and conservation parameters are calculated. Therefore, there is a strong interest in direct future investigations on pair ecology and behaviour. A life-history approach seems appropriate to analyse pair behaviour, and the high number of radio-tracked fledglings provided by the projects gives a unique opportunity in this direction.

Pair bond may also determine not only the spatial situation of territories but also its maintenance in the same spatial areas over consecutive years. It is necessary to address territory-overlapping approaches in the early stages of the settlement but also during the reproductive life of individuals.

Goals: 1. Investigating some critical parameters such as age at pair formation in relation to pair density (from regions where the species is reintroduced to high densities areas), age of first breeding attempt, age at egg laying, age at first breeding success, productivity or territory maintenance between years. 2. It is also interesting to approach issues as pair formation and replacement patterns due to one of the members' disappearance (natural death, intraspecific competition, or human-related causes).



4. Post-fledging dispersal and bird personality: developing a common protocol to investigate bird personality before release.

Brief description: Animal 'personality', defined as repeatable inter-individual differences in behaviour, is a subject of rapidly growing research interest. Individual differences in behaviour are now an increasingly relevant research field in several disciplines, but in conservation biology, we observe a gap. One possible test that can be done in captivity (very cheap and fast) is the Novel Object Test (NOT). Recent research suggests that personality could be a tool in planning release programs: in some studies, personality has been shown to be a good predictor of survival in the wild. So, successful reintroduction programs can be informed by personality traits, even if the use of this tool is not widespread. The idea is to perform a simple NOT (a first test was already done in 2018 in Sardinia with good results) where we can introduce three objects in the aviary (with 3 replicates with different objects) and record the behavioural responses. Later we would like to correlate individual personality with survival and dispersal (together with other aspects). These behavioural personality experiments can be linked with stress level in birds that can be measured by corticosterone levels in feathers or blood. The hypothesis could be that bird with more pro-active personality (more interested in novel objects) should have a lower stress level.

In addition to NOT tests in relation to corticosterone levels and since many of the released birds will be radio-tagged, the relationship between corticosterone levels and patterns of movement activity in the early stages of dispersal and settlement can be evaluated by addressing spatial analysis approaches. This can provide reliable models and relationships that can be applied to future reintroduction program individuals for this species.

Goals: 1. Although novel object tests are a common tool for assessing animal personality, it is not always clear what behavioural variables should be measured during the test and how they should be interpreted. We would like to better investigate this topic to develop a robust testing protocol that could potentially have wide applications in management and conservation planning.

5. Human disturbance: analysing the effect of human disturbance on bird movements and possibly other behaviours.



Brief description: Human disturbance affects bird ecology through the temporary disruption of some behaviours, such as diurnal rhythms; escape flight distance, spatial displacement and temporary or permanent variations of nest site location and home range. Synergic effects of some human activities, especially hunting, on decreasing bird tolerance to human proximity were described in several species. Proximate effects can be observed in body conditions as birds can face energetic bottlenecks given by the reduction of feeding grounds and available time for feeding. Survival rates can decrease due to increased mortality by direct persecution or decreased physical conditions, and fecundity due to decreased physical conditions, the break-up of pair bonds and disaggregation of family groups (in case of the Bonelli's eagle, shortening of the dependence period). Long terms impacts can be found in changes in mortality, recruitment, range expansion, gene flow, hence in population dynamics.

Goals: 1. Identifying the main effect of different sources of human disturbance on spatial displacement, home range dynamics, and survival probability.

6. Genetics

Brief description: Phylogeography and population genetics of Bonelli's eagle. So far, only 1 or 2 papers published from Western Europe. A world phylogeography may be useful in order to be sure to use the best genetic lineage for birds reintroduced. Both genetic and genomic approach should be applied to obtain complete information and support the phylogeographic conclusions. Another interesting topic to develop is how reintroduced birds contribute to increasing genetic diversity in the local population.

Goals: 1. Obtaining a world phylogeography for the Bonelli's eagle. 2. Creating a gene databank for the Bonelli's eagle to organize captive breeding and contrast illegal traffic of birds. 3. Assessing the role of reintroduced birds in shaping gene variability in case of restocking.

7. Interactions with other species/raptors

Brief description: Bonelli's eagles are top predators and their presence/absence can change prey community in terms of demography, habit use and behaviours. On the other hand, Bonelli's eagles are subject to competition with other birds, especially golden eagle in the western Palearctic and territorial displacements, direct killings of juveniles and adults occur in presence of residential golden eagle pairs.

Goals: 1. Understanding the effects of the reintroduction of Bonelli's eagles, especially in presence of breeding pairs, on bird and mammal communities, with special reference to endangered species (e.g. booted eagle, little bustard, Audouin's gull) and smaller raptors; 2. Determining the patterns of territory size and situation of both



Bonelli's eagles and potential competitors. 3. Describing the effects of competition with the golden eagle in terms of prey and habitat selection and demography (productivity, duration of pairs, pair replacement, etc.). 4. Large-scale interactions with ecologically related species (e.g. golden eagle and griffon vulture) using fuzzy-logic and the idea of favourableness.

8. Flight behaviour of the Bonelli's eagle in relation to human-made structures

Brief description: the Bonelli's eagle (and the osprey) greatly suffers from electrocution and collisions with power-lines, while it seems little affected by wind farms, compared to golden eagles or vultures. Can this difference be explained by flight behaviour and wing morphology that make them more prompt to escape collisions? Or by a lesser tolerance to windfarm, inducing an avoidance of wind turbines and resulting in habitat loss?

Goals: 1. Comparing flight tracks of eagles (Bonelli's eagle, golden eagle, and eventually osprey and vultures) recorded with high-resolution GPS devices in areas close to human infrastructures, in order to quantify their avoidance or escape behaviours.