



## SYMPOSIUM PROCEEDINGS

# New approaches and technologies against poaching

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with contribution of Carla  
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## Editorial

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## Abstract

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Since more than 20 years the reintroduction of a migratory Northern Bald Ibis population in Europe is ongoing. It is currently carried out in the frame of a European LIFE-project (LIFE20 NAT/AT/000049 - LIFE NBI) with 10 partners under leadership of Zoo Vienna. Since the start of the reintroduction project, illegal bird hunting has posed a substantial threat to the birds. Northern Bald Ibis have been victims of poaching in all these years, but despite extensive measures taken against illegal hunting in Italy only one culprit has been convicted so far. This shows that illegal hunting is a low-risk environmental crime and one aspect of combating it is increasing the risk of detection and prosecution in the post-poaching phase.

This symposium is part of a series of events in the context of an anti-poaching campaign to be implemented during the next four years. For this initial event, we invited experts to question and discuss primarily the following three topics:

- (1) How to determine the monetary value of wild animals;
- (2) Enhancing crime scene investigations with advanced remote monitoring technologies;
- (3) Enhancing crime scene investigations by voluntary involvement and application of current forensic methods.

The event was hosted by Parco Natura Viva as one of the LIFE-project partners and took place over two days in English language with international guests and in a hybrid mode - with in-person and online participants.

This report summarizes all the interventions of the experts present at the symposium and highlights the conclusions that emerged from the meeting and the fusion of notions on different aspects that could contribute to improving the situation of illegal hunting in Italy.

## Introduction

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### The reintroduction of the Northern Bald Ibis

The Northern Bald Ibis (*Geronticus eremita*) is classified as endangered on the IUCN Red List. This migratory species was once distributed over North Africa, the Arabian Peninsula and large parts of Europe (Schenker, 1977; Fritz & Janák, 2022). In Europe, the species became extinct in the Middle Ages while African and Middle Eastern migratory populations died out during the 20th century. Two wild colonies still persist on the Moroccan Atlantic coast, but they have abandoned their migratory behaviour and live sedentarily in a limited geographical area (Bowden et al., 2008).

Historical evidence and fossil findings testify that in the past the Northern Bald Ibis nested on the northern foothills of the Alps, the northern Adriatic region, Hungaria, Bulgaria, and from France towards southern Spain (Schenker, 1977; Fritz & Janák, 2022; Schenker et al., 2024).

In 2002, a feasibility study on the reintroduction of the Northern Bald Ibis in Europe was started. After 12 years of ecological, behavioral and methodological research, a reintroduction project could be initiated in the frame of a first LIFE project (LIFE+12 BIO/AT/000143 - LIFE Northern Bald Ibis; Fritz et al., 2024).

It is the world's first attempt to reintroduce an extinct migratory species into the wild. In 2019, at the end of this first LIFE project the rewilded migratory population already consisted of 142 individuals, all of them spending the winter in a common site in southern Tuscany (Fritz et al., 2024).

At the end of this LIFE+12 project, a Population Viability Analysis (PVA; Drenske et al., 2023) calculated a population size threshold of 314 individuals towards a self-sustaining population ( $\lambda > 1$ ), i.e. no management and translocation measures will be required to have a probability of extinction close to zero in the next 50 years. The project received a grant for a second LIFE project (LIFE20 NAT/AT/000049 - LIFE NBI) which aims to exceed the threshold towards a self-sustaining migratory population in the period till 2028. Additional objectives are the sustainable reduction of mortality caused by human activities (specifically illegal hunting and electrocution), the creation of synergies with policy areas engaged in contrasting threats to biodiversity and habitat protection, and the dissemination of successfully implemented and developed practices for the reintroduction and management of the Northern Bald Ibis, for the benefit of other conservation projects.

### Objective of the symposium and topics covered

The scientific symposium is intended to complement and support the anti-poaching measures undertaken in the context of the LIFE project (LIFE20 NAT/AT/000049 - LIFE NBI). These measures comprehend all the legal actions needed to identify the perpetrators of crimes against Northern Bald Ibis. Alongside these post-poaching measures, a series of preventive actions are implemented, specifically public relations activities and political lobbying.

Due to the evidence of substantial threats to the species from illegal hunting and the resulting extensive measures implemented over a period of almost two decades, the Northern Bald Ibis has become an indicator and flagship species for the fight against illegal hunting and has often catalyzed public attention on this problem, especially in Italy.

Italy is widely recognized as a hotspot for illegal bird hunting. According to estimates from the report *The Killing* (Birdlife International, 2015), up to 6 million birds are killed or illegally captured in Italy each year. Due to the lack of an effective strategy to combat crimes against wild birds, the European Union has initiated several pilot procedures against Italy over the years, seeking clarifications and urging the country to implement concrete and effective measures to address this issue. In 2017, Italy introduced a National Action Plan to combat poaching, which outlines a series of actions for bird protection through significant regulatory adjustments and the identification of seven key poaching hotspots across the peninsula. Due to the action plan, 43% of cases involving the illegal possession, capture, trade, or killing of wild birds occur in these designated areas.

A key objective of our anti-poaching campaign is to help strengthen Italy's existing legal framework for biodiversity and wildlife protection, as well as to support the implementation of the Italian National Action Plan against wildlife crimes. To achieve these aims, we collaborate with institutions to monitor and track offences against the Northern Bald Ibis at both administrative and legal levels, taking legal action in every poaching incident. Additionally, we maintain partnerships with several environmental organizations that share our goals, enabling the exchange of action protocols and valuable resources to advance our cause.

The rate of Northern Bald Ibis losses due to illegal hunting in Italy remains alarmingly high. Despite an extensive anti-poaching campaign and considerable efforts from both our team and law enforcement, only one offender has been convicted in over 20 years. This highlights that illegal hunting continues to be a low-risk crime. Increasing the risk of detection and prosecution is therefore essential and represents the core objective of this symposium. We have pinpointed three key topics that require improvement to enhance the effectiveness of anti-poaching strategies (Figure 1).

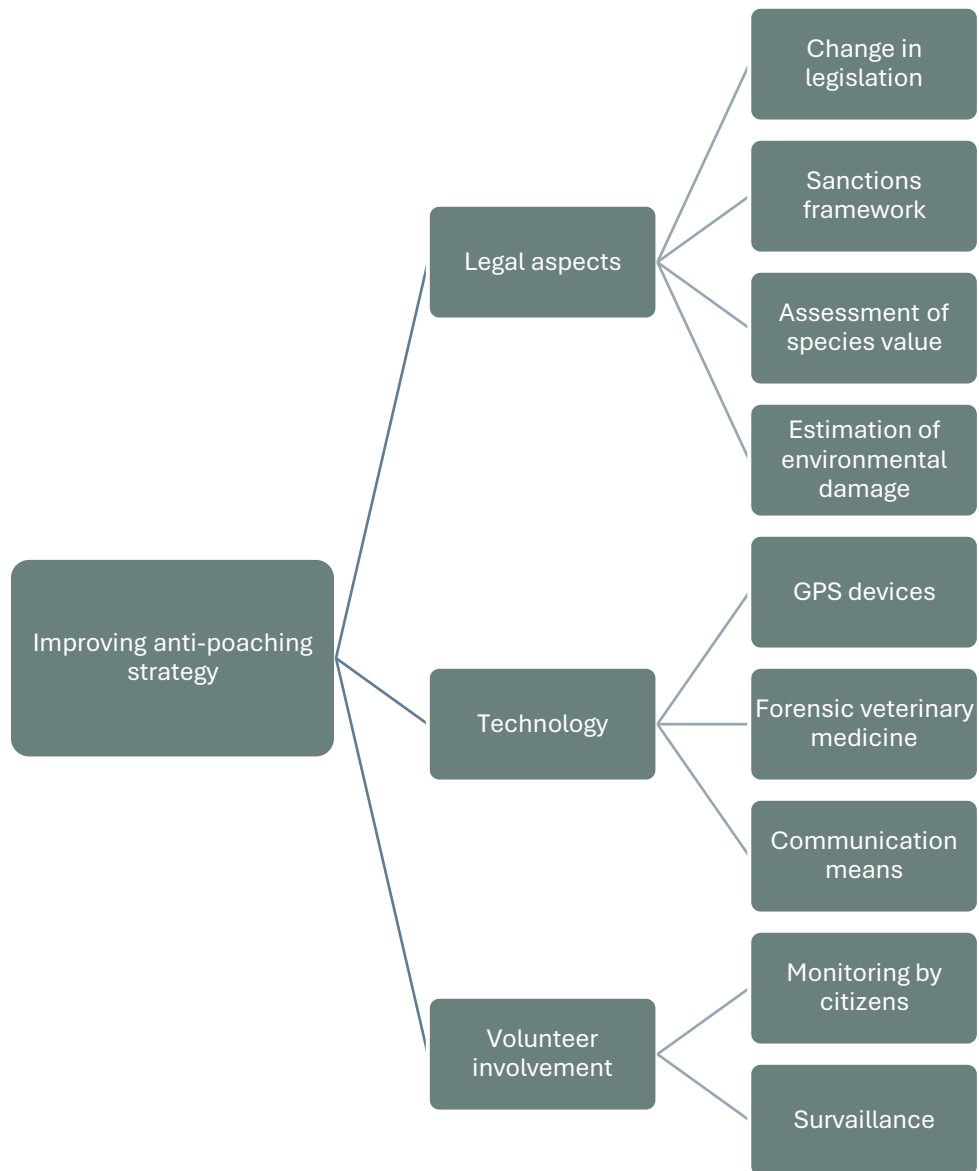


Figure 1 Three key topics that require improvement to enhance the effectiveness of anti-poaching strategies

### Robinson S: ENPE's activities, objectives and history and work around Wildlife crime (IKB training packs and the current objectives of the group)

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The European Network of Prosecutors for the Environment (ENPE), is an EU-funded International Non-Profit Association (AISBL), focused on the provision of support to operational state prosecutors in the fight against environmental crime.

Established informally as a network of 8 prosecutors in 2011, it took shape more formally in early 2012 following a judges and prosecutors conference in Dubuy, Belgium with the intention of setting up a fully registered association, similar to the European Union Forum of Judges for the Environment (EUFJE). On 01 September 2016, the association was formally registered in Brussels, Belgium, by Royal Decree.

Working alongside other European enforcement networks and agencies, such as EUFJE and the European Union Network for the Implementation of Environmental Law (IMPEL), ENPE is a growing network of 62 organisation and individual members, representing 35 countries with active specialist Working Groups established where members deliver training and guidance to help prosecutors tackle environmental crime.

In 2016, as part of the LIFE-ENPE project (project reference LIFE14 GIE/UK/000043), the first ENPE Wildlife Crime Working Group produced a comprehensive set of training packs, in conjunction with the United Nations Environment Programme (UNEP) Convention on Migratory Species (CMS), focused on fighting the Illegal Taking and Killing of Wild Migratory Birds (IKB) in the Mediterranean region of Europe. The conclusion of this collaboration was the publication, delivery and translation of this pack into five languages in 2021 to focus on areas of significant illegal activity, which has been promulgated to thousands of specialists, and which is still being rolled out in several European countries today.

The focus of the training was the activity of IKB and in particular, the Mediterranean region (South and East) where the most significant numbers of wild birds are illegally taken and killed (25 million estimated annually in the whole region – source: “The Killing”, Birdlife International publication, 2014). The joint ENPE and CMS IKB training pack was preceded by a well-attended specialists workshop convened in Segovia Spain, and hosted by the Spanish Ministry for Agriculture, Food, Forestry and Environmental Affairs, where 37 delegates represented 17 different states were present. Of particular significant was the presence of representative from Egypt, Tunisia, Israel and Lebanon, as well as Italy, France, Spain and Cyprus.



Figure 1 Panoramic view of the Segovia ENPE & (UNEP) CMS IKB Workshop, 09 May 2018 (ENPE)

The conclusions and key messages from this workshop were that:

- *Specialist prosecutors greatly enhance the fight against IKB.*
- *The creation of specialised police forces, or their equivalent with police-like powers, greatly increases the possibility of success in the fight against wildlife crime and illegal killing of birds in particular. Spain's SEPRONA provides a good example.*
- *Both the above are most effective when part of a national commitment by the relevant governmental ministries and departments, and with underpinning of modern and effective legislation.*
- *International cooperation on what is a regional, European, Middle Eastern and African problem is vital.*
- *Addressing wildlife crime requires specific training; this workshop delivered an important example in this regard.*
- *Legislation (e.g. on hunting) requires improvement in some countries to enable prosecutors/investigators to clearly distinguish between legal hunting and poaching (which is, in effect, IKB).*
- *The readiness of attendees to initiate and/or support the development of, or proposals for the amendment of, national legislation and to assist relevant ministries/authorities in their countries exists and would increase the effectiveness of enforcement against IKB.*
- *Intensification of international cooperation beyond the European network is intended.*
- *The Intergovernmental Task Force on IKB in the Mediterranean under CMS (MIKT) can play a vital role as a platform for international cooperation<sup>1</sup>.*

The joint ENPE & CMS IKB training pack was developed taking on board the learnings from the workshop and has since been finalized and rolled out in two different formats (one including restricted ongoing cases) to hundreds of specialists in five different languages.

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<sup>1</sup> Magnusson, L., Innes, A., Jarlas, C., Stoykov, S., Almpouras, G., Istad, T. & Van Vossel, B. (2020) Wildlife Crime (WG1). Final Report 2016-2020. LIFE-ENPE Project LIFE14 GIE/UK/000043 Action B2: Working groups to improve consistency and capacity. European Network of Prosecutors for the Environment.

The training was delivered via a series of sessions focusing on the following areas, interspersed with case studies demonstrating best practice:

- Habitats and species protection – collaboration (e.g. RfH)
- Network of Designated European sites e.g. ‘Emerald network’
- Requires action by members in relation to endangered species
- EU contribution is Natura 2000 network
- Highlights specific EC Directives e.g. Birds Directive 2009/147/EC

A key aspect of the over-arching enforcement of this area is the application of enforceable domestic legislation, which was a significant area of discussion.

The Wildlife Crime Working Group re-convened in 2022 and is continuing its work in supporting prosecutors engaged in enforcing wildlife crime across Europe and beyond. The focus is to deliver exemplar case studies from across Europe to demonstrate best practices in prosecution. The group will also seek to co-ordinate their work and deliverables with the European Commission Directorate-General for Environment’s Wildlife Action Plan WAP) whilst at the same time addressing priority areas around wildlife crime prosecution as identified by ENPE’s membership and stakeholders.

## Albarella G: Poaching in Italy

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Around 25 million birds are illegally killed each year in the Mediterranean basin, including more than 5 million in Italy. Within the Mediterranean basin, Italy has the second highest number of illegal killings.

Poaching of birds therefore represents a real threat to the conservation of migratory species in Europe, Asia Minor and Africa

For this reason, the Secretariat of the Bern Convention (Convention on the Conservation of European Wildlife and Natural Habitats) promoted the drafting of an action plan to combat poaching (Tunis action plan), which was then supported by the Bonn Convention (Convention on Migratory Species) through the creation of a specific task force.

In Italy, the main illegal activities are the killing of protected species and, in particular, the use of illegal means such as electronic decoys, traps or nets, hunting in protected areas, hunting in closed periods, hunting without a license, and illegal bird trade.

Due to the widespread nature of the problem and the numerous reports received, the European Commission initiated a pilot procedure against Italy in 2013, which highlighted various critical points in our country regarding effective actions to combat illegal activities, the absence of which could represent a violation of the Birds Directive.

In 2017, Italy adopted a National Action Plan to tackle poaching of wild birds, with the provision of 31 direct and indirect actions. Seven black spots were also identified where 45% of the problem occurs, with the remaining 55% of the country.

Regular operations were carried out by the Carabinieri Forestale in black spots and many others outside. The protection associations often made a significant contribution to the success of law enforcement activities through the work of their volunteers and volunteer hunting guards.

Despite the direct control actions carried out, poaching remains a serious problem.

Unfortunately, many actions of the NAP have not been implemented or only partially implemented, firstly the one concerning the tightening of penalties.

In July 2023, the European Commission opened a new pilot procedure against Italy for infringement of the Birds Directive: among other allegations (concerning hunting times, species hunted and the use of lead-containing ammunition in wetlands), is the failure to implement the NAP.

## Aiello D: Protection of wildlife and Italian legislation: Analysis of recent developments

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Italy's formal commitment to the European Commission, through the publication of the national action plan on combating illegal offences against wild birds, has led to the closure of the EU Pilot procedure (2013)5283, which was initiated in 2013 due to widespread issues related to the missed prevention and repression of crimes against wild birds. Exactly 10 years after the opening of this procedure, the European Commission, prompted by environmental protection associations, reevaluated the Italian case, noting the persistence of a series of critical issues, including "widespread poaching episodes" confirmed by a series of reports from public authorities and NGOs. Other issues include the reduction of police personnel and the failure to increase sanctions against poachers and hunters. These factors have led to the opening of a new procedure: EUP (2023)10542, for violations of Articles 5, 6, and 8 of the Birds Directive 2009/147/EC. The procedure highlights further violations such as:

- the continued issuance of hunting calendars by regions allowing the shooting of certain bird species during their return to nesting sites and the hunting of species in poor conservation status without effectively implemented management plans.
- the violation of Regulation (EC)2021/57 limiting the use of lead-containing ammunition within or near wetland areas. This procedure adds to another one, issued in the same year: EUP (2023)10419, also for alleged violations of the Birds Directive, as well as the Habitat Directive 92/43/EEC determined by the amendment of Art. 19 of Law 157/1992 regulating the management activities of wildlife, which, by reducing the prerogatives of law enforcement agencies and scientific bodies, allows hunters to carry out control activities even in protected areas and during periods of hunting prohibition. This procedure has now turned into a full infringement procedure: (INFR(2023)2187). Despite these consequences, the Italian Government and Parliament, as well as many regions, throughout 2023 continued to enact measures aimed at reducing the already-scarce protections provided by wildlife legislation. In addition to the regulations and administrative measures that have been passed, a number of clearly unconstitutional bills are currently being discussed in Parliament, which, if passed, would mark a further and very serious reduction in protection levels.

## Topic area 1: How to determine the monetary value of wild animals

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### Campanaro C: Why does the environmental and economic value of wildlife legally matter?

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This session will attempt to address the question of why the environmental and economic value of wildlife legally matters. Before delving into this inquiry, it is worth considering why this might be relevant when discussing anti-poaching efforts. The situation regarding biodiversity protection in Europe and in Italy is alarming; every day, hundreds of species are illegally hunted without the responsible parties being identified and convicted. The reasons are varied: inadequate penalties, resulting in a lack of investigations; insufficient oversight of highly dangerous activities for biodiversity protection, such as hunting.

Therefore, we require new and diverse tools to combat poaching and assist judges and law enforcement in identifying poachers. In this context, it is crucial to explore, beyond new scientific tools, the economic and environmental value of biodiversity, particularly of endangered species such as the Northern Bald Ibis. Assuming that behind every specimen belonging to a species lies both environmental and economic value, illegal killings result in not just the loss of wildlife but also environmental and economic harm.

The lecture will briefly discuss the legal framework surrounding the Northern Bald Ibis, including endangered species regulations and potential offenses. Subsequently, it will examine the various types of values and damages associated with wildlife crimes. Indeed, every form of protection — biodiversity, state heritage, and animal welfare — entails both value and subsequent damage. Regarding biodiversity, questions arise regarding how to measure the environmental value of wildlife. This is a crucial issue, as proof of serious environmental damage grants access to significant legal tools, such as Article 452 bis of the Italian Penal Code, which imposes 6 years imprisonment and fines on those who cause substantial harm to ecosystems, biodiversity, flora, or fauna. This provision is much more severe than general penalties related to hunting infringements and facilitates further investigations, such as call records, to combat case dismissals. Additionally, there are no alternative measures, such as probation or compensatory fines, for these offenses.

The pursuit of this penalty necessitates scientific inquiry, what constitutes "significant and measurable compromise" or "deterioration" of fauna, and how is it measured? This underscores the crucial interconnection between science and law in combating poaching. Conservation science must inform legal frameworks to imbue legal proceedings with scientific rigor and support investigations. Moreover, while economic and environmental damage claims can only be pursued against those responsible, in cases where the perpetrator is not found,

such as in most of the poaching cases, there are still numerous avenues available if we possess detailed information about the environmental value of endangered species.

This data could be utilized to advocate for increased investigations, oversight, legislative changes, or the suspension of specific activities causing significant environmental and economic damage, all in the collective effort to effectively protect wildlife.

## Fritz J: What is the value of a Northern Bald Ibis?

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I will try to raise questions about what the value of a Northern Bald Ibis is. Maybe also clarifying right at the beginning that the Northern Bald Ibis is just a representative for many endangered species which face the threat of illegal hunting. I think all of you more or less know this migratory ibis species. It went extinct in Euro parts already 400 years ago. Since 20 years we are aiming to reintroduce a migratory population in Europe by the use of this human-led migration as a reintroduction method. Meanwhile, we have a wild living population which migrates in autumn down to the wintering site in Tuscany and in spring back to the breeding sites north and south of the Alps, where they raise their chicks. This population consists of about 250 birds, which is already close to the threshold for self-sustainability.

Actually, almost 80 % of the birds carry GPS devices. In his speech, Bernhard Gönner will tell you more about this from a technical perspective. It provides us with a huge dataset, essential to understand the spatial temporal pattern of the birds, but also allowing us to define and identify the cause of death for about 55 % of the losses.

According to these data, the main mortality cause in our population is electrocution with 44 %. This means the birds use medium voltage power poles to roost and sleep. And due to their size, if these power poles are not protected accordingly, then they come into the electric circuit and die.

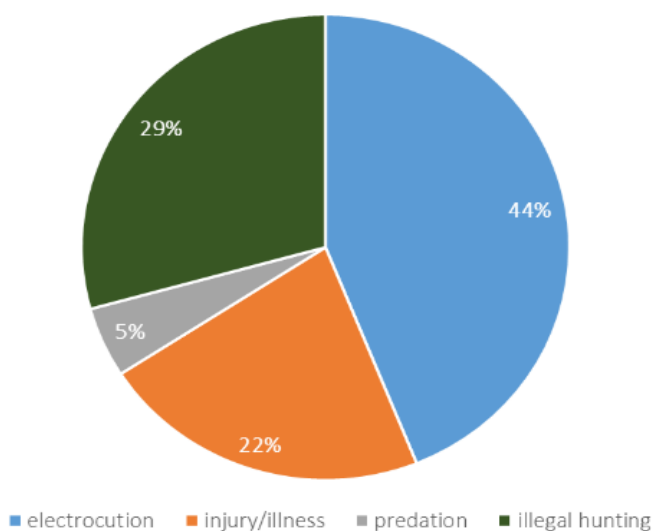


Figure 1 Mortality statistics in Italy 2014-2020

Electrocution occurs in all countries except Germany, where the majority of power poles are retrofitted, whereas illegal hunting on Northern Bald Ibises happens almost exclusively in Italy. About 58 % of the losses in our population are on Italian territory. Out of these losses, 29% are due to illegal hunting (Fig.1), so almost one third.

I want to tell you shortly the story of our most prominent birds called GoJa. In 2009, this human raised female followed a ultralight aircraft to Tuscany. In 2011, it became the first bird which migrated from

Tuscany on its own back to the breeding site Burghausen in Bavaria. One year later it again returned to Bavaria and became the first bird which raised two chicks and guided them to

Tuscany. This bird's behaviour was really essential for our project, it basically represented the success of 13 years of feasibility study.



*Figure 2 Jane Goodall is telling the story of GoJa with a feather of GoJa in her hand.*

But in autumn 2012 the story ended dramatically, when a hunter in the region of Livorno shot GoJa together with one of its offspring. This became the first and so far, the only case where the hunter could be identified and sentenced. He was by the way a member of Federcaccia.

The damage estimate in this case was 11,000 Euro for GoJa and only 1,900 Euro for Yedi because it was in the periods of the project where we had only very low budgets.

So, this damage estimate not at all

represents the value of these two individuals for our project and for conservation of the species in general.

Therefore, the concept of financial damage estimation based solely on effective investments is a common legal practice. It makes sense to assert this effective economic damage in the context of criminal proceedings. But from a general perspective, a new concept is needed to define the value of wild animals and the damage resulting from environmental crime in terms of ecological and societal losses. This concept needs to concern values for human societies like ecosystem services and cultural values. It also needs to concern the effect of the species on its environment. But beyond that the concept should also include what is called intrinsic values.

Intrinsic value in animal conservation refers to the idea that natural entities have inherent worth and value, independent of their usefulness or benefits to humans. This implies that the value of a species or the damage caused by the loss of individuals of a species is greater the rarer the species is. That's basically also the concept of the IUCN Red List. And regarding this, the Northern Bald Ibis has a high intrinsic value, since it was critically endangered for 24 years before it was downlisted to endangered in 2018.

The Northern Bald Ibis is not regarded to have a disproportionately large effect on its environment, therefore it is not regarded as an ecological keystone species. This is at least the assessment based on the limited knowledge we have of the species so far.

In history, the species provided ecosystem services to humans in terms of food, as it was known as a well-tasting food species. It hunted and chicks were collected out of the nests. Nowadays, the immediate benefit for people is more cultural and socioeconomical. For example, the presence of birds in the breeding grounds and the accompanying media presence is used by tourism, trade and artists. In addition, the species also has increasing cultural value as a keystone species for research into bird flight and migration. Scientific articles are continually published on this subject.

Our project was already twice rewarded by funding out of the European LIFE-program. This repeated funding is based in particular on the fact that the species is classified on the Red List as threatened with extinction. The European Community thus recognises the fundamental right to life and thus the intrinsic value of this species. This is a remarkable feature of this funding programme, and it distinguishes our European society. However, there is still a long way to go from this general recognition of the right to life until this intrinsic value is also manifested in various societal contexts. A significant context for species protection is the jurisprudence surrounding environmental crime. This is an area in which we want to continue to engage even more intensively in the future.

# Montanaro D & Calcagni L: The Environmental Liability Directive and its implementation in Italy: an instrument for the biodiversity restoration

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The Environmental Liability Directive (ELD - Directive 2004/35/CE) represents a pivotal piece of legislation within the European Union's environmental law framework. Enacted on April 21, 2004, the directive introduces a comprehensive liability regime aimed at preventing and remedying environmental damage. It underscores the 'polluter-pays' principle, thereby ensuring that operators whose activities have adversely affected natural resources are held financially and legally responsible for a "compensation in kind"; monetary compensation is not permitted.

The ELD was implemented into Italian law in 2006, within the sixth part of the Environmental Code (law n° 152/2006), identifying the Ministry of the Environment as the competent authority responsible for fulfilling the provided duties. Since then, ISPRA (Italian Institute for the Environmental Protection and Research) has been the main technical and scientific body called upon to provide support in a large number of cases of environmental damage assessment. This role was strengthened in 2017 with the establishment of the SNPA (National System for Environmental Protection), a network made up of all local and provincial environmental agencies coordinated by ISPRA, with the task, among others, of supporting the Ministry of the Environment in environmental damage proceedings.

Within the framework of the ELD, 'environmental damage' is a term that connects to broader concepts. It is defined as a significant and measurable adverse change to natural resources, specifically protected species, natural habitats, water, and land referring to other active EU instruments aimed at protecting the environment, such as the Habitats Directive, the Birds Directive, the Water Framework Directive, and the Marine Strategy Framework Directive.

One of the main problems encountered in the implementation of the ELD lies in the phase of damage assessment. Indeed, the law gives definitions of the environmental damage for all the natural resources covered, but there are no indications regarding the methods of assessment. In particular, the environmental damage to protected habitat and species is defined as significant adverse effects on reaching or maintaining the favourable conservation status of such habitats or species. The concept of favourable conservation status of a natural habitat and a species is made explicit in analogy with what is reported in the Habitats Directive. Moreover the ELD indicates a list of measurable data that should be considered to determine the significant adverse change to the baseline condition such as: the number of individuals, their density, or the covered area; the role of specific individuals or damaged areas in habitat conservation; the rarity of the species or habitat at local, regional, and Community levels; the species' propagation capacity and viability, as well as the habitat's ability to regenerate naturally; the potential for recovery within a short time without intervention, leading to a

condition equivalent to or better than the baseline. Actually, a measurement of these parameters is not easy and the ELD does not indicate thresholds or criteria to be considered for the ascertainment of the significance of an impairment.

Trying to solve the issue of the national ELD implementation and to standardise environmental damage assessment procedure, ISPRA has developed, within the SNPA network, a guideline defining methods and criteria for the evaluation of the environmental damage (SNPA Guidelines n. 33/2021). Firstly, SNPA introduced the concept of “clues of environmental damage” which means data, circumstances or other element indicating the possible existence of environmental damage. If clues are founded, an accurate investigation becomes necessary to demonstrate the significance and the measurability of the damage. Regarding biodiversity, two types of clues were defined: direct clues, when it is known that an event had impacts on protected species or protected habitat, and indirect clues, when it is known that an event had impacts on the habitat of a protected species or on the species typical of a protected habitat. In any case, the ascertainment of the environmental damage should be carried out at both national and local scale. As an example, the schemes of the analysis in case of the ascertainment of damage to birds covered by Birds Directive at national and local scale are reported in figure 1 and 2 respectively. For the evaluation of significant adverse effect on the conservation status of birds at national scale, the analysis is mainly conducted by considering data on population and their risk of extinction based on the IUCN Red List. As can be seen in figure 1, threshold values defining the significance of deterioration of nesting birds’ population (i.e. killing of birds) have been identified (1% of natural mortality, or 5% for birds Least Concern in the Red Lists). The definition of these values was based on the EU Commission Guidance Document “Hunting under the Birds Directive” which indicate the same values as one of the conditions that must be fulfilled by Member State for derogation from hunting prohibition. The assessment on a local scale (figure 2) can be much more complex as it often requires studies and evaluation conducted on-site and guided by an expert judgement. If the damaging event occurred within a Natura 2000 area, the evaluation could refer to the information contained in the Standard Data Forms considering, in particular, the classification of the degree of conservation of the habitat for the species. In all the other cases an analysis of at least two parameters becomes fundamental: the value of the species (rarity/peculiarity) and its capacity of recovery.

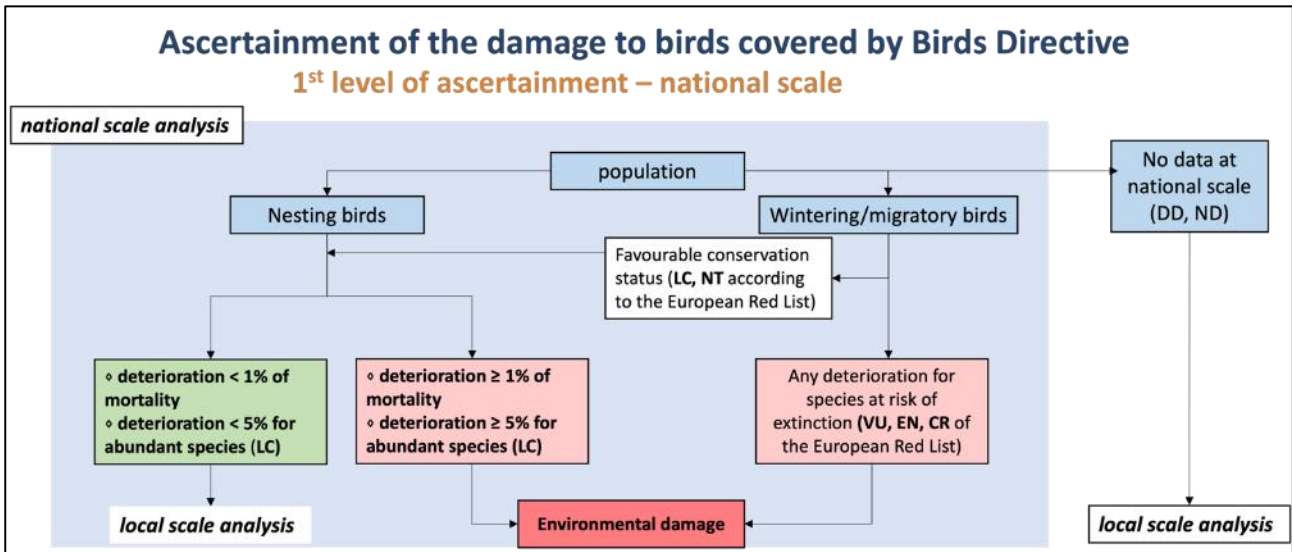


Figure 1 Ascertainment of the damage to birds covered by Birds Directive - national scale analysis (source: SNPA Guidelines n° 33/2021)

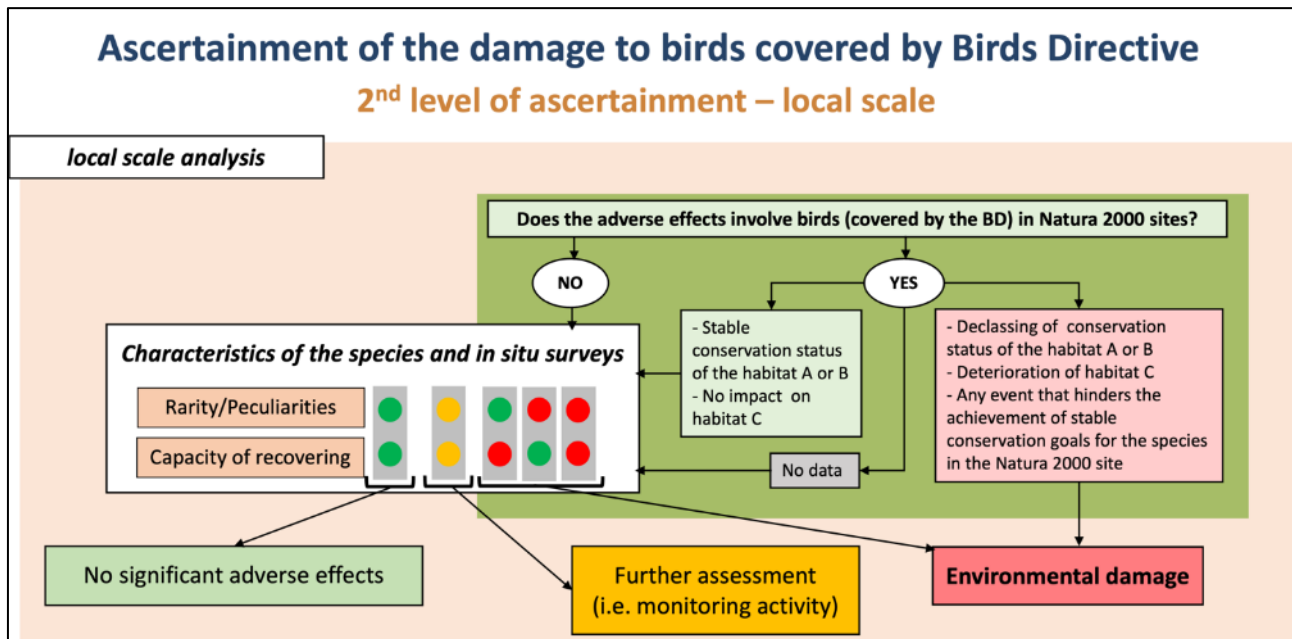


Figure 2 Ascertainment of the damage to birds covered by Birds Directive - local scale analysis (source: SNPA Guidelines n° 33/2021)

In case of damage to protected habitat and species (and water) the ELD provides three kinds of remediation: primary, complementary and compensative remediation. “Primary remediation” means any measure able to return the natural resource to its baseline condition or towards the baseline condition. Even natural recovery, if it occurs in a short time, and all the actions that can favour this process can be considered as primary remediation. When the primary remediation is not sufficient to reach the final goal, a “complementary remediation” is necessary, that is any other measures, even in another site, able to bring the natural resource or services provided by it to the original state. The third type of remediation is the “compensatory remediation” which means any action that must be implemented to consider the interim losses. Interim losses can be defined as a temporary damage cause by the fact that

the damaged natural resources are not able to perform their ecological functions or provide services to other natural resources or to the public, from the time of the damaging occurrence until the moment when the primary or complementary measures have taken effect (figure 3).

The remediation of protected habitat and species under ELD, supporting their return to the original status also considering the interim losses, represents an effective tool to guarantee the biodiversity restoration against the negative effects induced by damage anthropogenic occurrences.

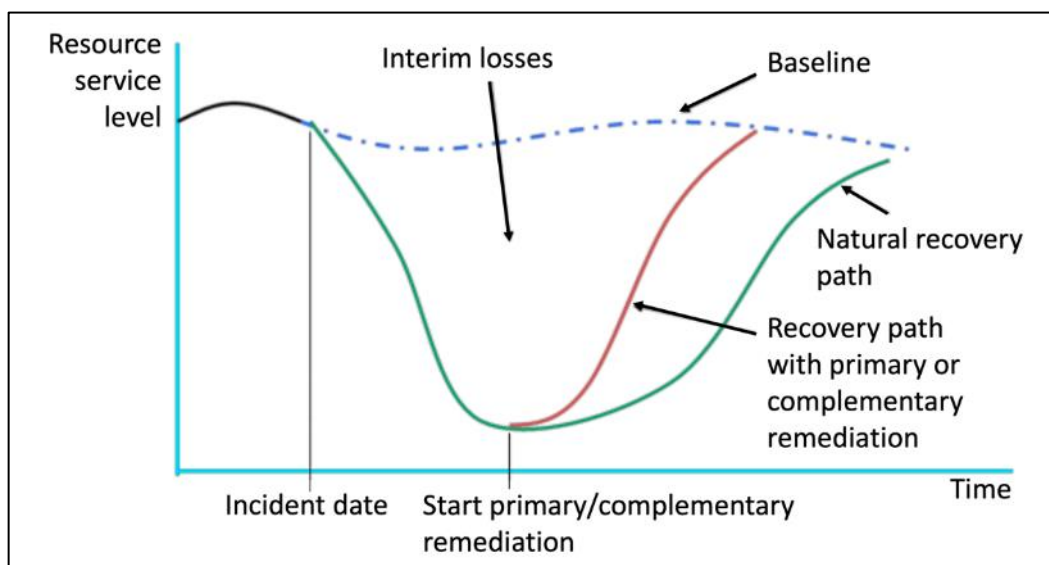


Figure 3 Remediation of the environmental damage

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## Look S: wildLIFECrime - Concept of a transnational Eproject to combat wildlife criminality in Germany and Austria

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Much is being done at national and EU level to protect endangered species, yet wild animals - including strictly protected ones - are often acutely threatened by illegal persecution. Wildlife crime does not only take place in Africa or Asia, but on our doorstep. The illegal killing of protected species by shooting, trapping and poisoning is also a well-known problem in Austria and Germany. Besides rare birds of prey, the victims are also lynxes, wolves, beavers and otters.

In addition to national and international law, all EU member states have committed themselves in EU directives to protect endangered species from illegal acts and to apply effective, dissuasive and proportionate penalties for environmental offences. Through many years of documentation, illegal persecution has been identified as one of the most important causes of death, e.g. for white-tailed eagles or imperial eagles. But other birds of prey and mammals also suffer from this threat. For species that have almost or completely disappeared from Germany and Austria and are now re-establishing themselves here, illegal persecution has particularly drastic effects, as the loss of even one individual can endanger their return and destroy cost-intensive conservation measures.

However, it is assumed that only a small proportion of cases are actually discovered and that this is the "tip of the iceberg". The extent of illegal persecution is often underestimated and only becomes known through the work of those involved in nature and species conservation. It has become a priority for the police in Europol's EMPACT initiative, but there is still a lack of knowledge and experience in dealing with these special offences. Particularly in the justice system, wildlife crime is often given a lower priority, as there are a multitude of other cases and awareness of its serious impact on conservation is still relatively low. The conviction of responsible perpetrators therefore remains the absolute exception at present.

The wildLIFECrime project aims to sustainably reduce wildlife crime in Germany and Austria. With a holistic approach, illegal persecution is to be tackled together with relevant institutions and stakeholders at all levels:

### *Prevention*

A variety of measures are to be applied to prevent illegal wildlife persecution from occurring in the first place:

- Research to better understand motives for illegal persecution
- Active conflict management in hot spot areas

### *Detection, expert processing, and forensic investigation of cases*

It is fundamentally important that cases of wildlife crime are discovered and reported. These must then be recorded and optimally processed for further police investigations as well as forensically examined. This is achieved by:

- Capacity building of stakeholders and existing networks to improve the identification, documentation and reporting of potential cases
- Development/establishment of reporting platforms and databases for case registration
- Optimization of forensic methods and knowledge transfer between laboratories

### *Increased knowledge among police, public prosecutors, and judges*

A lack of experience and reference cases means that cases are often not adequately investigated, are closed without a trial, or the sentence remains significantly below the legal possibilities. So far, there are hardly any further training opportunities in the field of species protection, especially in law enforcement and the judiciary. The following activities are planned:

- Target group-specific further training offers and practice-oriented guidelines for relevant authorities (criminal police, environmental police bodies, public prosecutors, and judges)
- Creation of a "case database" with examples of relevant species protection criminal cases with complete judgements
- National, transnational and international networking of central actors in the criminal justice chain

### *Improved legal framework*

Several measures are envisaged for more effective prosecution of species protection offences:

- Evaluation of the legal framework, analysis of deficiencies and obstacles in the prosecution of wildlife crime and development of concrete proposals for its improvement
- Proactively engage decision-makers and political representatives to increase participation, ensure access to justice and share conservation-related information
- Regular dialogue with competent authorities and involved stakeholders on the challenges and approaches to solutions in species protection law

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<sup>3</sup> European Commission (1992) Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of

# Desair J & Samson-Divisia A: The Bioval Project: a non-binding, practical instrument to value ecological damages in court

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BIOVAL is a joint project of the [EU Forum of Judges for the Environment \(EUFJE\)](#), [the European Union Network for the Implementation and Enforcement of Environmental Law \(IMPEL\)](#), and [the European Network of Prosecutors for the Environment \(ENPE\)](#). It aims at creating a non-binding, practical instrument to value damage to nature in court.

## The genesis of BIOVAL:

The project started in 2020, on the ground of the constatation, derived from a decision by the Court of appeal of Ghent of 28 June 2018, that damage to nature was very often impossible to repair *in natura*. In that specific case, the Court found that it was impossible -and prohibited by the law- to breed and re-introduce into nature marsh harriers to replace the ones that had been poisoned by the offender. In such cases, although monetary compensation may be explicitly allowed by the law, judges are often ill equipped, for lack of time, tools, and scientific expertise, to value the damage to nature and calculate accurate financial compensation. Through a survey carried out among EUFJE's EU members in 2020, the BIOVAL team found that, even though valuation systems or compensation lists exist in some countries (e.g. Bulgaria, Croatia, Estonia, Finland, Hungary, Latvia, Lithuania, Romania, Spain), the amounts vary significantly from country to country or region to region (e.g. Spanish regions), the criteria and grounds behind the calculation were unclear, if mentioned at all (except for Finland), and difficult to obtain.

The BIOVAL project was therefore initiated to help legal professionals calculate a financial compensation for damage to nature when restoration *in natura* is not possible. BIOVAL focuses, not on sanctioning, but on financial restoration. Without prejudice to the Environmental Liability Directive, BIOVAL is based upon the principles of environmental liability and “the polluter pays”.

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wild fauna and flora.  
<https://eur-lex.europa.eu/eli/dir/1992/43/oj/eng>

European Commission (2008) Directive 2008/99/EC of the European Parliament and of the Council of 19 November 2008 on the protection of the environment through criminal law <https://eur-lex.europa.eu/eli/dir/2008/99/oj/eng>

European Commission (2009) Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds  
<https://eur-lex.europa.eu/eli/dir/2009/147/oj/eng>

Examples of projects: EDGAR project in Germany <https://www.greifvogelverfolgung.de>, PannonEagle LIFE for Central Europe <https://www.imperialeagle.eu> or LIFE Euro Large Carnivores <https://www.eurolargecarnivores.eu/en>

The major advantages of using such a valuation instrument in administrative, civil or criminal procedures would be the greater legal certainty and the shorter case duration. It may also lead to more equal treatment of similar cases assessed in different contexts (different regions, different courts, different procedures...). BIOVAL also contributes to reaching the goals of the EU Biodiversity Strategy 2020-2030 of improving enforcement and restoring nature. BIOVAL is also in line with the requirements of Article 5§3(a)(ii) of Directive 2024/1203 of 11 April 2024 on the protection of the environment through criminal law, as it provides authorities with a tool to calculate financial compensation when damage to the environment is irreversible or cannot be restored by the offender.

The BIOVAL methodology was developed with the expertise of the Research Institute for Nature and Forest (Instituut voor Natuuren Bosonderzoek – INBO), from 2021 to 2024, after examining existing price list systems and literature on the topic. Draft reports were presented and discussed at several expert workshops in 2022 and refined after each workshop to take into account the feedback thus received. The methodology was finalised in January 2023, together with a first list of compensation values for 100 species of vertebrates including birds, mammals and reptiles.

#### The methodology:

Valuing nature is not something that should be done without thorough consideration and a clear aim. The danger of commodifying nature always lurks around the corner and multiple valuation methodologies are available, all leading to a different but potentially incomplete outcome. It is therefore imperative to set up a robust and inclusive valuation process. In BIOVAL, the team built on the latest scientific insights to provide a robust, relevant and inclusive valuation of nature, taking into account its plural values.

The BIOVAL methodology consists of an additive formula including four criteria that are evaluated for the species that has been irreversibly damaged: extinction risk, ecological significance, cultural significance and contribution to welfare. The outcome is scaled to an acceptable monetary amount through a fifth criterion, which is the size or lifespan of the species. The formula is weighted, giving the most importance to extinction risk, and compensations are increasing exponentially as species are assessed at higher levels for the criteria. This resulted in compensations ranging from €83 to €50.000. The list of compensations is subsequently obtained through assessing the five criteria in a Delphi expert workshop and a final correction for enforceability. With this novel way of calculating compensations for irreversible damage to nature, the different values of nature are reflected, leading to a more balanced outcome. The formula is a scientifically grounded, socially acceptable and transparent way of calculating the compensation for the damage to species. However, it is not a calculation of the value of a species and should therefore never be applied outside of the intended use.

#### The development of case law using the BIOVAL tool:

The BIOVAL methodology was successfully used in a first case in March 2023, confirmed in appeal in January 2024:

On 7 March 2023, the Criminal Court East-Flanders, Ghent division, ordered a financial compensation, for illegal catching of starlings, of 15.400 EUR (200 EUR x 77 starlings), using the BIOVAL calculation method (extinction risk: 2 EUR + cultural value: 166 EUR + ecological value: 16 EUR + contribution to prosperity: 16 euros = 200 EUR per starling). This decision was made considering that restoration in nature was impossible and even prohibited by the law (Flemish Species Regulation of 15 May 2009). This civil compensation was to be paid to the Flemish Environment and Nature Fund for environmental restoration purposes (Mina Fund – public fund financing prevention and remediation projects relating to nature and the environment) and is distinct from the criminal sanction that was ordered (120 hours community service).

The decision was appealed. On 26 January 2024, the Court of appeal in Ghent upheld the decision, considering that compensation was the only possible form of recovery, as the breeding and release of starlings to repair the damage caused to nature was impossible and prohibited by the law. The court approved the amount of the compensation calculated through the BIOVAL methodology, and approved the attribution of the compensation to the Mina Fund as a public fund that is *“partly funded according to the principle ‘the polluter pays’, in this case ‘the perpetrator pays’”* and whose purpose is *“to cover the costs of decontamination and restoration not covered by the revenue from levies and fines”*. The court added that *“(t)his compensation restores the legal situation”*.

The BIOVAL calculation method was used again by the Court of First Instance of East-Flanders, Oudenaarde division, on 27 February 2024, in a case regarding various CITES breaches and involving 43 species. Considering that restoration in nature was impossible and prohibited by the law, and that the author of environmental crime causing damage to such an extent that it cannot be repaired may not escape his obligation to repair, through monetary compensation to the MINA Fund. The Court added that this compensation may be ordered at the request of the Public Prosecution Service or *ex officio*, and ordered the defendant to pay a total of 68,545.06 EUR to the MINA Fund. The decision was appealed and the proceedings are still ongoing.

#### The BIOVAL Tool website and dissemination:

Throughout 2023, the BIOVAL project was presented at several events to judges, prosecutors and other legal practitioners. The BIOVAL team also started developing a practical online tool that legal professionals in Flanders could use or from which legal professionals in other regions and countries could draw inspiration to value damage to nature in court.

In May 2024, the BIOVAL Tool website was launched at <https://biovaltool.eu>. It presents and explains the methodology, provides for an indicative list of compensation values developed for the Flanders region of Belgium, and offers summaries of cases using the BIOVAL calculation method and compensation list.

On May 2024, the French newspaper Libération published an article on BIOVAL based on an interview of the BIOVAL team (EUFJE and INBO). It is available at:

[https://www.liberation.fr/international/europe/elections-europeennes-grace-a-des-ong-les-atteintes-au-vivant-mieux-indemniees-20240522\\_BMB5Y34FIRCDLKUUZ5B2M56ZRA/](https://www.liberation.fr/international/europe/elections-europeennes-grace-a-des-ong-les-atteintes-au-vivant-mieux-indemniees-20240522_BMB5Y34FIRCDLKUUZ5B2M56ZRA/)

The BIOVAL team is now working on the next steps, including setting up training sessions for judges and other legal professionals, meeting with European and national institutions and experts with a view to impulse a wider development of similar tools throughout Europe, as well as possibly expanding the list of species and the scope of the tool.

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## Andreotti A: Economic assessment of bird mortality. The case study of lead-poisoned waterbirds as the result of lead gunshot ingestion

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Lead poisoning is a well-known threat to waterbirds. To avoid bird mortality from the ingestion of spent lead gunshot lying on the bottom of wetlands, on December 3<sup>rd</sup> 2015 the European Commission asked the European Chemicals Agency (ECHA) to prepare an Annex XV restriction dossier pursuant to Article 69(1) of Regulation (EC) 1907/2006 with a view to introduce a restriction on the use of lead gunshot in wetlands.

During its accurate investigation, ECHA gathered information on every aspect related to this issue, identifying pros and cons of a restriction. However, available data did not allow ECHA to economically quantify the benefits that may arise from the phasing out of lead cartridges. To overcome this problem that could undermined the approval of the restriction, a group of researchers carried out an ad hoc assessment.

In European wetlands, at least 40 bird species are exposed to the risk of lead poisoning caused by ingestion of spent lead gunshot. Adopting a methodology developed in North America, about 700,000 individuals of 16 waterbird species were estimated to die annually in the European Union (EU) (6.1% of the wintering population) and one million in whole Europe (7.0%) due to acute effects of lead poisoning. Furthermore, threefold more birds suffer sub-lethal effects.

The economic loss due to this lead-induced mortality of these 16 species was assessed by calculating the costs of replacing lethally poisoned wild birds by releasing captive-bred ones. The cost of buying captive-bred waterbirds for release was assessed based on market surveys, whereas the number of captive-bred birds to be released to compensate for the loss was calculated taking into account the high mortality rate of captive birds (72.7%) in the months following release into the wild. Following this approach, the annual cost of waterbird mortality induced by lead shot ingestion was estimated at 105 million euros per year in the EU countries and 142 million euros in the whole of Europe. For several reasons these figures should be regarded as conservative. Inclusion of deaths of species for which there were insufficient data and delayed deaths caused indirectly by lead poisoning and effects on reproduction would probably increase the estimated losses substantially. Nevertheless, these results were enough to suggest that the benefits of a restriction on the use of lead gunshot over wetlands could exceed the cost of adapting to non-lead ammunition.

The methodology followed to assess the economic value of waterbirds was validated by the Committee for Socio-Economic Analysis (SEAC) of ECHA and the results of the study were included in the restriction dossier submitted by ECHA to the European Commission. Furthermore, the entire procedure followed to monetize the loss of birds was published on a scientific journal, so that the same methodology could be used in other contexts to quantify the environmental damage related to the loss of wild birds.



## Gómez González J: Wildlife Value Framework and changes in value perceptions induced by tourism: Case study in the Colombian Amazon

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Wild animals are important worldwide because of the multiple values they represent for human societies. Different frameworks have been proposed to understand the values of wildlife from economic and noneconomic perspectives. Despite efforts from different disciplines to provide a holistic framework for the analysis of wildlife values, the focus is still based on the monetary value derived from market prices. Introducing a comprehensive value wildlife framework aims at analyzing the broad spectrum of values that wildlife represents to human societies and to describe the steps that allow a comparison of benefits and costs perceived by different stakeholders under various management interventions. Currently, implementation of the framework is underway in the municipality of Puerto Nariño, situated in the Colombian Amazon. The objective is to discern how socio-economic shifts induced by tourism have altered the perceived wildlife values among different stakeholders.

## Topic area 2: Enhancing crime scene investigations with advanced remote monitoring technologies

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### Rutz C: Using cutting-edge bio-logging technologies for detecting and reporting animal deaths

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In this talk, I will provide an overview of how state-of-the-art animal-borne tracking devices ('bio-loggers') can be used to detect and report mortality events in wild animals. Specifically, I will discuss approaches to inferring deaths from movement patterns and other sensor readings, to collecting additional data to map environmental context and gather evidence of potential criminal activity, and to relaying relevant information in near-real-time to researchers, conservation practitioners and other stakeholders. In my view, recent advances in bio-logging technology can be leveraged to remotely document natural mortality events and illegal killings, making important contributions to wildlife conservation.

## Gönner B: Status-quo of GPS monitoring possibilities in NBI project

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After years of feasibility studies, the reintroduction of the Northern Bald Ibis in Central Europe started in 2014, in the context of an EU funded LIFE+ project (LIFE+12 BIO/AT/000143 – LIFE Northern Bald Ibis). In the project we also had the necessary funding for GPS-monitoring of almost the whole population. In ten years – from 2014 until 2023 – we purchased 681 transmitters and spent more than half a million euros on GPS-tags, data transfer fees and material. Therefore, we were able to equip about 80-90 % of the population with GPS transmitters.

When starting in 2014, we used battery-powered GPS transmitters. Until 2019 we used a total of 185 devices. They consisted out of a tracking and communication module, which were very small (only 46 x 21 x 6.5 mm) and light (1.4 grams). The system was completed by a SIM card and a 670 mAh lipo battery. Data were sent via SMS. Obviously, these tags had some constraints. The birds needed to be caught regularly to change or recharge the battery. There was always the trade-off between the number of positions/data-points per day and the battery lifespan. These tags were assembled by our project staff, which effected the reliability of the systems. The advantage was that the transmitters were very slim and most of the time covered by the feathers, when put on the back of a bird in a foil-covered backpack.

To avoid regularly catching the birds to recharge the batteries, we started to use solar powered GPS transmitters. In 2016 we tried a prototype produced by the University of Konstanz. We also purchased transmitters from Anitra in 2021 and from Druid/Interrex in 2023. But our main supplier over the years is "Ornitela", UAB from Lithuania. Since 2018 we purchased 421 "OrniTrack-E25"-transmitters (see figure 1a-c). The housing was specially modified for us, with adaptations of the lateral attachment points and the bridge between solar panel and transmitters. In total the transmitter has dimensions of 61 x 25 x 20 mm and weighs 23-25 grams. Since 2023 we purchased transmitters with 4G-technology, as Switzerland already turned off the 2G and 3G network. Right now (April 2024), we have 201 active devices and 220 suspended or terminated devices. These transmitters have a strong waterproof housing, which is 3D printed, a solar panel, an internal Lithium-Polymer battery and a high sensitivity 99 channel module GPS receiver. They are equipped with a GSM/GPRS or a 4G-module (depending on which model it is) and several other sensors, including 3-axial accelerometer, 3-axial magnetometer, temperature sensor and light intensity sensor. The transmitter is put on the lower back of the bird via leg-loop of Teflon tube. The advantage of the solar powered transmitters is that no recharging is necessary, and they provide huge amount of data with data points every 15 min – or even more. We also purchase these transmitters as complete system, including the transmission of data. A disadvantage is that the solar panel needs to be elevated to be exposed to sunlight as much as possible and is thereby not covered by feathers, which might also have negative aerodynamic effects.



Figure 1 a-c: Pictures of the OrniTrack-E25 transmitter with adaptation of the bridge and four lateral attachment points, used in the “LIFE Northern Bald Ibis”-project.

In 2017 we discovered that some birds which carried solar powered GPS transmitters suffered from a unilateral corneal opacity (Fritz et al. 2020<sup>5</sup>). From 2016 until 2018 a total of 25 birds were affected in varying intensity, up to blindness. In all cases only one eye was affected, and it only appeared in birds carrying solar transmitters fixed on the upper back via wing loop. In most cases the opacity was reversible, when the transmitter was removed or fixed on the lower back via leg-loop. Northern Bald Ibises roost with their head on the back, one eye closely placed to the device, if it was positioned on the upper back. In this case the opacity is probably caused either by repetitive slight temperature rise in the corneal tissue due to electromagnetic radiation by the GSM module of the device or by a repetitive slight mechanical irritation of the corneal surface. We still don't know how exactly that works and want to investigate this further in the future. Since we placed all transmitters on the lower back, we had no further cases in our population.

The “OrniTrack E-25”-transmitters provide a lot of data for every data point, including technical information (identification number of the device, date & time of the data point, number of satellites during GPS fix, battery voltage and current charging by the solar panel, horizontal dilution of precision of GPS fix). From the GPS module latitude and longitude are transmitted, as well as altitude above mean sea level, ground speed and movement direction, all measured via GPS. The transmitter also provides data from a magnetometer and an accelerometer, both in X-, Y- and Z- axis. It measures the internal temperature of the transmitter and the light intensity.

Most of our transmitters in use are set to collect a data point every 15 minutes from sunrise till sunset and transmit the data every 4 hours. For example, on April 15, 2024 we received 58 data points from the GPS-transmitter of “Merle”, who is currently staying at Albinia, Italy in the wintering area (see figure 2). By analysing the GPS data in combination with for example altitude and ground speed, we can interpret what the birds are doing where. In total we receive about 10,000 data points every day. All data are published at the online data base “Movebank” ([www.movebank.org](http://www.movebank.org)). In total there are already more than 12 Mio deployed datapoints of our reintroduced Northern Bald Ibis population in “Movebank”.

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<sup>5</sup> Fritz, J., Eberhard, B., Esterer, C., Goenner, B., Trobe, D., Unsoeld, M., Voelkl, B., Wehner, H., Scope, A. (2020) Biologging is suspect to cause corneal opacity in two populations of wild living Northern Bald Ibises (*Geronticus eremita*). *Avian Res.* 11, 38. <https://doi.org/10.1186/s40657-020-00223-8>

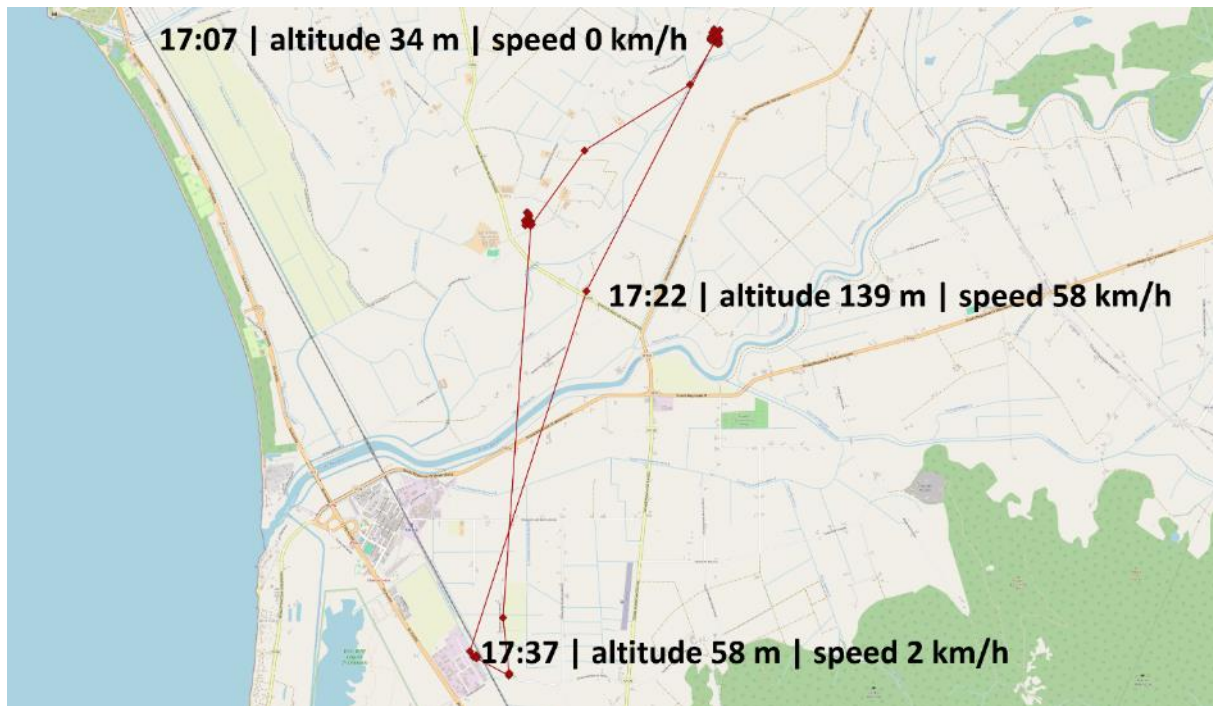


Figure 2 Data from the GPS-transmitter of “Merle” from April 15, 2024 with additional information (time, altitude, ground speed) for three consecutive data points.

The data provided by the accelerometer and magnetometer also enable analyses on the behaviour and well-being of the tagged birds. This can be seen in the data of the last days of “Knubble” in December 2023 (see figure 3). “Knubble” hatched 2023 in Überlingen at Lake Constance. In autumn the juvenile bird lost the connection to experienced birds which knew the route to the wintering area in Central Italy. Then she did something unexpected. On December 15 she started to fly south-west over the Mediterranean Sea, crossing open water, which is normally avoided by Northern Bald Ibis, as there are no up winds. Nevertheless, “Knubble” flew to Corsica, and further on the next day, more than 700 kilometres over open water from Corsica to an oil rig near the coast of Spain. After spending the night there, she flew on to the mainland and spend the next days in the area. Unfortunately, “Knubble” was shot dead just 10 days later on the December 26. All these events can be identified in the data from the accelerometer (figure 3). In the days flying over the sea the accelerometer shows very high amplitudes in the z-axis, higher than in the days after, when the bird stayed on the mainland. Starting on December 26, when she got shot, the accelerometer indicates reduced activity, probably due to the injury, and later no activity, because “Knubble” has died. The last data points with big changes are caused when the body was found and moved by a local environmental agent. During the night the transmitters are inactive and provide no data points, which causes the straight lines in the data from the last datapoint of the previous day to the first data point of the next day. These does not indicate a time of no activity – although the activity during night is probably lower than during day.

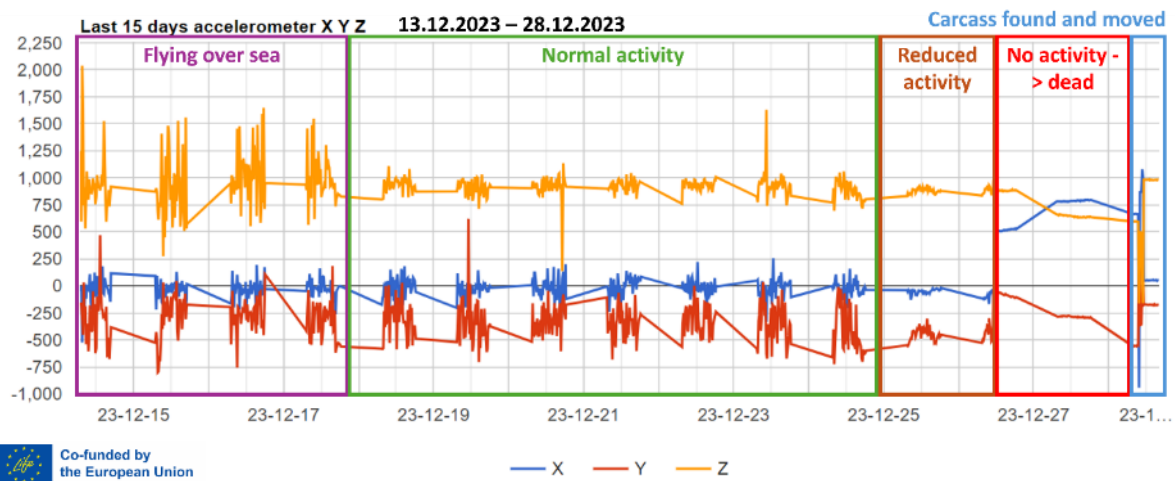


Figure 3 Data from the accelerometer of “Knubbel” for the last 15 days (13/12/2023 – 28/12/2023) including an analysis of the behaviour/condition of the bird. The transmitter is not active during the night and therefore does not provide data points during this time, which corresponds with the straight lines every day.

In summary, we spend a lot of money and effort in the GPS-monitoring of about 80-90 % of the reintroduced Northern Bald Ibis population. But the resulting huge amount of data provide a lot of possibilities for analysis of individual behaviour and well-being as well as on the behaviour and development of the whole population.

## Mazza M: IoT solutions for animal monitoring and tracking

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Dr. Mazza's presentation explains how the development of ultra-low power electronics for animal-borne sensors presents unique challenges, with weight optimization being the primary concern. This critical constraint varies depending on the animal species and their environment. For flying birds, the sensor package must not exceed 3% of the animal's body weight, while aquatic animals like mantas and sharks can accommodate slightly heavier devices, up to 5% of their body weight, due to the buoyancy effect of water.

A notable example of miniaturized sensor technology is an innovative insect-borne Bluetooth system. This system was designed for a unique application: using "cyborg insects" like cockroaches to locate people trapped in collapsed buildings. The device, weighing just 1.6 g in total, incorporates a Bluetooth transmitter and a microphone for smart detection. Significantly, the battery alone accounts for 1.1 g, while the electronics make up the remaining weight, highlighting the crucial role of battery optimization in these systems.

Dr. Mazza delves into battery technology by examining various options, from basic lead-acid batteries (commonly used in cars) to advanced lithium polymer and lithium-ion batteries. Current state-of-the-art battery technology can achieve approximately 200 W·h/kg, equivalent to 720 J/g. This energy density becomes a critical factor in designing sustainable animal-borne sensors.

The operational mode of wireless communication significantly impacts a device's power requirements. Specifically, the distinction between transmission and reception capabilities plays a crucial role in energy consumption. Systems designed solely for data transmission demonstrate substantially higher energy efficiency compared to those incorporating reception capabilities or bidirectional communication functionality. This differentiation becomes particularly significant in the design of ultra-low-power devices where energy conservation is paramount.

One possible solution is to employ innovative sampling techniques to reduce data quantity, demonstrating how edge computing concepts can be applied to minimize power consumption while maintaining functionality. This approach represents a crucial strategy in developing practical, lightweight sensor systems for animal-borne applications.

Dr. Mazza highlights the delicate balance between functionality, power consumption, and weight in developing animal-borne sensors, showcasing how innovative solutions can address these challenging constraints.

## Raab R: Investigating the main mortality reasons of the European red kite population by high-resolution GPS telemetry tracking

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The main goal of the LIFE EUROKITE project is to reduce anthropogenic causes of mortality of the red kite in Europe. The efficient protection of these species requires the detailed understanding of overall mortality reasons, especially focusing on those caused by legal and illegal human activities. The LIFE EUROKITE project focuses on a Europe-wide representative sample which is achieved by using high-resolution GPS telemetry tracking of more than 2,900 tagged red kites from 14 European countries, allowing fast and exact locating of dead birds. This considerable database is only possible through cooperation and data exchange with multiple international partners.

Results so far show that Illegal activities are more frequent compared to mortality caused by infrastructure (road and rail traffic, power lines and wind turbines) for the red kite in Europe. Poisoning and shooting are the main anthropogenic mortality reasons for red kite in Europe.

Thanks to GPS telemetry tracking the project achieved some major results in the conviction of persecutors.

## Monti F: The Italian osprey reintroduction project: GPS tracking and mortality causes

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As part of a long-term monitoring program, more than 100 Mediterranean ospreys *Pandion haliaetus* (both adults and juveniles) were tagged with GPS-GSM transmitters and monitored to study their spatio-temporal behavior. The birds were marked in Corsica, the Balearic Islands and especially in central Italy, as part of the “Osprey Project”, where there is now a breeding population following a reintroduction project. A summary of the project phases and milestones, population parameters, GPS tracking and causes of mortality is reported. Mortality was assessed directly when a dead bird was recovered in the field or indirectly when the bird did not move for more than two consecutive days, based on its static GPS locations. Of 32 mortality events, GPS tracking and field investigations made it possible to ascertain death in 75% of cases. Death has mostly been indirectly associated with human activities: electrocution on power lines, collision with wind turbines, drowning in fishing nets. We also recorded a fatality due to a train impact and a bird died after being burned at an oil facility. As a direct cause, illegal shootings occurred in 3 cases in Malta and in the Sardinia and Umbria regions of Italy. Overall, we recorded a higher mortality rate for juveniles that died or disappeared within the first year of life, especially during the winter period. GPS tracking has been useful for estimating the use of protected areas in both Europe and Africa, but also for quickly identifying critical issues and, in some cases, rescuing and recovering individuals in danger and transporting them to recovery centers for the necessary care and subsequent release.

## Ceccolini G & Cenerini A: Poaching on Egyptian vulture

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In their presentation, Dr. Anna Cenerini and Dr. Guido Ceccolini explained their multi-year work for the protection and development of the Egyptian vulture population in Italy.

The Egyptian vulture, classified as endangered in the IUCN Red List, faces severe conservation challenges in Europe, where approximately 4,500 breeding pairs remain. The species has experienced a significant decline of at least 10% over three generations. The situation in Italy is particularly critical, with the species classified as critically endangered. From an estimated 150 pairs distributed across various Italian regions at the beginning of the 20th century, the population has drastically declined to merely 9-13 pairs, primarily concentrated in the southern peninsula: two pairs in Basilicata, one in Calabria, six to nine pairs in Sicily, and a new breeding pair discovered in Sardinia in 2019.

The Endangered Raptor Center (CERM) stands at the forefront of Egyptian vulture conservation in Italy through its comprehensive and multi-faceted approach. Based in Southern Tuscany, the center run by Dr. Guido Ceccolini and Dr. Anna Cenerini, implements a conservation strategy that combines captive breeding with wild release programs and habitat support initiatives.

At the heart of CERM's operations is its captive breeding program, which focuses on maintaining a genetically diverse population of Egyptian vultures. This program is complemented by the establishment and management of supplementary feeding sites strategically located in Basilicata and Sicily, providing crucial support for both released and wild vultures in these regions.

The success of CERM's breeding program is evidenced by its impressive statistics over three decades. Between 1993 and 2023, the center achieved remarkable results with 75 chicks born, of which 73 successfully reached fledgling age - a testament to the program's excellent care and breeding protocols. The program's effectiveness has particularly accelerated during the LIFE Egyptian Vulture project (2018-2023), during which 32 chicks were successfully bred.

The organization's release program has also demonstrated significant achievements. Over a twenty-year period (2003-2023), CERM has successfully released 51 captive-bred vultures into the Italian wilderness. These releases were conducted through two channels: 23 vultures were released through CERM's independent initiatives, while 28 were released through a collaborative effort with ISPRA as part of the LIFE Egyptian Vulture Project.

The released birds face severe challenges, primarily from human-related threats and particularly in the period right after release during their first autumn migration. Between 2004 and 2022 Dr. Cenerini and Dr. Ceccolini looked at the main cause of mortality of 18 individuals in the first 6 months after release, and the main cause was poaching or suspected poaching (especially in Sicily and Malta), followed by drowning during Mediterranean Sea crossings.

Other natural incidents and unknown causes, and a small percentage died due to electrocution on unsecured power poles, poisoning and collision on wind turbine.

The most explicit evidence of poaching comes from two tragic cases where birds were confirmed to have been shot: Clara, who met her fate in Sicily in 2018 shortly after being released as part of a conservation program. Her death represents a particularly disheartening example of how poaching can directly undermine conservation efforts. The second case is the one of Isabelle, whose life ended near the Dingli Cliffs in Malta, an area that should have provided safe passage during migration. This location's prominence as a shooting site highlights the need for increased enforcement in known migration corridors.

Several other cases present compelling evidence of poaching activities: Flora's disappearance in Basilicata occurred in a hunting dog training area, raising serious concerns about the misuse of such designated spaces. The location and circumstances strongly suggest illegal hunting activity. Tommy's case provides indirect evidence of shooting during a sea crossing, demonstrating how vulnerable birds are during migration over water, where enforcement is particularly challenging.

Of particular concern is the emergence of poaching at sea between the Aegadian Islands and Tunisia, potentially driven by the taxidermy black market in Malta. This threat affects not only Egyptian vultures but also other migratory birds such as spotted eagles, black kites, and marsh harriers.

To address these challenges, Dr. Cenerini and Dr. Ceccolini recommend rigorous inspections of fishing boats in the Trapani province, as well as patrolling the area covered by the migration routes during the peak season (mid-August to mid-October) by environmental associations and law enforcements. This increased presence of the authorities in known poaching hotspots will ensure timely action when a crime occurs or serve as deterrent.

The situation is particularly concerning as poaching at sea may contribute significantly to the continued decline of breeding pairs despite ongoing conservation efforts over the past two decades.

## Dagys M: Using GPS transmitter data for identification and interpretation of suspicious events

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In this presentation, Dr. Mindaugas Dagys exposes the functioning of Ornitela's GPS devices, and which improvement will be possible in future using the latest technologies. Ornitela is one of the leading companies developing GPS tracking devices which enable significant advancement in animal monitoring. These devices integrate three essential sensors to provide comprehensive data about animal behavior and movement: (1) the GPS transmitter provides precise location tracking, (2) a magnetometer that monitors the animal's orientation in three-dimensional space, and (3) an accelerometer which captures detailed movement patterns and activity levels. Together, these sensors create a sophisticated monitoring system that delivers insights into wildlife behavior.

This integrated sensor array enables researchers to collect comprehensive behavioral data, including detailed movement patterns and body positioning. The system excels at monitoring activity levels and can detect both normal behavioral patterns and concerning anomalies. Perhaps most critically, it can identify potential mortality events and abnormal behaviors that might indicate distress or injury.

The system incorporates real-time alert mechanisms designed to flag potential concerns immediately. When a device detects sustained immobility through its accelerometer, it triggers an alert that could indicate either mortality, device detachment. Similarly, the system monitors for irregular positioning data, which might suggest fatal incidents or problems with the harness.

Ornitela's current server-based solution represents a sophisticated approach to data analysis. The system processes multiple data streams simultaneously, including accelerometer readings, temperature data, movement speeds, and geographic coordinates, along with various environmental parameters. If a suspicious event is detected a warning is sent out and intervention of field personnel may be necessary. The platform's flexibility allows for continuous refinement of analytical parameters and adaptation to specific research needs.

In future Ornitela will develop advanced on-board processing capabilities that will enable real-time data analysis directly on the devices, not only on server. This innovation will allow for immediate GSM alert transmission and faster field response times when suspicious events are detected. Also, the power supply of the devices will be upgraded by the incorporation of more efficient solar cells or higher energy density batteries. The energy management will also be improved by utilization of alternative power sources (piezoelectricity or thermal gradient).

Communication capabilities will be enhanced through improved GSM module connectivity and more reliable data transmission systems. The next generation of devices will incorporate additional sensors, including audio recording capabilities, video capture systems, and advanced physiological monitoring tools such as heart rate tracking and ECG measurement.

These developments will be supported by sophisticated analytical systems capable of advanced behavioral classification, event identification, and early warning detection for various health concerns including mortality and poisoning.

## Topic area 3: Enhancing crime scene investigations by voluntary involvement and application of current forensic methods

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### Fritz J & Peroni R: Challenges and Priorities in Combatting Illegal Bird Hunting: Insights from the Northern Bald Ibis Reintroduction Project

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The **Northern Bald Ibis (*Geronticus eremita*)**, once widespread around the Mediterranean, is an emblematic species with a storied history (Fritz & Janák, 2022). The species was migratory all over his historic range with known wintering sites along the west coast and east coast of Africa. Over the centuries, more or less all populations disappeared, including their migration traditions. Only one population was remaining which live in Morocco on the Atlantic coast. It's not migratory anymore.

#### **The Role of Zoos in Preservation**

In the 1930s, European zoos began breeding Northern Bald Ibises using individuals from Morocco's Atlas region, a population that has since vanished. This captive population, managed under the **European Endangered Species Program (EEP)**, became the foundation for research, conservation, and reintroduction initiatives.

#### **Reintroduction Programs: A Glimpse of Success**

One notable effort is **Proyecto Eremita** in Spain, which has been ongoing for two decades and successfully established a secondary population (Boehm et al., 2021). Other projects, such as the initiative in Birecik, Turkey, maintain semi-wild populations.

Our conservation project, supported by the **European LIFE Programme** (LIFE20 NAT/AT/000049 – LIFE NBI) focus on re-establishing a self-sustaining migratory population (Fritz et al., in press). A key innovation in this project is the **human-led migration**, where birds follow microlight aircraft to learn the migratory routes and establish lasting migration traditions. One migration tradition leads from breeding sites north and south of the Apls to a common wintering site in southern Tuscany, located in and around the WWF Laguna di Orbetello.

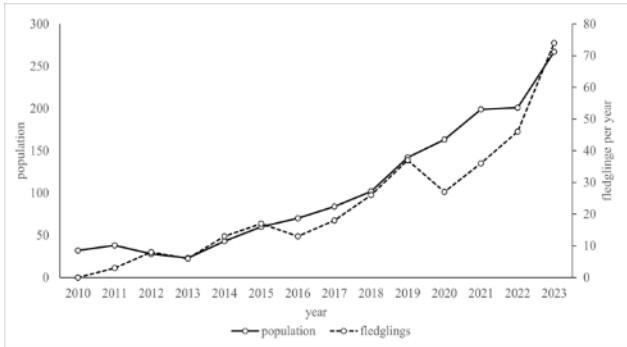


Figure 1 LIFE Northern Bald Ibis project: population development and reproduction from 2010 to 2023.

These efforts have shown success. Since 2011, a constantly increasing number of birds migrate along this pathway. Since 2012, the rewilded populations is reproducing, with over 70 fledglings in 2022 and 2023. End of 2023, the population consisted of 256 individuals. Projections suggest achieving a sustainable population of more than 350 birds by 2026 or 2027 (Drenske et al., 2023; Fig.1).

### Threats to Survival

Despite progress, the Northern Bald Ibis faces significant challenges, predominantly with anthropogenic origin. The two largest threats are **electrocution** and **illegal hunting**.

About 44% of documented mortality is due to **electrocution** on unsecured medium voltage power poles. Simple insulation measures could nearly eliminate these fatalities, yet they

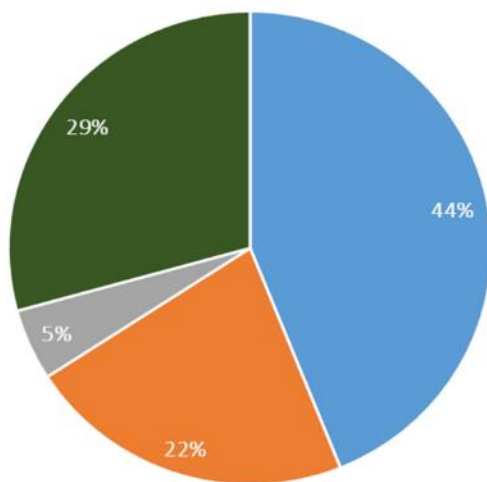


Figure 2 Mortality causes in Italy 2014-2021. Blue: electrocution; orange: injury and illness; grey: other causes; green. Illegal hunting.

depend on financial and political commitment. Germany is a case study that shows the effectiveness of these measures. Based on legislation from 2012, the majority of medium-voltage pylons were insulated by 2017. Since then, there have been no more losses due to electrocution in Germany, with the exception of one case, which occurred on a pylon that had not (yet) been retrofitted.

**Illegal Hunting** poses a complex challenge, particularly in Italy, where traditions of bird hunting persist. Due to Birdlife International an estimated **4 to 6 million birds** are illegally killed annually. The Northern Bald Ibis is an indicator of the substantial

threat posed by this environmental crime. Around 30% of losses in Italy are caused by illegal hunting.

Over 90% of losses occur during the hunting season, with hotspots where also legal birds hunting is common, like the Livorno region, Brescia, Friuli and other regions. These hard facts and numerous individual cases clearly indicate that the illegal hunting is mainly carried out by bird hunters with hunting licenses.

Italian hunting associations have largely ignored these issues despite ongoing communication from our side. Rather than acknowledging and taking responsibility for crimes committed by some of their members, they deflect blame onto anonymous poachers and even cast themselves as victims. A recent example is a statement from *Federazione Italiana della Caccia*, the largest Italian hunting association, claiming: "The Federation has always been at the

forefront in combating illegality and poaching, which are entirely unrelated to hunting and hunters, who are, in fact, the most affected by these actions" (FIDC, 2024).

Despite numerous investigations, only one perpetrator has been convicted in 20 years, highlighting the low-risk nature of this crime. This person was in fact a member of the *Federazione Italiana della Caccia*.

### **Collaborative Efforts for Change**

Efforts to combat illegal hunting involve engaging hunting associations to foster cultural shifts within their communities. In 2014, a landmark agreement was signed at Parco Natura Viva in Bussolengo in presence of conservationists and renowned figure Jane Goodall, emphasizing cooperation to protect the Northern Bald Ibis. These initiatives aim to bridge gaps and encourage hunters to support conservation objectives.

In addition to preventive measures, effective **post-incident responses** are critical. This includes rapid investigations, evidence collection, and collaboration among experts, law enforcement, and NGOs to ensure accountability. Challenges remain, particularly due to the ibis's migratory nature, which spans vast territories, complicating enforcement and monitoring efforts.

### **Looking Ahead**

While the road to sustainability is fraught with challenges, the successes of reintroduction projects offer hope. With continued conservation efforts, enhanced collaboration, and addressing anthropogenic threats, the Northern Bald Ibis may once again repopulate its historic range. These efforts not only preserve a species but also symbolize the resilience of nature when met with human determination and care.

### **Example of two poaching cases**

During the hunting season 2023-2024 we had concrete evidence of six cases of illegal hunting on our Northern Bald Ibis and all were reported in areas where hunting activity is traditionally intense. The poaching cases numbers are constant every year and the actual number of deaths per hunting season due to illegal hunting is likely higher, as many cases lack concrete evidence due to missing bodies and GPS trackers.

Two of these six cases were particularly exemplary and will be presented as follows. Such detailed reconstruction is possible only because the GPSs that the birds carry give precise information on the location, speed and position of the animal's body axes: these devices are therefore essential investigative tools.

The first case involves an Ibis named **Twinkle**, who was killed on **October 23, 2023**, in **Friuli-Venezia Giulia** inside a hunting reserve. GPS data provided a detailed timeline of Twinkle's last moments, showing that the bird was healthy and migrating south before being shot in flight over hunting lodges. When the bird was already dead, the GPS tracked its movement inside a nearby house, where signals continued for about an hour before permanently ceasing,

conceivably because the author of the crime disposed of the body and the GPS device to eliminate the evidence. Despite a forestry officer started the investigation while the GPS tracked Twinkle inside the house, neither the bird nor the GPS device was recovered, because the search warrant for the house was not requested to the Prosecutor. Nevertheless, the house owner admitted he had been hunting that morning exactly in the hunting lodges located in the area where Twinkle fell injured (Figure 3).

From this case we can clearly see that the use of GPS tracking in wildlife crime investigation represents a uniquely modern investigative opportunity: investigators have access to precise, real-time digital evidence of the crime - essentially a technological witness that can track the victim's location before and after death. When a GPS-tagged protected species is poached, investigators find themselves in the remarkable position of potentially knowing exactly where the evidence is located, sometimes even watching it move in real-time on their screens.



Figure 2 Twinkles's last GPS positions (violet) and position of the two hunting lodges (yellow).

The second case, occurring in the region of **Latium**, involved the simultaneous killing of three Ibises: **Diego, Eugen and Lenz**, on **December 6, 2023**. GPS data showed they were healthy the evening before their deaths. The next morning, all three were killed in quick succession. The Carabinieri Forestale quickly responded, finding and recovering all three bodies, which were analysed and X-rays confirmed the presence of lead pellets from hunting rifles.

The simultaneous killing of three Northern Bald Ibis is an unprecedented phenomenon and represents a devastating blow to global conservation efforts. The combined analysis of the GPS data, the bodies, the trajectory of the projectiles, as well as the trajectory of the flight and the

shots enabled a precise identification of the circumstances of the killing: three precise shots at stationary were fired on clearly identifiable birds. The dead bodies were left on the ground to be discovered: this strongly suggests it was not a case of mistaken identity or opportunistic hunting, but rather a deliberate and calculated attack on these protected animals, reflecting a disturbing level of contempt for both wildlife conservation laws and the survival of a species on the brink of extinction.

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## Maccagnan F: The role of forensic pathology in bird illegal hunting: a focus on Northern Bald Ibis forensic necropsy

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Italy is one of the three Mediterranean countries with the highest number of birds illegally killed, with Syria and Egypt. The Northern Bald Ibis reintroduction project faces major losses due to illegal hunting during the autumn migration. The Centro di Referenza Nazionale per la Medicina Forense Veterinaria (CeMedForVet) at the Istituto Zooprofilattico Sperimentale del Lazio e della Toscana “M. Aleandri” provides the authorities with veterinary technical assistance in cases of suspected poaching and illegal hunting. Our contribution is based on a forensic protocol, which includes the following steps: inspection at the site of death, GPS data, radiographic examination, and forensic necropsy. Further exams can be added, such as the ballistic exam. We analyzed 34 Northern Bald Ibises found dead in Italy between 2016 and 2023, which were suspected to have been victims of poaching, following the veterinary forensic guidelines. Human-related causes accounted for 61% of the deaths, including illegal hunting (26%), blunt force trauma (29%), and electrocution (6%). Natural causes, namely starvation (12%), predation (15%) and disease (6%), accounted for 33% of the deaths. 6% of the causes of deaths remained undetermined. 89% of ibises that died due to illegal hunting were found during the hunting season. Human-related causes have been decisive for the survival of these animals. These findings underline the importance of a forensic approach in providing not only a cause of death diagnosis, but also additional information that is necessary for prosecuting crimes against animals.

## De Donno D: Civic engagement for a culture of legality in environmental protection. The experience with youth for Northern Bald Ibis

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In the early 1990s, Jane Goodall started the environmental education program R&S because it became clear to her that the fate of forest habitats that are home to chimpanzees is linked to the development of human populations living on the edge of the natural reserves, and to the involvement of the younger segment of the population, not least because of the high rate of citizens under the age of 17. In addition, a program focused on youth involvement inevitably expands to include families and counteracts the sense of powerlessness and consequent apathy expressed by young people, in Africa as in Western societies, toward environmental challenges. In Italy, the Jane Goodall Institute is reaching out to young people with the same principles, involving them in concrete projects for meaningful impact in their communities. In the educational project related to the reintroduction of the Northern Bald Ibis and to bird illegal hunting, we chose to adopt storytelling, observation and word of mouth.

# Galaverni M: Zero poaching or zero wildlife? The role of volunteers and technologies to prevent wildlife collapse

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Despite still limited public attention, global biodiversity is plummeting at an unprecedented rate in human history, with species extinction rates estimated to be hundreds to thousands times higher than the average background rates, and with about 1 million species at risk of extinctions (IPBES, 2019). These numbers indicate the starting phase of a new massive biological crisis, after the fifth one that led to the disappearance of dinosaurs and other iconic taxa ca. 66 million years ago.

To better give a hint on this frightening process by focusing on those species closest to us, vertebrate populations have declined, on average, by almost 70% in the last 50 years (Living Planet Report 2022) and the current biomass of mammals on the Planet is estimated to be composed by 36% human beings and 60% livestock, with only 4% represented by wild mammals, further indicating the current unbalance of life on Earth.

The causes of this crisis are well known: i. habitat loss, fragmentation and degradation; ii. Species overexploitation or unsustainable consumption. iii. Invasive species and diseases; iv. Pollution, in its different facets, and v. climate change, with increasing impacts (IPBES, 2019).

In this context, poaching falls within the second driver, with huge effects on wildlife populations both in highly natural and human-dominated landscapes, including a number of species at risk.

Thus, bridging the gap to achieve zero poaching is crucial in order to lower the impact of overexploitation at the global and local level, contribute to invert the curve of biodiversity loss and reach the goals of the global Biodiversity Strategy defined by the 2022 Kunming-Montreal agreement within the Convention on Biological Diversity (CBD).

This could be done by conducting regular assessments on the effectiveness of the actions taken, use the best available tools and approaches, increase field staff capacity, successfully engage local communities, improve prosecution approaches, and increase cooperation at the regional and national levels. In this context, strengthening the collaboration between humans and technologies can leverage the effectiveness of contrasting poaching in every step of the process.

WWF has a long history of applying new technologies to wildlife monitoring and protection. The first examples at the global level are represented by the application of unmanned aerial vehicles (UAV) and real-time video recordings to patrol Namibian Parks back in 2014, followed by the testing of prototype thermal cameras and machine learning to identify suspected poachers, then launching the WildLabs.NET network to foster the cooperation across developers and users of technology tools applied to nature conservation. Another widespread and successful tool is SMART (Spatial Monitoring And Reporting Tools), which by overlaying

environmental data with those collected during patrolling activities can elaborate risk maps and support the prediction of future poaching attempts thanks to machine learning and Artificial Intelligence (AI).

In this presentation, we will see some of the current applications of technologies to poaching prevention and wildlife conservation, supported by the involvement of trained volunteers, in a number of case studies developed in the latest years by WWF in Italy.

Thanks to its position across the Mediterranean basin, complex geology, wide longitudinal and altitudinal variation, resulting in varied climates and biogeographical regions, Italy is one of the countries with the highest biodiversity in Europe, but is also a crucial node in illegal international trades of wildlife species, with particular connections with South America, Africa and Asia, also hosting a number of black spots of local poaching, especially against birds but also mammals, fish and other taxa.

In this context, the early adoption of UAV by WWF hunting and fishing guards, a unit of trained volunteers appointed by public authorities to support public officials in preventing and ascertain wildlife crimes, has contributed to keep a high surveillance pressure in areas at higher risk of poaching and supported the early identification of illegal activities. The same tools can be also successfully applied to the monitoring of protected species such as the loggerhead sea turtles (*Caretta caretta*), allowing trained volunteers to investigate longer stretches of beaches in order to identify nesting sites and eventually protect them against human disturbance or destruction, as accomplished during the EuroTurtles LIFE project.

Moreover, technologies have been applied also to the surveillance of nesting sites of several species of Mediterranean raptors at risk of extinction, such as the Bonelli's Eagles (*Aquila fasciata*), the Lanner falcon (*Falco biarmicus*) and the Egyptian vulture (*Neophron percnopterus*). Specifically, the placement of real-time GSM-connected camera traps allowed to constantly monitor nesting sites and to identify potential attempts of stealing eggs or nestlings, which poachers then try to circulate in illegal raptor trading routes. This approach, applied within the ConRaSi LIFE project, coupled with GPS tagging of nestlings and volunteer surveillance camps, allowed to significantly increase the reproductive traits (fledging rate, productivity rate, reproductive success) of Bonelli's eagles and secure their conservation status.

Another successful combination to support anti-poaching activities is the deployment of real-time bioacoustic recorders coupled with cloud storage and AI sound pattern recognition. This approach has been tested within the Nature Guardians project developed by WWF Italy, Huawei Italy and Rainforest Connection (RFCx) in three Natural State Reserves in central and southern Italy: within a few months, it allowed to collect hundreds of thousands recordings, that AI helped classifying into the vocalizations of almost 50 bird species, and to identify sounds potentially linked to illegal activities, such as gunshots or saw chains, sending real-time alerts to the Reserve personnel and volunteer guards. This prompted the identification of illegal acoustic devices used to attract songbirds to capture them and the successful prosecution of the poachers involved.

Nonetheless, these are only a few examples of technologies that combined to human resources can foster the contrast of wildlife crimes. Beside them, we always have to seek a systemic, long-term social and behavioural change that can be accomplished also through education and communication, directed in particular towards potential consumers, advocacy and social mobilization. Because only together can we stop wildlife crimes and the overall biodiversity crisis we are triggering, transforming ourselves from causes to solutions.

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## Pizzati P: Communication, Deterrence and Volunteers

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Any initiative that wants to reduce the threat of Ibis poaching must be based on deterrence. Creating deterrence is more than anything a communication problem and therefore, in my opinion, all our initiatives must be oriented towards effective communication.

I don't believe that the hunter who shoots an Ibis does so by mistake: their appearance makes them easily distinguishable from all other species.

Among the birds that may resemble the Northern Bald Ibis are the Cormorant (*Phalacrocorax carbo*) and the Glossy Ibis (*Plegadis falcinellus*) but both are NOT huntable. The Cormorant can only be the object of specific, circumscribed and limited "culling plans".

The point is that hunters rely on impunity, and the new government guidelines have greatly reinforced this sense of impunity.

The Vicenza Provincial Police estimates that poaching has grown by 40% in the last year.

On the other hand, the forces assigned to anti-poaching controls in the field are increasingly reduced, because they have fewer personnel and this is used in other activities.

Last year, the Provincial Police of Vicenza issued 131 administrative reports, found 45 criminal offenses but killed 15,000 animals in its containment and eradication plans.

It is clear that there is little time left for checks.

In my opinion we must make people understand that shooting an Ibis can have very serious consequences.

A European project like this, where almost all the animals have a GPS device and are followed in their movements, has a very impressive image of scientific and technological sophistication.

The fact that you can always know where every single Ibis is with extreme precision and that there are equally precise measurements on the moment in which something abnormal happens is easily communicated to the media.

The fact that by resorting to article 452 bis of the Penal Code one can have access to telephone records to verify who was in that place at that time makes it possible to know the names of those who were present in that place on that day.

An objection that a hunter could make is this: "I was in that place at that time, but I didn't shoot".

Their line of defense would be this.

However, it is possible to act effectively at a media level against this line of defense.

Even if smooth-bore rifles do not leave a recognizable trace on the bullets as do rifled rifles, which allow, after the bullet has been recovered, to ascertain with a ballistic test whether it was fired from that weapon, it is equally possible to carry out various checks.

This would naturally be a "circumstantial trial", because definitive proof of the crime would be missing (which is practically always missing), but elements could be collected to present a Crime Report to the Prosecutor's Office.

From the perspective of deterrence, the risk of having to face a trial in any case seems quite important.

It goes like this.

It is necessary that during the autopsy the pellets are recovered by the operator (IZS) who will insert them into a signed and sealed container, with precise references to the numbers shown on the rings of that Ibis that was shot down.

At the same time, the investigating police will have to verify the brand and "number" of the cartridges used by the suspects identified through telephone records (which could be more than one).

This number indicates the size of the pellets contained in the cartridge.

Example: the "number" 14 indicates pellets of 1.1 mm in diameter, the number 8 indicates pellets of 2.3 millimeters.

The ideal condition would obviously be one in which the Police quickly arrives at the place where the Ibis was shot down and checks which cartridges the hunters present on the spot have, but this condition will occur very rarely (as is obvious), however after having identified the suspects through telephone records, it will be possible to go (with a search warrant) to have the cartridges shown to the individual hunter's home.

At that point it will be possible to acquire the data of the brand and "number" of these cartridges. The analysis of the pellets extracted from the carcass will have to do two things: measure the exact diameter of the pellets using a centesimal decimal caliper, (measuring the size with the precision of one hundredth of a millimetre) and proceed to the chemical analysis of the material that makes up the pellets.

In fact, each factory produces pellets with different dimensions and composition.

The bullets are made mostly of lead (over 90%) with additions of bismuth, arsenic and antimony to improve the characteristics of the alloy.

A chemical analysis to identify the percentages of the four main components costs around 85 euros at the Chemical Analysis Laboratories located in each Province.

If the diameters and compositions coincide, the circumstantial evidence would be quite important.

To strengthen deterrence we can communicate to the press that these investigations are carried out every time an Ibis is shot down.

Communication to the press is something that costs nothing and can be done at any time.

To be of help in the phase following poaching, the Volunteers who intervene on site must know exactly what to do, in the event that it is absolutely not possible for a Police Force to intervene on site within a reasonable time.

It will therefore be necessary to provide the Volunteers with indications to make the intervention effective: these indications are those of Forensic Veterinary Medicine.

They will have to contextualize the exact location of the discovery through GPS coordinates and through photographs, then they will have to photograph the body in the condition in which it is found, they will have to examine the surrounding area in search of traces, footprints, blood, feathers and any other sign or find that can help reconstruct what happened.

They will have to document the presence of people or vehicles in the area and in the end, only if the intervention of a Police Force is not possible, they can collect the body, handling it in the most delicate way possible, to transport it where indicated.

Another thing that Volunteers can do very well is examining the places where the events occurred.

The Volunteers usually live in the area where the events occurred and have a good knowledge of the area, they know the places frequented by hunters and they know where all the hunting stands are, where the hunters park their cars, usually far from the point where they hunt, because they must not be seen by birds.

In several cases it was the Volunteers who examined and photographed the "crime scene" sending measurements and coordinates which were essential to understand exactly what had happened: the GPS data were integrated with the on-site examination.

Precise understanding of the flight paths and points transmitted by GPS are often only possible after these inspections.

Volunteers are often people who are extremely passionate about Ibises, who they have followed for years, noting their movements, the relationships between them, between couples and between parents and children.

They travel hundreds of kilometers to see and photograph the Ibises, all of which they know the names and individual stories of.

They are people who sometimes live up to 100 km away from the points where the events occur, and who leave immediately to look for data that can be useful.

This happens because the Waldrappteam Project is perceived as something exceptional and extremely exciting, to be followed every day with the Application or directly on site.

These Volunteers constitute a great capital of knowledge and passion which must be appreciated and valorised because they will be able to provide enormous help.

## Summary and Conclusions

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The symposium marked a pivotal moment of interdisciplinary collaboration, bringing together institutions and supervisory bodies, experts from legal, conservation, communication, and technology sectors to cultivate new partnerships and synergies, aimed at devising comprehensive strategies to combat wildlife poaching and enhance biodiversity and wildlife protection.

The Italian regulatory framework and the current supervisory situation in the country present significant obstacles to effective wildlife protection. The current system demonstrates profound structural weaknesses that effectively enable wildlife crime. Despite the best efforts of the judiciary, police forces and NGOs, the relevant legislation appears to be totally inadequate to allow for effective investigations, and surveillance is insufficient, creating an environment in which poaching is seen as a low-risk criminal activity. In an environment of substantial and almost absolute impunity, they count on the fact that their illegal activities will probably never be punished, they act with a high degree of confidence, which stems from the knowledge that the current system has significant gaps in control and prosecution mechanisms, making the likelihood of suffering legal consequences extremely low. Where wildlife offences are prosecuted, the fines imposed are so minimal that they can be regarded as a mere operational cost for those conducting systematic criminal activity, which is far more profitable than the potential legal consequences involved.

To effectively counter these structural deficiencies in the wild animal protection system, two aspects are imperative:

1. **Adequate institutional reforms**, also in connection with the transposition of EU Directive 2024/1203 on the Protection of the Environment through Criminal Law. Systematic changes to the legal and sanctioning framework for wildlife crime are indeed necessary. An updated and strengthened regulatory system, based on concrete scientific evidence, can establish an effective deterrent mechanism, significantly raising the potential costs for offenders and ensuring a more effective protection of biodiversity. This will be the subject of a specific conference in Rome on 20 May 2025 organised by Waldrappteam in collaboration with LAV, WWF, LIPU.
2. Define accurate and shared investigation **best practices** also with new tools and technologies.

Regarding point 2), it is crucial to enhance and refine the post-poaching investigation phase by developing innovative and validated methodologies for the collection and analysis of evidence in poaching cases. A more rigorous and scientifically grounded investigation can enable the construction of subsequent solid legal cases that establish significant case law precedents. These precedents serve a dual function: on the one hand, they provide investigators with more effective prosecutorial tools to pursue future similar cases; on the other hand, they profoundly alter the risk-benefit calculus in favour of animal conservation, increasing the risk for perpetrators and raising the threshold for the commission of these crimes.

Achieving these strategic objectives requires the synergetic implementation of, among others, **three fundamental and interconnected measures**, each of which represents an essential pillar in strengthening wildlife protection systems.

1. **Advanced GPS Tracking:** Almost all wildlife crime goes unpunished because it is impossible to know the exact time and place where the crime was committed, in the absence of direct witnesses and immediate presence at the crime scene. Implementing sophisticated geolocation technologies can dramatically increase the probability of identifying and prosecuting poachers. Real-time monitoring systems could provide immediate alerts during wildlife episodes, transforming our reactive approach into a proactive defense mechanism, thus providing crucial information to investigators to enable them to start investigations based on solid data.
2. The involvement of **forensic veterinary medicine**, its experts and its instruments, from the first minutes in which the crime is discovered. From the accurate analysis of the crime scene to the urgent examination of the bodies of the murdered animals and the associated autopsies, following scientific and validated procedures that will enable important information to be acquired for investigative purposes. The characteristics and clues found at the crime scene and on the body of the animal can provide investigators with valuable information, if analysed scientifically and in the correct manner.
3. Assessing and quantifying **environmental damage related to biodiversity crimes:** The development of scientifically rigorous methodologies integrated into the relevant regulatory system to quantify the ecological impact of the loss of a wild animal can strengthen the documentation attached to complaints and subsequent investigations and trials. By presenting detailed empirical evidence and scientifically validated analyses of the broader consequences of wildlife crime, as well as providing more compelling evidence for potential prosecution, we can elevate these offences from crimes considered minor to serious environmental violations.

These methodological and technological advancements are essential to provide the competent authorities with comprehensive data, which provide a solid basis to support effective investigations leading to prosecutions and convictions of the perpetrators. An updated and more robust legal framework can create a strong deterrent against poaching and protect biodiversity effectively.

Another crucial element to effectively strengthen anti-poaching strategies is the creation of a strong information-sharing network between the competent authorities and NGOs such as WWF, LIPU, LAV and others. Such a collaborative network allows not only for the efficient sharing of information and best practices but also creates the conditions for developing more sophisticated investigative capabilities through the integration of different skills and resources. The network approach generates a multiplier effect in the effectiveness of law enforcement actions: the combination of technical expertise, operational resources and territorial presence of the different organisations creates a more capillary and efficient surveillance and response system. Moreover, this structured collaboration amplifies the capacity to raise public

awareness, facilitating the dissemination of coordinated messages supported by concrete evidence on the seriousness of wildlife crime and the importance of its prevention.

The amplifying effect of public communication extends beyond mere awareness-raising, creating significant social and political pressure for the strengthening of the regulatory framework. Systematic documentation and strategic dissemination of poaching cases help build a public consensus that supports the adoption of stricter measures and creates pressure for systematic changes in favour of environmental protection. The integration of advanced technology, rigorous science-based investigations, legislative reforms and strategic communication creates a comprehensive and stronger system to protect biodiversity and reduce environmental crime.

In this context, coordinated action towards public administrations is a key strategic element in the prevention of poaching. This includes stricter regulation of hunting activity, including calling for shorter hunting seasons and reducing the number of areas where hunting is permitted, as well as ensuring adequate controls where hunting is allowed. The integration of rigorous scientific data, advanced monitoring technologies and systematic documentation of violations, combined with targeted lobbying, can catalyse significant changes in hunting management policies and reduce opportunities for poaching.

The Italian Hunting Associations present themselves as key partner in protecting endangered species like the Northern Bald Ibis. However, recent data from the European LIFE project (LIFE20 NAT/AT/000049 – LIFE NBI) contradict this narrative, as they document significant threats from poaching. It is particularly relevant to note that 90% of poaching episodes occur during the autumn migration, a period that coincides with the Italian hunting season, thus suggesting a possible involvement of hunters as the main perpetrators of these illegal actions. These findings raise critical questions about the role of hunting associations in conservation efforts. Our LIFE-project emphasizes the need for stricter action from hunting associations against illegal activities within their ranks and stronger cooperation with conservation organizations to effectively combat poaching. The discrepancy between statements of hunting associations and the reality on the ground highlights the urgent need for accountability and action within the hunting community to ensure the protection of vulnerable species like the Northern Bald Ibis.

In conclusion, addressing illegal wildlife killing requires an integrated, multidimensional approach that combines technological innovation, legal reforms, strategic collaboration, and public engagement. The integration of innovative GPS tracking technologies and rigorous environmental damage assessments, coupled with enhanced post-poaching investigations, will help create a more robust and proactive system for wildlife protection. Strategic partnerships between authorities, NGOs, local communities, and an effective commitment of hunting associations to counter illegal actions against wildlife are also crucial. The proposed strategy aims to transform the current passive conservation model into an active, dynamic and action-oriented approach to biodiversity preservation, that creates lasting change, shifting societal values towards greater environmental stewardship and ensuring the protection of endangered species, such as the Northern Bald Ibis.

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