



ERBFacility
EUROPEAN RAPTOR BIOMONITORING FACILITY
COST ACTION 16224

WG4 & cross-WG Virtual Meeting
22 April 2021

**TAKING FORWARD A EUROPEAN RAPTOR SAMPLING
PROGRAMME & THE ERBF ADVICE HUB**

Hosted by Chris Wernham (BTO Scotland) & the ERBFacility WG4 Team

MEETING REPORT

This event is organised by COST 16224 Action European Raptor Biomonitoring Facility and supported by COST (European Cooperation in Science and Technology)

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Organising Committee:

Chris Wernham (Lead WG4)
Rui Lourenço (Deputy Lead, WG4)
Al Vrezec (Vice Chair of ERB Facility & WG4 Team)
Jovan Andevski (WG4 Team)
Arianna Aradis (WG4 Team)
Yael Choresch (WG4 Team)
Silvia Espín (WG4 Team)
Ulf Johansson (WG4 Team)
András Kovács (WG4 Team)
Pablo Sánchez Virosta (WG4 Team)
Stavros Xirouchakis (WG4 Team)

Other speakers:

Urška Ratajc
Maria Dulsat
Rob Robinson
Metodija Veleviski
Paola Movalli
Guy Duke

We also thank all the other participants who joined us for this virtual meeting and who provided helpful suggestions.



Young Tawny Owls (Al Vrezec)

MEETING OBJECTIVES & OUTPUTS

This virtual meeting was convened by Working Group 4 ('Field Arena') to update the whole ERBFacility network on development of the framework for a European Raptor Sampling Programme (ERSamP) and a web-based ERBfacility 'Advice Hub', designed to hold guidance on all aspects of the sampling programme. Participants from all three ERBFacility arenas (field, collections and analysis) were encouraged to participate, and over 90 network members registered for the event.

The specific objectives of this meeting were:

1. To update all interested ERBFacility network participants from all three arenas (field, collections and analysis) on the work that has taken place and the stage of development of the framework for a European Raptor Sampling Programme (ERSamP) and a related web-based ERBF Advice Hub.
2. To inform the ERBFacility network about the existing structure and content of the Advice Hub – and seek suggestions, particularly on any gaps in the advice provided currently, and to give an opportunity for members of the ERBfacility network to get involved in the development of any additional guidance materials.
3. To seek suggestions on how best to disseminate the contents of the Advice Hub and encourage wide use of the guidance materials that it contains, including potential future development and maintenance of ERSamP and the ERBF Advice Hub during the lifetime of COST Action 16224 and beyond.
4. To inform the network about the current state of knowledge of training and capacity building needs in relation to ERSamP across Europe, and seek to fill gaps in this knowledge by country.

The meeting aimed to produce the following outputs:

1. Compiled suggestions for additions/improvements to the Advice Hub and any offers of help with final drafting of materials.
2. Compiled suggestions for how best to ensure that the guidance contained within the Advice Hub is disseminated and adapted as widely as possible across Europe, and maintained and developed if necessary during the lifetime of COST Action 16224 and beyond.
3. Compiled suggestions on future training needs in relation to the European Raptor Sampling Programme, including suggestions for where our current COST Action can help to deliver training before the end of the Action.

MATERIALS PROVIDED

Ahead of the meeting, the following draft materials were made available to participants:

- A draft of some parts of the Advice Hub, showing the structure, the approach used and the draft content (available [here](#)).
- Previous work to review existing field capacity across Europe (explained in the report from the ERBF Slovenia September 2019 workshop available [here](#)) – including a summary for each country that was assessed in Appendix 4 of the Slovenia workshop report. The filled templates from the reviewing carried out at the Slovenia workshop of existing and required capacity for each country were also made available ([here](#)), and the blank template ([here](#)) for use either by countries that had not yet completed a template, or by participants who wished to provide comments or more detail for an existing country.

Comments on the Advice Hub and the Capacity Review are still needed and can be sent to chris.wernham@bto.org until the 30 August 2021.

We asked in advance that participants focus on some key questions at the meeting:

1. Were there any major gaps in the structure/sub-structure/main contents of the Advice Hub in providing guidance to support a future European Raptor Biomonitoring Facility and, particularly, a European Raptor Sampling Programme?
2. How will it be best to host, disseminate and publicise the Advice Hub to ensure it is widely used but also kept up to date?
3. How can we ensure that the Advice hub is of maximum use to people from each arena but also that it helps to bring people from the different arenas together to do more interdisciplinary work focused on raptors?
4. Where is training/capacity building most needed to support a future ERSamP (types of training, geographical gaps)?

These questions were discussed during the meeting and participants were also given a month after the meeting to provide further comments on the Advice Hub and the capacity templates.

The whole meeting was recorded in Zoom and is available for viewing [here](#).

SESSION 1

European Raptor Sampling Programme & the Advice Hub

Chris Wernham initiated the meeting with an [Overview Presentation on the ERB Facility COST Action and the European Raptor Sampling Programme \(ERSamP\)](#).

Silvia Espín, Pablo Sánchez Virosta and Chris Wernham gave a [presentation on the structure and overview content of the “ERB Facility Raptor Advice Hub](#). The Raptor Advice Hub is currently available in [Google drive](#), and all network participants are welcome to include their comments until the end of August 2021. The Advice Hub objective is to provide a first point of contact for people interested in contributing to a future ERB Facility. It will be a web-based platform bringing together the main data needed to facilitate cooperation and coordination, increase capacities and harmonise future raptor biomonitoring activities. The target audiences are broad, including: professional ornithologists; raptor ecologists; field researchers; volunteers (e.g. ringers and raptor monitoring observers); veterinary scientists; ecotoxicologists and analytical chemists; among others.

The Raptor Advice Hub currently starts with an overview of the 10 main entries (see Fig 1), and the reader can click on them and is redirected to a new page, each of which offers the main information, references and links to websites/documents with additional and more detailed information. The main contents presented in the different entries are:

1. *Raptor identification, ageing and sexing*. Providing basic clues for identification, age and sex determination.
2. *How to monitor raptors*. In this entry we provide context on monitoring as early warning of contaminant effects, characteristics of raptors that influence choice of monitoring techniques, choice of parameters to monitor and study areas, and guidance for each type of parameter to be monitored.
3. *How to share your monitoring data*. This entry will compile a list of places where monitoring data are shared currently.
4. *Information on legislation, permits, licensing and wildlife crime*. In this section, we provide diagrams showing the general pathway in the raptor sampling process for biomonitoring purposes, highlighting the stages where permits or licenses might be required. Procedures to comply with the European and National legislation during sampling are also described. We have compiled useful links to relevant information on legislation in different European countries.
5. *How to get people involved in raptor research*. This section gives context on which types of audience we try to encourage to take part, their motivations, what are the barriers and how do we find solutions, what specialist

skills are needed and how can we help people to obtain them, how to reach the appropriate audiences, and once people are engaged, how do we retain their motivation and involvement.

6. *Training opportunities and skills sharing hub*. This entry is a growing section providing links to training materials, summer schools, on-line training videos and courses.
7. *Species-specific guidance*. This section gives links to guidelines on specific species or groups of species.
8. *How to collect samples*. In this entry we provide links to sampling protocols and guidance videos to perform necropsies and collect samples. In addition, guidelines for contextual data collection and recording sheets are provided.
9. *How to submit samples for analysis*. This section shows information on the volume/mass of sample, type of container and transport conditions required for contaminant monitoring in different matrices, and detailed information on packaging, labelling, paperwork and legal considerations.
10. *What can we analyse and where*. This final entry presents diagrams on the main contaminants and biomarkers that can be analysed in different matrices. Furthermore, a list of European laboratories that agreed to be included in the Advice Hub is presented, helping users to easily find laboratories to send samples for contaminant analysis in Europe.



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ERBFacility Raptor Advice Hub



Click on the picture (CTRL + CLICK) to get additional information.

Fig 1 - Preview of the main menu of the Raptor Advice Hub.

Next Rui Lourenço provided a [presentation giving an Example of the approach adopted in providing guidance – monitoring raptor diets](#). The presentation was centred on the section “**How to obtain contextual data on the diet of raptors**” of the **Advice Hub**, under the topic “**How to monitor raptors**”. The objectives of this section of the advice hub are: A) List the methods used to study the diet of raptors and their advantages and disadvantages (taking into consideration species/groups); B) Indicate the parameters used to describe the diet of raptors that are most relevant for ecotoxicological studies; C) Provide references to relevant scientific articles and books on diet studies; D) Provide links to webpages with useful information.

Accordingly, the expected contents of this section of the Advice Hub are: A) Main methods used to study the diet of raptors (advantages/disadvantages; species/groups for which it is used); B) Main parameters used to describe the diet of raptors (quantification parameters; diet diversification measurements); C) References to scientific articles and books (method description; method comparison; prey identification); and D) Links to webpages.

An inclusive approach was used to consider the large number of raptor species, diet study methods and considerations, which included a literature review of papers on the diet of European raptors. So far, 292 published papers have been analysed, which resulted in a dataset of 401 entries corresponding to combinations of raptor species and associated diet study method. The review included 49 species separated into five groups: vultures - 4 species; large eagles - 7 species; small to medium sized raptors (eagles, kites, hawks, harriers) - 15 species; falcons - 8 species; owls - 15 species.

The data set characterization included: country, raptor group and species representativeness. The main methods considered were: (1) analysis of pellet contents; (2) joint analysis of pellets and prey remains; (3) identification of prey remains; (4) direct observation of prey consumption or prey deliveries to the nest; (5) passive observation – photos or video-recordings of prey consumption (at perches or nests); (6) analysis of stomach contents of raptors found dead; (7) analysis of food stores – prey accumulated in nests; (8) analysis of stable isotopes of feathers.

The main results describe the frequency of use of the different methods, overall, by group of raptors, and by raptor species. The data analysis includes potential variations in mean sample size and mean study duration associated with each method and raptor group.

The Advice Hub will include a table in which the advantages and disadvantages of each diet study method will be presented, as well as the raptor species for which the method is more suitable and frequently used. An example was shown for pellets and prey remains.

Discussion on Session 1

During the summing up session, Guy Duke (Chair of the ERB Facility) made the following helpful suggestions regarding further development of the advice hub:

- The hub has a wealth of content - it will be important to make it easy to navigate around the Hub and also to search it for keywords. This will depend on time/resources being found to convert the draft hub into a well-structured web-based tool.
- The science continues to advance and new resources continue to come online- how can the hub be kept up to date? This will depend on either future funding for ERB Facility development and/or an organisation willing to host the Advice Hub in the longer term.
- Housing the Hub in the short-term - consider how to house the Hub on the ERB Facility website - the Hub needs to be set within the right context, which explains why it is valuable to monitor contaminants in raptors, relevance to chemicals management, etc.
- Housing the Hub over the longer-term - ERB Facility ends April 2022, and may be followed by a one-year COST Innovators Grant to prepare a business plan - sustaining the Hub should be considered as part of that. The Core Group should give thought to how and where to house the Hub longer-term
- It would be good to extend the Hub content to cover the Collections and Analysis arenas and audiences. Perhaps we could provide different entry points for the various audiences, e.g. I am a field ornithologist, I am a museum curator, I am an analytical chemist....
- Might we add case studies, which demonstrate how monitoring contaminants in raptors has societal and scientific impact. The ideas presented by Pablo Sánchez Virosta (Section 2 below) are a first attempt to provide case studies to illustrate why cross-arena working on ecotoxicological studies is so valuable both for raptor conservation and human health benefits. This might help inspire other people to get involved in cross-disciplinary work on contaminants in raptors.

In the wider discussion on the Advice Hub the following useful points were also made:

- The "opening page" on the Hub requires a convincing showcase of the value and need of collaboration across the three arenas.
- The Hub draft is quite long – so a nested structure will be required so that information can be accessed easily.
- The aspect of collections (museum point of view) is currently missing (but see the presentation by Paola Movalli on this below).
- In the case of long-term storage for monitoring, should we focus on a single sample type to gain in simplicity? Should we focus on one or two sample types, since it is difficult to store carcasses long term?
- For collecting samples in a systematic way, we need conservation methods that fit for many projects.
- The appropriate focal tissues for long-term storage have to be set by Analysis Arena, and Collections and Field Arena should define the most suitable and feasible focal species. Collaboration is important here.
- **Further discussion of candidate tissues for systematic long-term storage: feathers (the easiest), livers (the best), bones.**
- Freeze dried tissues are also easy to store long term at room temperature (better frozen but not needed).
- Feather collections in general already exist in museum collections (also skin collections), but are feathers enough for certain contaminant monitoring aims? Feathers are easy to store and transport, livers less so, but the pros and cons should be explained in the Advice Hub.
- Historic specimens might be contaminated with preservation chemicals, leading to biased ecotoxicology results (although meticulous washing techniques can minimise the problem substantially).
- Feathers can provide information on contaminants only for the time that they have been growing. Liver can provide better indication of longer exposure, and bone can provide life-time exposure to some chemicals.
- The best sample type depends on the goal of the monitoring scheme, but if you want to have something instead of nothing (because of lack of capacity and storage), maybe feathers are easy to start with.
- There is a need for a guideline for long-term storage – with regard to taxidermy procedure and necropsy procedure, both of which can ruin specimens if not conducted appropriately.
- In the hub, the advantages and disadvantages of each sample type can be described, not all valid for everything, and refer to our previous publication that explains this very well: Espín et al. Tracking pan-continental trends in environmental contamination using sentinel raptors—what types of samples should we use? *Ecotoxicology* volume 25, pages 777–801(2016); <https://link.springer.com/article/10.1007/s10646-016-1636-8>.
- Setting a range of different standards in the Hub might be appropriate: the silver standard (feathers only) vs. gold standard (feathers+livers+etc.). This is important to set in the Advice Hub, so we can gain maximum useful storage of samples at pan-European scale.
- Is there a general opinion that it is important to store ERBF specimens long-term, so in museum collections as skins (+feathers) at least. Such storage should already be started as part of the Proof of Concept (PofC) study to give some legacy to the whole PofC.

During discussion over diet analysis in raptors, the following points were made:

- Possible use of environmental DNA in analysing pellets, nest material or excrements for diet composition. The problem is to identify small and soft-bodied prey in pellets, e.g. earthworms, which might have impact in contaminant bioaccumulation, but are missed in classical pellet analysis. There are some studies outside of Europe using swab samples of beak and/or talons but not enough yet to reveal all the advantages and disadvantages of the method. It will require a good reference bank of material to be available.
- For pellets it seems much more cost-effective to analyse the pellets themselves rather than DNA, but it could be very useful for faecal samples?
- High-throughput DNA sequencing may provide huge amount of data: Ouso, D.O., Otiende, M.Y., Jeneby, M.M. et al. Three-gene PCR and high-resolution melting analysis for differentiating vertebrate species

mitochondrial DNA for biodiversity research and complementing forensic surveillance. Sci Rep 10, 4741 (2020). <https://doi.org/10.1038/s41598-020-61600-3>.

- A new technique [DNA metabarcoding coupled with high-throughput-sequencing (HTS)] is probably in future going to revolutionize our ability to investigate the dietary ecology of species including raptors. (see e.g.: Metabarcoding for parallel identification of species, sex and diet of obligate scavengers: an application to globally-threatened Gyps vultures. Conservation Genetics Resources volume 13, pages 61–77 (2021)).
- It is important to be consistent in the method since different methods can provide contrasting results. Three possible approaches were discussed:
 1. visual inspection of remains
 2. genetics, including metabarcoding
 3. stable isotopes, there are many tissues that can be used, including potential prey.
- It is also important to define the resolution of results:
 1. large groups
 2. species ID
 3. quantification of proportion of species
- It is often most useful to know the % of major prey than a list of all species, so this quantification can be important (how do methods correlate?). The trophic level of prey is particularly important to know.
- Pellet studies can be done by volunteers for mammal working groups, see: <https://www.zoogdiervereniging.nl/wat-we-doen/monitoring/meetprogrammas-nem/nem-verspreidingsonderzoek-muizen>. However, there can be a bias if using these studies for raptor diet analyses because only the mammals are reported (not other taxa in the diet).
- Annual prey analysis in monitoring changes in diet through time – need to think about the practicalities and resources needed, and whether methods are comparable (at least having the power to detect larger changes in diet through time).
- Some Tawny Owls that were sampled for the Proof of Concept study from Portugal had stomach contents that could also be collected – valuable as they are from the actual individuals that will be analysed for contaminants but must also consider potential biases when analysing these.
- It would be useful to have some insights about the spatial and time extent of the dataset of studies that Rui Lourenço reviewed (problem of short-term and very small spatial range). The studies were very variable from one-off studies to those lasting 50 years. None of the diet studies reviewed had also studied contaminants – hence the value of the ERB Facility work trying to bring these aspects of diet and contaminants together.
- Long-term diet studies should ideally be coupled with availability of prey.
- Diet studies should be more routinely coupled with studies of contaminant (e.g. work by Rhys Green on pellets in the UK looking at lead content, perhaps not yet published).

SESSION 2

Encouraging cross-arena working and the role of the Advice Hub

In this session, chaired by Al Vrezec, we discussed the importance and benefits of cross-arena working in the scheme of European Raptor Biomonitoring Facility, as this involves very different expertise and researchers to achieve our final goal, which is a monitoring scheme of contaminants in raptors.

[Al Vrezec's introductory presentation](#) explained that, within the EU, this is a highly needed scheme to assess environmental and human health using raptors (top predators) as key sentinels, the development of which started over a decade ago with the European Science Foundation networking project EURAPMON

(<https://www.eurapmon.net/>) that operated between 2010 and 2015 and included two arenas: the Analysis and Field Arenas. With the launch of COST project ERBFacility in 2017 (<https://erbfacility.eu/>), a new arena joined the initiative, the Collections Arena, filling the gap between Analytical and Field Arena.

Each arena holds specific expertise and profiles, which are important in achieving a pan-European raptor biomonitoring scheme. The Analysis Arena includes mainly laboratories focused on ecotoxicological studies, and a profile of most involved people in veterinary science. The Collections Arena includes mainly museum collections and the main focus of this infrastructure is taxonomy and historical studies, with museum curators being mostly of biological profile. However, new values of such collections are recently emerging making it beneficial not only to store museum specimens but also frozen specimens, which are collected on a regular basis, mainly at local or regional scales. Therefore, the role of museums and environmental specimen bank collections is of crucial importance for our initiative. The Field Arena focuses on the fieldwork: in obtaining primary information on raptor populations (ecological/population monitoring information) as well as engaging in the field collection of different sample types. The Field Arena collaborators are mainly biology profiled researchers working in the field of ecology, ornithology and biodiversity conservation, and also with strong connection to the citizen science. In initial thinking, the monitoring scheme should involve a fully collaborative network of a variety of participants from the different arenas to run a European Raptor Biomonitoring scheme (see Fig 2).

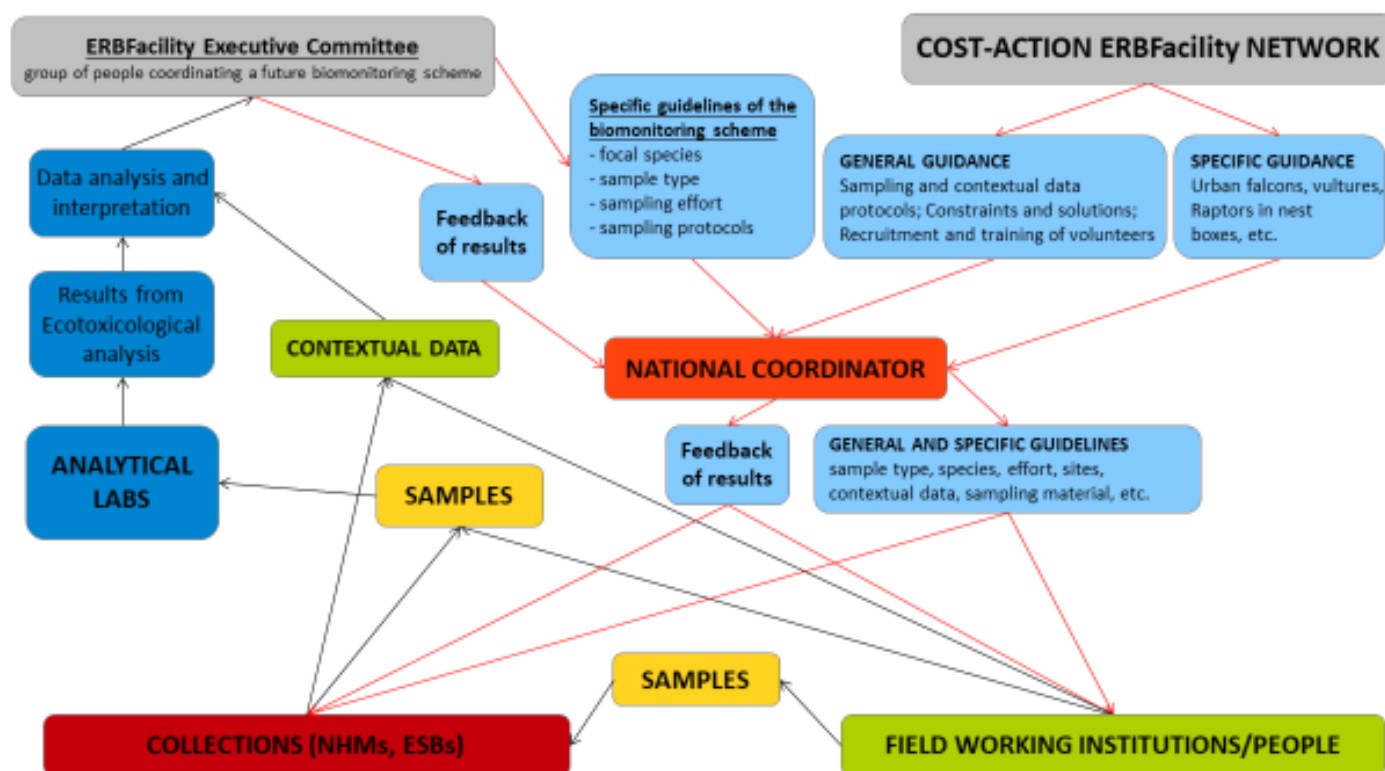


Fig 2 - COST ERBFacility network scheme (by Rui Lourenço)

In these terms, there are different expectations from and to arenas regarding their contributions and benefits in the network, which should be considered in order to keep any such network functional (see Table 1). These include short-term contributions, especially regarding pilot Proof of concept action, and long-term contributions and benefits, which should be considered in the long-term operation of any future monitoring scheme.

Table 1 - Short- and long-term contributions and benefits of the three arenas in a European Raptor Biomonitoring scheme.

Arena	Direct short-term contributions to the network	Specific long-term contributions and benefits
Analysis Arena	Analysis of samples from selected tissues for selected contaminants	Development of analytics for new emerging contaminants (& diseases) in connection to human and environmental health
Collections Arena	Regular collection/storage of selected samples and their provision to the laboratories with specimen contextual data	Long-term preservation of different type samples by building storage facilities for continental based specimen banks and scientific collections for retrospective analyses
Field Arena	Active and passive field collection of samples and monitoring of population contextual data for contaminant interpretations	Development of continental wide monitoring scheme for key contextual data that would serve contaminant biomonitoring, raptor conservation and research

For the scheme to operate, it is necessary to assure cross-arena collaborative work that includes sharing of data, samples and skills. Samples are usually sourced in the Field Arena, but also in Collections Arena, and the flow of samples goes to Collections Arena for long-term storage and to Analysis Arena for analysis of samples. The data flow is even more complex since there is a need for a backflow of data (feedback) from the Analysis Arena to the Collections and Field Arenas, and there is an additional data flow considering specimen and population contextual data, which are crucial for interpretation of contamination results. The main uses of data can be specified for interpretation of contamination results in Analysis Arena, for raptor conservation in the Field Arena and for the legacy (long-term storage for future research and interpretations) in the Collections Arena. Each arena holds its specific skills, which should be to some extent be shared between arenas to assure efficient work, benefits and competences in each arena. The current skills, protocols and methods held by each arena might not be suitable to achieve all previously stated benefits and competences for all arenas in the network and they should therefore be adjusted to a certain extent. The outcomes of successful sharing of skills will be correct samples for analyses in the Analysis Arena, valued specimens in the Collections Arena, and resolved sampling constraints in the Field Arena. Therefore, an Advice Hub combining all these skills is to be prepared under the ERBFacility framework (see Session 1 above).

In our current COST ERBFacility Action, the main initiative to test the network contributions and for resolving constraints in cross-arenas collaborations by sharing samples, data and skills, is the Proof of Concept study, which is focused on the pan-European assessment of metals (Hg, Pb) and second generation anti-coagulant rodenticides in the Tawny Owl (*Strix aluco*). Additionally, the ERBFacility network has mobilised samples for multi-target contaminant screening in Common Buzzard (*Buteo buteo*), which will be conducted under the framework of the EU Life Apex project.

The value of contextual data to contaminant studies – Tawny Owl proof of concept example

The Tawny Owl is chosen as the ERBFacility focal Proof of Concept species, for which pan-European analysis of the species livers is taking place for interpretation of spatial variation in contamination at EU scale. For this purpose, population contextual data on the species at pan-European scale are particularly important and were presented by STSM holder Urška Ratajč (Slovenia) with collaboration of Rui Lourenço (Portugal), Al Vrezec (Slovenia), Chris Wernham (UK), Silvia Espín (Spain), Pablo Sánchez Virosta (Spain), Simon Birrer (Switzerland) and Dani Studler (Switzerland).

[Urška Ratajč's presentation](#) explained that biomonitoring studies can provide early warning of emerging contaminant problems with the potential for pesticides and industrial contaminants to impact on humans. An important step towards improving large-scale biomonitoring is a proof of concept study. Tawny Owl is a suitable species for this task, because it is a generalist predator, it is widely distributed and rather extensively studied. The aim of our research is to prepare an overview of selected contextual parameters, which will serve as a baseline for interpretation for ecotoxicological results. We will assess geographical variation in each variable across Europe and draft best practice guidance for monitoring of selected contextual data. At the workshop, preliminary results were shared, which already show the importance of key contextual data for correct interpretation of biomonitoring results.

We split the contextual parameters into two groups. In the first group, there are parameters relevant for evaluation of the risk of contaminant exposure (e.g. diet, habitat and movements of the species, population size and breeding phenology). In the second group, there are parameters relevant for detecting the potential impacts of contaminant exposure on the species (e.g. population trends, mortality and breeding success). Based on their relative importance and data availability, a subset of these parameters has been analyzed: crude density, dispersal and diet from the “exposure group” and population trend and clutch size from the “impact group”.

Diet is one of the most important contextual parameters, since food intake is the main pathway for contamination and biomagnification. We have carried out an extensive literature search (over 200 studies, with over 400 locations across Europe). The results of the review analysis show that there are some countries with no available data, plenty of gaps in invertebrate part of the diet, many articles including only mammalian prey and only a minority of articles calculating biomass proportions (see Fig 3). By far the most important contamination and biomagnification pathway across Europe is through small mammal intake but local birds can be important too (particularly in urban and suburban areas). Invertebrates are hunted upon more frequently in the southwest of Europe & Mediterranean area but their biomass is negligible. Fig 3 shows higher frequencies of herbivore mammals in the north, and omnivores towards the south of Europe. Insectivore and carnivore mammals are of only minor importance.

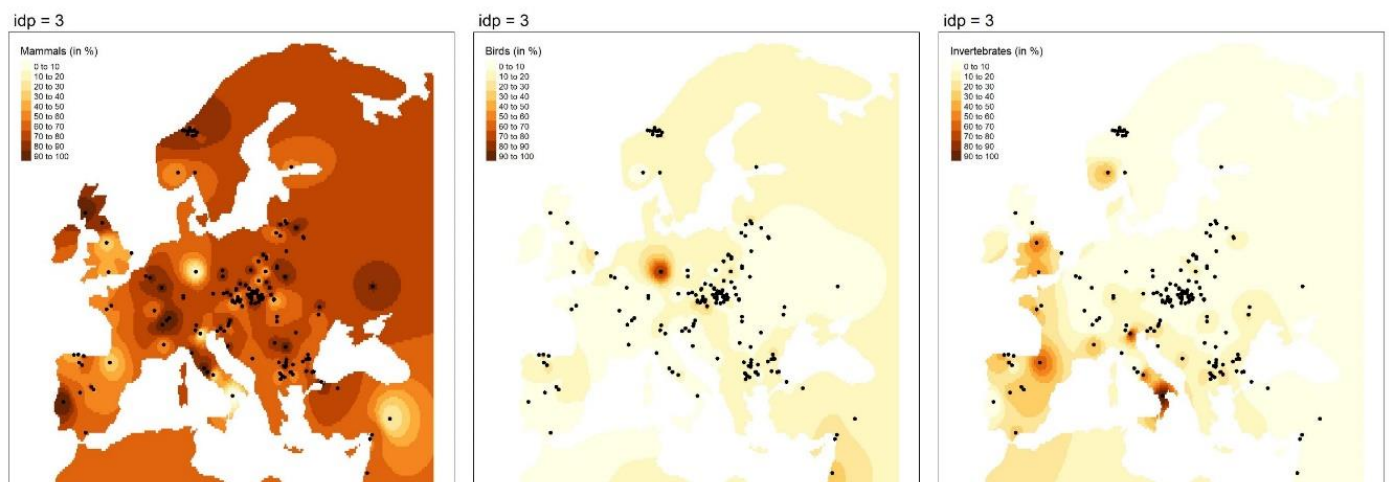


Fig 3a - Main Tawny Owl prey groups by frequency (%). Mammals – left, birds – middle, invertebrates – right.

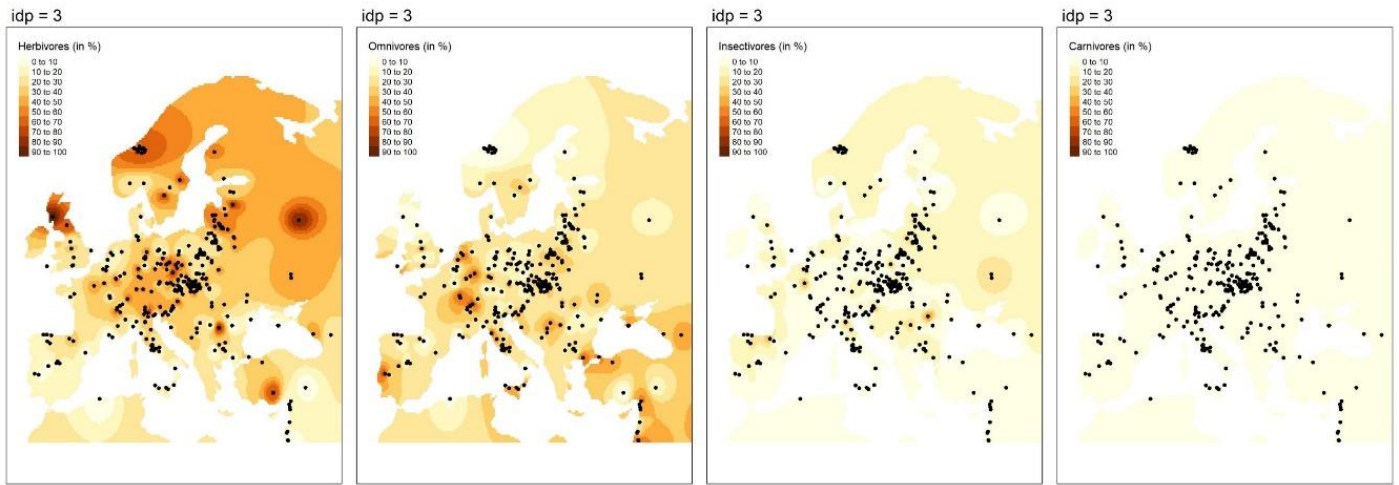


Fig 3b - Tawny Owl mammal prey proportions by their diet (%): herbivores, omnivores, insectivore and carnivores.

Concerning the dispersal data, there are huge gaps in southern and Eastern Europe (Fig 4). Young owls tend to disperse further, even more so in the north. There are exceptional movements of a few hundred or even a few thousand km, but on average the distances are below 20 km, and for adults the mean is only 5.4 km. These results tell us that the Tawny Owl is a good indicator on a local level.

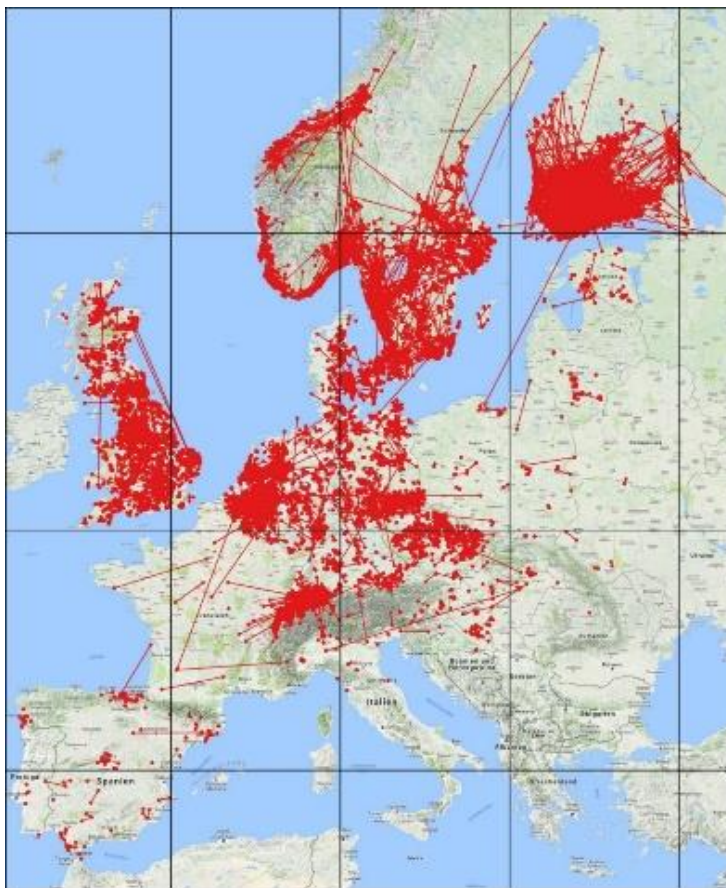


Fig 4 - Tawny Owl dispersal distances of adults (mean 5.36 km) and young (mean 19.58 km).

Tawny owl population density differs across Europe, with high densities in Belgium, the UK, Poland and Latvia and an apparent population stronghold in the Balkan Peninsula (see Fig 5). Data for population trends are less accurate and lacking for many countries. A negative local/regional trend could be an early warning for potential contamination problem (see Fig 5).

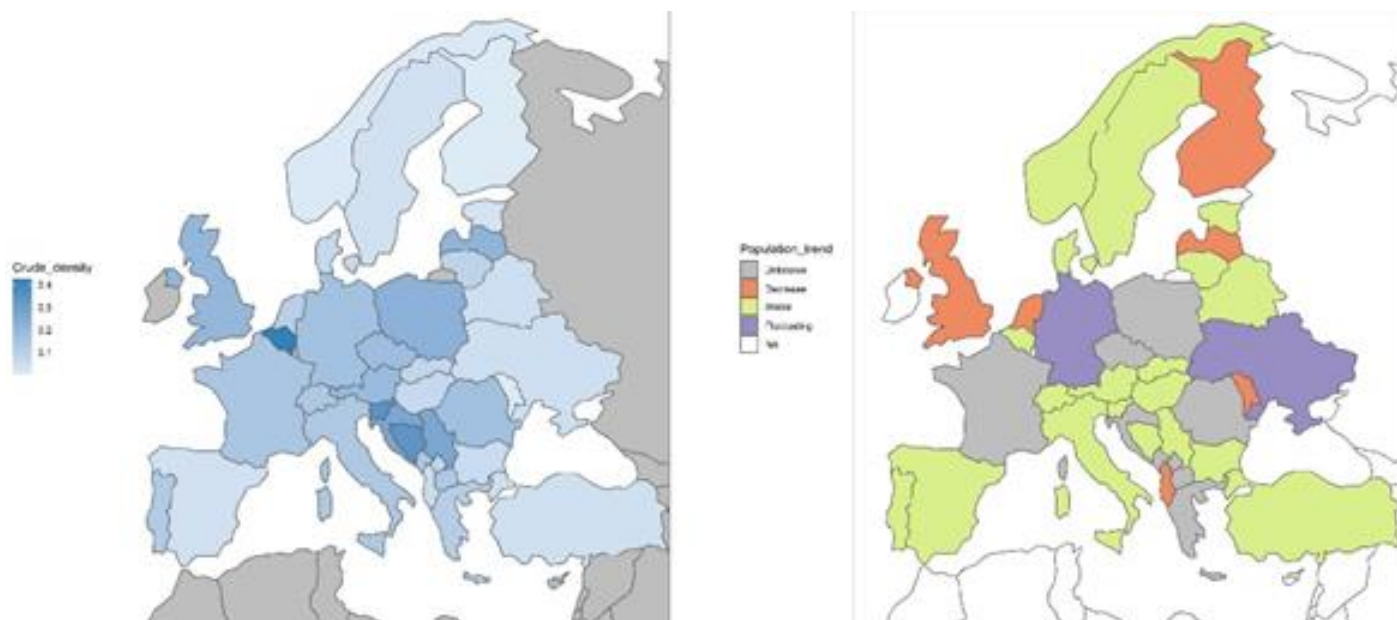


Fig 5 - Tawny Owl population densities (crude density, pairs per km², left) and population trends (right).

Besides population density and trends, monitoring breeding parameters is the simplest way to gain information about changes in the population – especially in regions with extensive nest-box monitoring systems. Changes in nesting frequency, clutch and brood sizes and nest abandonment rates could all be possible indicators of contamination effects. Our results are preliminary, but already a rather high variation in clutch size across Europe is apparent (see Fig 6).

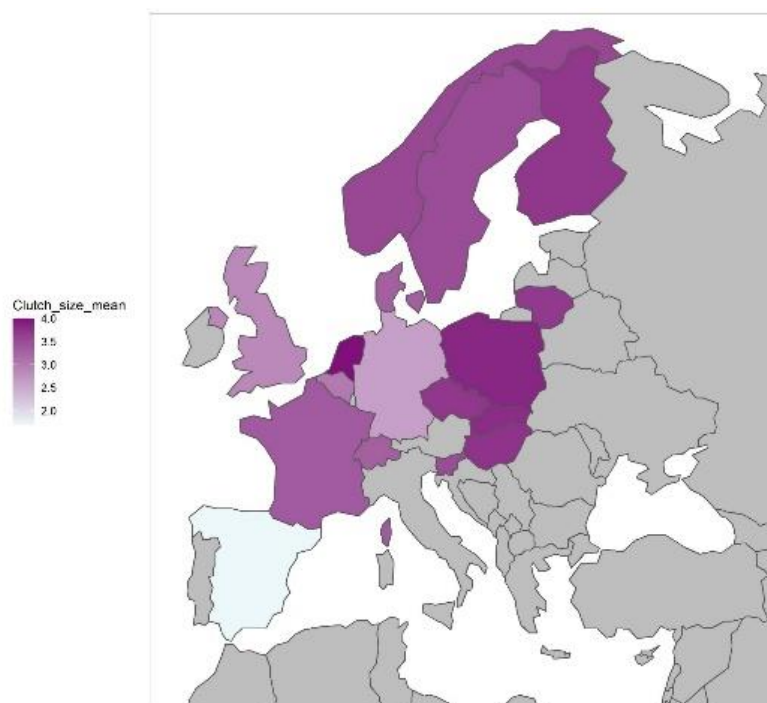


Fig 6 - Tawny Owl clutch size variation across Europe (mean number of eggs per active nest).

Our research has flagged up some gaps in our knowledge about the species. These missing gaps in crucial contextual parameters ideally need to be filled at a pan-European scale. Interpretation of contaminant results should benefit from knowledge of these contextual parameters and their spatial variations across Europe; a lack of such contextual data could lead to incorrect conclusions from contamination results.

The value of contaminant studies for raptor conservation

Population contextual data are important for interpretation of contaminant analysis results, but feedback data flow on the ecotoxicological results is equally important for raptor conservation, giving clear benefits for at least two participating arenas, as shown by Pablo Sánchez Virosta and Silvia Espín (Spain) and Chris Wernham (UK) in a [presentation showing the value of ecotoxicological studies to raptor conservationists](#). The presentation highlighted how population declines demand investigation into their causes and potential conservation interventions, for example intentional and unintentional poisoning (including contaminant exposure), which are already well-known threats to raptors. Raptors were among the first wildlife species known to be affected by anthropogenic pollutants, and they are vulnerable to environmental contaminants in part due to their trophic position at the top of the food chain. Some traditional and more recent examples were presented, including: (i) the classic case of organochlorine compounds causing deformities, eggshell thinning and direct mortality; (ii) Pb intoxication caused by ingestion of Pb shots and ammunition fragments; (iii) poisoning of *Gyps* vultures with diclofenac, highlighting the first diclofenac intoxication in a wild avian scavenger in Europe that was recently reported; and (iv) potential new threats to raptors such as contaminants of emerging concern. Although industrial chemicals, plant protection products, pharmaceuticals and biocides are regulated in the EU, the monitoring of their effectiveness in protecting against environmental pollution is lacking. In this sense, raptors can be powerful sentinels of marine and terrestrial contamination. For this purpose, it is essential to bring people from different arenas together: raptor conservation and monitoring studies benefit from more ecotoxicological research to understand contaminant exposure and associated health effects and mitigate against drivers of decline. On the other hand, ecotoxicology benefits from monitoring studies to get samples and essential contextual data for contaminant interpretation. To be effective, policy and conservation action must be informed by scientific understanding of the threats raptors face and the range of potential conservation interventions.

Discussion on Session 2

In the discussion on the value of contextual data to contaminant studies, the following points were made:

- Contextual data should be more routinely correlated with contaminant levels in studies.
- For determining clutch sizes, museum collections should be considered as well, as many preserve egg clutches but the information is not published and so is not currently accessible. Could be useful for both historical clutch sizes versus present sizes, and also for egg shell thickness.
- There is a large online database of all Hungarian clutches in egg collections.
- Unfortunately there is no current database of egg clutches in egg collections across Europe.
- There is a need to agree on the taxonomy to follow to be sure we talk about the same (sub) species limits and interpret results from publications the right way in COST ERBF. The proposal is to follow: Gill, F, D Donsker, and P Rasmussen (Eds). 2021. IOC World Bird List (v 11.1). Doi 10.14344/IOC.ML.11.1. <http://www.worldbirdnames.org/>
- We need to increase contact with others working in the field arena. Looking forward on contextual data, for species like Tawny Owl, there are annual updates on population change. However, spatially explicit changes are also potentially available - from national monitoring schemes that contribute for example to the Pan European Common Bird Monitoring Scheme but potentially many other specific schemes.

In the discussion on the value of contaminant studies for raptor conservation, the following points were made:

- Certain chemicals are regulated in the EU, however many of the thresholds used as 'safe' currently need revising and this will only be achieved with more monitoring. There are quite a few interesting patterns of poor health with low levels of contaminants and low levels may be having some influence on findings. Population contextual data can be very important in identifying such low-contaminant-level effects.

- What should be the alarm level of a chemical or its impact on raptors in order to be banned from EU? The case of Diclofenac in Spain is one serious example for the ERBFacility. Identification of chronic effects in a population should be taken seriously and should raise alerts.
- The use of monitoring data for influencing regulation within the EU is important, but at a higher level, influencing the global level "Stockholm Convention" can also be an ambition for use of the data we can help generate.
- The "One health" concept: Considering the fact that raptors, among other birds, are potential reservoirs of West Nile Virus infections, many WNV surveillance programs (incl. wild birds) are currently running across Europe. Joining forces with such projects could further strengthen capacity building for all research areas involved (and therefore limit related costs). This does not of course solve related problems such as storage capacities in lab/museums. An idea could therefore be to demonstrate the applicability and cost/benefit aspects of this by applying for further funding also involving other scientific disciplines and would thus contribute to increased awareness among scientists of other fields. A further benefit of that would be to relate contaminant levels/infection burden with possible health-related parameters in raptors, among other birds.
- Consider further the interplay between pollution and disease.
- Note that freezing at low temperatures can destroy the ability to test for pathogens.
- Note this Horizon EU Project on disease outbreaks: <https://mood-h2020.eu/>
- **A major message is that future funding applications must take account of the resource needs across the whole network and all three arenas if we are to make good progress with a pan-European monitoring scheme. But we must have some clear focus by species, tissues, storage methods, contextual population needs and so on, so that resources can be allocated appropriately.**

SESSION 3

Future training and capacity building needs in relation to the European Raptor Sampling Programme

One of the high-level aims of the ERBFacility COST Action Field Arena (WG4) is to characterise the existing capacity across Europe to take part if any future European Raptor Sampling programme, and to recommend priority areas (skills, geographical) where capacity building is needed. A review of this capacity across Europe was initiated at a WG4 workshop in Slovenia in September 2019 (see the [Slovenia workshop report here](#)). An introduction to this session was provided by Chris Wernham, explaining that a summary for each country that had been assessed already is provided in Appendix 4 of the Slovenia workshop report. Templates summarising capacity and gaps in each country have already been filled for: Austria, Estonia, Finland, Germany, Greece, Iceland, Israel, Italy, North Macedonia, Portugal, Romania, Slovenia, Spain and UK. These are available on a Google drive [here](#)), and the blank template ([here](#)) is available for use, either by countries that have not yet completed a template, or by participants who would like to provide comments or more details for an existing country.

Maria Dulsat gave a [presentation summarising the training and skills gaps identified by the ERBF constraints study](#), the results of which are now published in Science of The Total Environment ([here](#)).

Rob Robinson gave a [presentation explaining the capacity review process, and the situation with respect to current capacity in the UK](#). A series of standard questions are asked in the review (see Box 1), with the hope that every country involved in the ERBFacility COST Action will complete the Excel template with answers to these questions.

Box 1 - Questions considered by the Capacity Review

1. Please think about the different types of 'actors' (field participants) that will be needed to help deliver a pan-European Raptor Sampling programme, for example:

- ringers to collect samples
- rehabilitation centres, vets, the general public to collect samples and carcasses
- raptor monitoring volunteers and professionals to collect contextual population information (e.g. breeding success, survival, population trends data)
- conservation NGOs that influence/support staff and volunteers who could take part
- museums/collections to collect and store samples

For each participant type, please list the relevant organisations within your country and any personal contacts you have with them. The idea is to understand the current capacity to collect more samples and contextual data in your country.

2. For the ERBFacility Proof of Concept study a decision has been made to focus on Tawny Owl and Common Buzzard as focal species. Specifically for these species, what is the current capacity to collect additional samples and contextual population data in your country?

3. What are the most significant gaps in capacity in your country (a) generally for taking part in a pan-European Raptor Sampling Programme, and (b) for taking part in the proof of concept study focused on Tawny Owl and Common Buzzard?

4. What general level of interest/conservation priority is attached to raptors by each of the participant groups in question 1 above? Are there formal or informal organised groups specialising in raptors/ERBFacility focal species? How high on government/NGO priorities are raptors/ERBFacility focal species?

5. In which area(s)/participant group(s) do you think there is the greatest potential to capacity build/train more people to get involved in the ERBFacility sampling programme/proof of concept study? How would this best be achieved?

6. If you found a fresh Common Buzzard or Tawny Owl carcass in your own country what would you do?

The UK is in a favourable position with respect to capacity to contribute to any future European Raptor Sampling programme, with an existing raptor biomonitoring infrastructure (e.g. the Predatory Bird Monitoring Scheme) and a long history of public/volunteer contributions to collecting carcasses for analysis and population monitoring of raptors to provide high quality contextual data (e.g. Scottish Raptor Monitoring Scheme, North East Raptor Forum and other local groups; a strong British & Irish Ringing Scheme and Nest Record Scheme).

The main constraints and needs highlighted for the UK are:

- There are still some geographical areas where coverage is poor (particularly in the north and west of Scotland where human population densities are lower).
- The long history of different groups already carrying out relevant studies can make it challenging to harmonise approaches or to innovate.
- There is still room to better coordinate activities between the different groups and improve contextual data availability.
- Strong legislation can make some activities difficult (e.g. blood sampling).

- Less focus is given to monitoring of commoner species and this still needs to be improved.
- There is a need to pass skills on to younger generations as many people involved are getting older!
- It can be expensive to get things done in the UK, so overall capacity is still limited.

Metodija Veleviski then spoke about the contrasting situation in North Macedonia, where development of much of the capacity required to contribute to any future European Raptor Sampling programme is still in its infancy. His talk was based on the [completed Excel file for North Macedonia capacity](#). Some of the points highlighted for North Macedonia were:

- Since the Slovenia workshop in September 2019, one new person is working professionally on birds in North Macedonia, increasing capacity by 25%. The museum also has one new taxidermist but still has no ornithologist.
- There is no functional centralised Ringing Scheme, and any ringing taking place is not yet appropriately regulated.
- A small number of priority species receive monitoring coverage but only opportunistic presence data are currently collated for most widespread diurnal raptor species, and owls are really under-covered (only a first step towards collecting presence information in the last few years; no monitoring of trends of any sort).
- Since the Slovenia workshop, a feasibility study for Wildlife Rehabilitation Centre(s) in North Macedonia has begun.
- Public interest in birds is growing, with social media playing a strong role in this, and there is greater interest in raptors than in most other bird groups, but training is still needed in every field related to a future European Raptor Sampling Programme.
- In terms of scientific research, the single permit for everything that is issued by the Ministry of the Environment functions very well but storage of any samples collected is currently impossible (no suitable freezer facilities available) and movement of samples abroad requires “patience and good luck” (North Macedonia is a signatory to CITES but it has proved impossible to export samples abroad to the EU so far). A large project on trade in wildlife that is now starting may help to rectify such problems in future.
- Some positive activities are underway: to improve the capacity of vets to carry out necropsies; and a national level working group to improve capacities in the Inspectorate of Nature and Ministry of the Interior (Police), particularly in relation to poisoning incidents. Deaths of protected species (from which samples may be required) must be reported to the Ministry of Environment or, if crime is suspected, to the Inspectorate of Nature/Police.

So, in summary, the situation in North Macedonia is improving rapidly with respect to capacities to contribute to a European Raptor Sampling Programme but, in the opinion of Metodija Veleviski, is still lagging behind most countries in the region, and certainly behind those in Western Europe.

Discussion on Session 3

In the discussion over current constraints on a European Raptor Sampling Programme, the following points were made:

- Lots of people (volunteers) are interested to work with raptors but because they are a sensitive group of species, there may be problems with the perceived or real ‘reliability’ of candidates, especially regarding raptor crime (stealing eggs or chicks from nests), which is still a problem in some European countries.
- Lesson from UK: ‘reliability’ of candidates can be a barrier to be able to invite lots of new-comers into raptor monitoring because of suspicions from the traditional raptor monitoring people. From experience with the Scottish Raptor Monitoring Scheme, it is usually helpful if new people are taken under a member’s wing (mentoring or buddy system) and slowly proven themselves to be trusted (or they may initially be allowed to work on the less sensitive species).

- Shipping raptor samples is a matter of practice. You have to practically experience sending the samples abroad and then you can see what magnitude of constraints there are and where. There will be lessons learnt in the ERBF Proof of Concept study and Life Apex Project that can be shared afterwards. In practice shipping can be very simple, but you have to find the correct way (which is country specific). It will be important to summarise the options and share them as part of the ERBFacility Action, including details of particular companies that are potential carriers (as the policies of a single company may also differ between countries).
- Additional constraint: CITES is now needed between UK and EU.
- Sometimes disease screening is needed, which increases costs before posting.
- Sending between museums that hold CITES permits usually works very well, but smaller (regional) museums often do not have CITES permits/exemptions and many/most labs don't have them either. That makes shipment legally not possible. Getting a CITES permit if possible is extremely valuable but does take time.
- Some organisations (like national museums) also have existing contracts with shipping carriers, so the paperwork is already set up.
- The costs of shipping samples can be extremely high (e.g. between Balkan countries and Spain) – the shipping can be more expensive than the analyses, and it can take many months to arrange.
- Some general guidelines (e.g. how to check companies) for shipping should be part of the guidance on the Advice Hub – including shared experiences from LIFE Apex.

THE LINKS BETWEEN THE COLLECTIONS ARENA (WG3) AND THE FIELD ARENA (WG4) IN TERMS OF THE FUTURE ADVICE HUB AND CAPACITY BUILDING TOWARDS A FULLY FUNCTIONING ERBFacility

In Introducing this session, Chris Wernham explained that the Advice Hub was always intended to be useful to all three arenas - the initial focus has been on the needs of field people because of the field arena group (WG4) has been leading development but it has always been our hope that the other arenas will support the work and we can expand the hub to include other arena information and guidance needs.

In her verbal presentation to the meeting, Paola Movalli (Lead, WG3) made the following points and suggestions regarding further development of the Advice Hub:

- The primary function of the Field Arena in the European Raptor Biomonitoring Facility is **to deliver raptor specimens to collections** - or in some cases directly to laboratories. The Field Arena also **gathers and provides relevant contextual field data** related to the raptor specimens, that help to interpret the results of contamination analyses.
- The primary function of the Collections Arena is to **process and store the raptor specimens**, and/or selected tissues from these specimens, in freezers at -20C, to allocate a unique identifier to each specimen, maintain digital records of specimens, to link each specimen to all data pertinent to that specimen, and to enable access to these specimens and tissues for contaminant analyses.
- The Collections Arena is an **important intermediary** between the Field Arena and the Analysis Arena. This has been demonstrated by our Proof of Concept work, where we have identified almost 4000 raptor specimens of our four priority species, available in collections for contaminant analysis.

- The Field Arena can in some cases deliver raptor specimens direct to labs, but **in most cases, raptor specimens will go to collections for storage**, until such time as they are required for analysis. Collections can also carry out other research on these specimens.
- There is considerable overlap between the Field and Collections Arenas in terms of personnel. Museum bird curators are often also active field ornithologists, and vice versa.
- To date, the guidance contained within the Advice Hub has been largely targeted at audiences in the Field Arena. However, **the Hub can be enriched substantially by work done under the Collections Arena**. This will clarify better, for audiences in the Field Arena, the role of the Collections Arena, and how the Field Arena can work more effectively with the Collections Arena and vice versa. It will also make the Hub more useful for curators and other staff working in Collections.

For example:

- o The Advice Hub already contains some information on **legislation and permits** - this could be enriched by work done under the Collections Arena on the international shipping of raptor samples (Jorgos Sbokos' STSM).
 - o The Advice Hub already plans to provide information in **how to share monitoring data** - this could be enriched by linking with Collections Arena work on a European Raptor Specimen Database and links to DiSSCo - the Distributed Systems of Scientific Collections, which aims to digitise and link all data related to all specimens in collections across Europe.
 - o The Advice Hub already provides information on **how to submit samples for analysis** - this section needs to reflect the important role that Collections play as intermediaries between the field and analysis arenas.
 - o The Advice Hub could also provide advice on the **processing and storage of samples** - WG3 is currently preparing a protocol on this for collections (Giuseppe Cicero's STSM).
- Adding this material from the Collections Arena may involve **adjusting slightly the main menu** of the Advice Hub.
 - The Collections Arena (WG3) will be **happy to work with the Field Arena (WG4)** to make these inputs to the Advice Hub.
 - The Advice Hub would also benefit from being **enriched by work done under the Analysis Arena (WGs 1&2)**, e.g. on priority species for contaminant monitoring, the sampling protocol, which matrices to use, etc.

FINAL DISCUSSION & SUMMING UP

During this final session, the following helpful points were discussed:

- Having the 'support' of the ERBFacility COST Action can be valuable for individual researchers and organisations for helping them to demonstrate the ongoing importance of their work in the field of raptor ecotoxicity and monitoring when trying to secure funding or other resources from organisations. Guy Duke (ERBFacility Chair) confirmed that ERBFacility can provide a formal letter to support such researchers currently, and also highlighted that the over-arching aim of ERBFacility going forwards will be to try to secure funding to provide these sorts of resources across European countries in future.
- The EU Green Deal, adopted recently as part of the latest growth strategy, does prioritise ambition towards a 'non-toxic environment', so the 'hook' is now there in EU policy and very significant resources should be available to support contaminants work including monitoring to achieve the non-toxic state. There is already a large initiative being planned under Horizon Europe for a European partnership on risk assessment in chemicals and undoubtedly there will be demand for effective monitoring of apex predators as part of this.
- The LIFE Apex project is already seeing intense interest from the European Chemicals Agency (Helsinki) and also other agencies (OSPAR, HELCON) that are beginning to see the value of data coming from biota in the field (rather than just from laboratory testing and modelling as in the past).
- ERBFacility has another year to run (to April 2022, assuming our extension with COST is confirmed) but it is hoped that funding will then be secured for a future network.
- We expect to apply for a COST Innovators Grant, which will provide a further year to develop a business plan to sustain a longer-term network but we are also looking at other ways of resourcing work going forwards.
- One important avenue will be to open up dialogue with the planned European Partnership for Risk Assessment in Chemicals (budget for the latter may be in the hundreds of millions of Euros) but the collaboration with the LIFE Apex project is also likely to be very valuable. The Horizon Europe framework programme of funding should also provide further opportunities (e.g. Marie-Curie Doctoral Training Networks; and under specific calls for proposals around Zero Pollution theme).
- We should also start to explore links with industry in terms of funding.

PROGRAMME

Time slot (CET)	Activities	Lead and assistants / notes
<i>Thursday 22 April</i>		
09:30 – 10:00	Connect to Zoom to test if you have not used it before	
10:00 – 10:15	Welcome and outline plan for the day	Chris Wernham (Lead WG4 – Chair for the session)
10:15 – 10:30	Progress with the European Sampling programme framework	Chris Wernham
10:30 – 10:45	The ERBF Advice Hub – structure and overview of content	Silvia Espín & Pablo Sánchez Virosta (WG4 Team)
10:45 – 11:00	Example of the approach adopted in providing guidance – monitoring raptor diets	Rui Lourenço (Deputy Lead, WG4)
11:00 – 11:15	Questions and suggestions on the advice hub	Chaired by Chris Wernham, Silvia Espín & Pablo Sánchez Virosta
11:15 – 11:30	COFFEE & SOCIAL BREAK	
11:30 – 11:40	Strengthening the links between arenas - case studies to demonstrate the value of bringing people from different arenas together.	Introduced by Al Vrezec
11:40 – 12:00	The value of contextual data to contaminant studies – Tawny Owl proof of concept example	Urška Ratajč (Short-Term Scientific Mission holder), Rui Lourenço & Al Vrezec
12:00 – 12:20	Showing the value of ecotoxicological studies to raptor conservationists	Silvia Espín & Pablo Sánchez Virosta
12:20 – 12:45	Discussion on dissemination of the Advice Hub and maximising its use (for giving guidance and encouraging arenas to work together)	Chaired by Al Vrezec
12:45 – 13:30	LUNCH & SOCIAL BREAK	
13:30 – 13:40	Future training and capacity building needs in relation to ERSamP – review of needs across Europe	Introduced by Chris Wernham
13:40 – 14:00	Training and skills gaps identified by the constraints study	Maria Dulsat & Rui Lourenço
14:00 – 14:15	Current capacity and gaps in the UK	Rob Robinson (with Gaby Peniche and Chris Wernham)
14:15– 14:30	Current capacity and gaps in North Macedonia	Metodija Veleviski (with Jovan Andevski)
14:30 – 15:00	Discussion around completing the review and next steps around future training	Chaired by Chris Wernham
15:00 – 15:10	The links between collections arena (WG3) and field arena (WG4) in terms of the future advice hub and capacity building towards a fully functioning ERBFacility	Paola Movalli (ERBF WG3 Lead)
15:10 – 15:30	SUMMARY OF THE DAY & NEXT STEPS	Guy Duke (ERBFacility Chair), Al Vrezec (ERBF Deputy Chair) & Chris Wernham (ERBF WG4 Lead)
15:30	CLOSE OF MEETING	