Better utilisation and transparency of bird data collected by TSOs

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Summary

There is a recognised need to mitigate against potential negative impacts that some powerlines might have on bird populations, and reducing collision and electrocution risk is a priority for Transmission System Operators (TSOs). Consequently, a significant amount of data is collected on presence of species, behaviour, and observed mortality rates to help better understand potential impacts and plan avoidance, mitigation and conservation strategies. However, such data are not yet fully centralised or available in a systematic way for wider use. This work aims to provide a first step in the centralisation and understanding of the quality and scope of bird data collected by TSOs through use of a questionnaire and workshop with TSOs, NGOs and academics. A total of 16 TSOs from Europe responded to the questionnaire (and a further six companies that were either outside of Europe or operated low/medium-voltage lines within Europe). In general, most TSOs collect at least some bird data during the construction and/or monitoring phases, but the extent and scope of the data differs among companies. Some TSOs have close partnerships with conservation non-governmental organisations, which appears to strengthen the amount and scope of data collected, and already participate in data sharing. However, others do not currently share their data widely because they lack the data or resources, there is no centralised system, and it is unclear who to share with and what to share. From the workshop, it is clear that there is a shared goal among stakeholders to reduce bird mortalities, whether it be for conservation or money-saving purposes and key data requirements include access to bird abundance data, sensitivity mapping to prioritise risk, information on mortalities and information on mitigation effectiveness.

Introduction

Worldwide there are thousands of kilometres of powerlines transporting generated energy from both traditional (e.g. coal and gas) and renewable sources (e.g. wind, solar, hydropower) to the end user. The global demand of energy is predicted to grow by over 25% from 2018 to 2040 (International Energy Agency, 2018), and the use of renewable energy in particular is expected to increase in the coming decades due to growing energy and climate change concerns. Concurrently, there is, and will continue to be, expansion of new powerlines globally. In some cases when inappropriately designed, overhead powerlines might pose a collision and electrocution risk to certain bird species, leading to serious detrimental effects on some avian populations (e.g. Schaub et al., 2010; Boshoff et al., 2011; Jenkins et al., 2011). Some bird groups are more at risk of powerline collisions or electrocutions than others. For example, large-bodied species such as raptors, cranes and storks are more likely to collide with overhead wires than smaller groups (Rubolini et al., 2005) and the likelihood of powerline-related mortality is dependent on species-specific factors such as flight behaviour, sensory perception and morphological features (Bernardino et al., 2018). Placement of powerlines in migratory pathways (Kirby et al., 2008) and areas with important habitat features (Garrido & Fernández-Cruz, 2003) are also thought be important factors in the rate of bird mortalities, while the design of pylons is the most important aspect that determines whether they pose an electrocution risk or not (Lehman et al., 2007).

In light of the dangers of poorly sited powerlines to some avian populations, there is a recognised need to mitigate against powerline collisions and electrocutions for conservation purposes. However, bird collisions and electrocutions can also have financial consequences for energy companies due to disruptions to power supplies. It is therefore in the company's interest to adopt the best mitigation practices to maintain reputation, public acceptance and compliance with national and international laws (European Commission, 2018). Indeed, there are a number of mitigation techniques that have been adopted globally. For example, Strategic Environment Assessments (SEA) and Environmental Impact Assessments (EIA) allow for careful planning of line routing and construction, and the installation of wire insulation, perching deterrents and line-marking devices aim to reduce bird collisions and electrocutions (Prinsen et al., 2012). Modifying the design of pylons and the location of lines at the planning stage and adopting safe designs and pylons will, however, be the most efficient approach to reduce electrocution and collision risk.

A number of studies have examined mitigation design and effectiveness (e.g. Janss & Ferrer, 2001; Barrientos et al., 2011; Barrientos et al., 2012; Sutherland et al., 2018) and a recent review surrounding bird collisions with powerlines found that research on this issue has advanced in recent decades (Bernardino et al., 2018). However, the authors conclude that more scientific evidence is needed on what powerline-specific factors (e.g. wire height) are affecting bird collisions and on the support for recommendations of good practice to

reduce bird collisions, and whether the induced mortality actually has population-level effects (D'Amico et al., 2018). Moreover, much of the scientific literature is unavailable or is available in a 'scattered' manner to energy companies, thus information on best practices to reduce bird collisions and electrocutions are not always obvious (Prinsen et al., 2012) and/or power companies might not always have the resources to conduct extensive literature searches. For electrocution, on the other hand, the safe design of pylons and mitigation methods for unsafe pylons have been established and applied in practice (e.g. Lehman et al., 2007; Eccleston & Harness, 2018; Hernández-Lambraño et al., 2018).

One approach to inform decision making could be to bring together data collected on bird presence, bird mortality and effectiveness of mitigation techniques by energy companies in a systematic fashion. Collating information in this way would provide a powerful means to assess the vulnerability of bird species to powerlines, that could in turn inform spatial planning and mitigation through mapping sensitivity and vulnerability of species, crucial for vulnerable species groups. This would also be useful to help avoid construction in areas of greatest risk or to target where mitigation measures should be prioritised, to minimise the cost to transmission companies. A recent example of this approach is for wind farms and collision risk vulnerability of birds and bats. Here, a global literature review and subsequent meta-analysis of collision mortality rates of species revealed hotspots of vulnerability, greatest vulnerability for raptors, and made recommendations of mitigation through wind farm optimal turbine size (Thaxter et al., 2017). Similar approaches have been taken for powerlines at the country level (D'Amico et al., 2019). However, covering a wider spatial scale, such as across Europe, would be highly informative. Parallels also exist in both wind farm and powerline sectors in issues of variable data quality, standardisation of methods and reporting, and general sharing of information making such approaches challenging.

This study aims to provide a first step in the centralisation, sharing and an understanding of the quality and scope of bird data collected by Transmission Systems Operators (TSOs) (or data used by TSOs and collected by a third-party) across Europe. Through use of a questionnaire we provide (1) an overview of the types of data collected by TSOs on bird-powerline interactions and (2) recommendations for better utilisation and sharing of such data. Following the questionnaire, we held a workshop to further understand and discuss the value of, and possible solutions to sharing, bird data and information.

Methods

Questionnaire design and distribution

A questionnaire aimed at TSOs was designed to obtain information on the bird data collected by the company or external contractors. The questionnaire contained 26 questions divided into five sections:

1. **Reasons for data collection and partnerships with organisations.** This section focused on legal requirements of collecting bird data and any partnerships with NGOs.
2. **Collection of bird collision/electrocution data.** Included questions on how and what data are collected and how long data have been collected for in regards to collisions and electrocutions.
3. **Collection of bird presence/abundance data.** Included questions on how and what data are collected and how long data have been collected for in regards to live bird presence and abundance.
4. **Making use of the data.** Consisted of questions in relation to the modification of infrastructure based on the bird data collected, including how data are stored.
5. **Sharing the data.** The final section was concerned with who owns the bird data, whether data are currently shared with other organisations, what prevents effective sharing of data, and whether a centralised database would be informative.

The questionnaire was circulated to all 11 TSOs that are members of the Renewable Grids Initiative (RGI), as well as other TSOs that have mutual partnerships and contacts with the authors of this report (C.T, S.O and J.P-H). Although European TSOs were the focus of this work, TSOs from outside of Europe were also contacted to provide additional information and to shed light on the potential for future work outside of the region, for example through the CMS Energy Task Force. Questionnaires were circulated at the end of December 2018 and the beginning of January 2019.

Follow-up conversations

Although the questionnaires were designed to obtain detailed information on bird data collected by TSOs, it is difficult to capture a true and complete picture with only a limited number of questions. As such, telephone calls were made to a small number of respondents to obtain further information on the type of bird data collected (e.g. information on species/birds of conservation concern etc.), relationships with NGOs (e.g. how useful the relationship is, how the relationship operates etc.), and the types and effectiveness of mitigation techniques (e.g. types of bird deflectors used, why they are placed where they are etc.). The main aims of these follow-up calls were to grasp how much information has been captured in the questionnaire responses and to inform topics of discussion at the subsequent workshop. Telephone conversations were held by E.K and four TSOs that indicated that they collected informative data (EirGrid, REN, Terna and RTE) and lasted approximately one hour.

Analysis of questionnaire responses

The numbers of TSOs to answer a specific option per question are presented using graphs, and any comments made by the respondents are summarised for each question. As respondents could often choose more than one option for each question, the graphs do not necessarily total the maximum number of respondents to answer the question. Any emerging patterns in the answers and comments, as well as particularly noteworthy comments and concerns are highlighted throughout the results section. This interim report is concerned with TSOs from Europe, so companies in charge of low/medium voltage lines (distribution system operators) and/or companies outside of Europe are not included in analyses here.

Workshop

As part of the RGIs two day 'nature workshop', on April 2 2019 we held an interactive session to gain further understanding and spark discussion on the value of bird data and information, and potential ways of effectively sharing such data. The participants were split in to three groups of ~10 participants, consisting of a mix of stakeholders (TSOs, NGOs, academic researchers and consultants). The session lasted for two hours and consisted of three tasks:

- *Task 1 – to discuss the value of collecting bird data and information*: Participants were asked to list the benefits of collecting bird data (i.e. raw data) and information (i.e. the outcomes from the raw data, such as reports). They were then asked to rank the importance of these benefits.
- *Task 2 – to gain an understanding of the benefits of sharing data / information types to different stakeholders:* Participants were provided with coloured stickers, depending on whether they represented a TSO, NGO or other (including academic researchers and consultants). They were then asked to place a sticker on the types of data / information they think are (1) important to them, and (2) important to share, provided to them as a matrix (Table 1).
- *Task 3 – to discuss potential ways of effective sharing of data:* Participants were asked to create a brainstorm of ways to share data and information. They were then asked to list the barriers and opportunities for each way of sharing.

To help assess the extent to which views were consistent or varied between different stakeholders, we performed some statistical analysis on the responses for task 2. Specifically, we conducted a Generalised Linear Model (GLM) fitted with binomial error structures to test for differences in what TSOs, NGOs and others (as three stakeholder groups) thought were the most important data / information types and topics. We also tested for differences among the three groups of the workshop (which contained a mix of stakeholders) to control for potential 'group' effects. We also tested for any interactions between the terms (for example, if there was an observed difference in the importance of data types, the interactive term would test if this

depended on the topic, such as electrocution or abundance). Analyses were conducted in the statistical package SAS. The results of the GLM are presented in the results, whilst key topics from the workshop are discussed in the discussion section of this report.

Table 1 *The matrix used for task 2 of the interactive session of the workshop. Participants were asked to place a sticker on the type of data / information collected on different topics related to birds at powerlines for what they think is (1) important to them as an organisation and (2) important to share among stakeholders.*

	Type of data / information				
	Raw data		**Information**		
Topic	**Unstructured data (e.g. not for a specific study)**	**Study data (e.g. post-construction monitoring)**	**Unpublished study reports**	**Peer-reviewed literature**	**Meta-analysis / reviews**
Bird abundance/presence	Species record / counts	Survey data	Of displacement	Of displacement	Review / meta-analysis of displacement effects
Collision	Records of collision	Surveys of collision	Of collision	Of collision	Review / meta-analysis of collision
Electrocution	Records of electrocution	Surveys of electrocution	Of electrocution	Of electrocution	Review / meta-analysis of electrocution
Mitigation effectiveness	Locations / types of mitigation measures	Data from studies of mitigation effects	Of mitigation effects	Of mitigation effects	Review / meta-analysis of mitigation effectiveness

Results

A total of 22 companies responded to the questionnaire; 16 of these were TSOs in Europe, two were TSOs outside of Europe and four were DSOs within Europe (Table 2). Amprion, 50Hertz, Transnet BW and TenneT (where operating in Germany) answered the questionnaire jointly, so results are compiled using 13 responses from European TSOs. Results for CEZ, ELMU, E.ON, VSDAS, YEDC and Eskom are shown in Appendix 1.

Table 2 *Name and type of companies, and the countries they operate in, that responded to the questionnaire. TSO = Transmission System Operator. DSO = Distribution System Operator (low/medium voltage level).*

Company name (abbrv.)	Type of company	Country of operation
Austrian Power Grid (APG)	TSO	Austria
Elia	TSO	Belgium
Fingrid Oyj (Fingrid)	TSO	Finland
Réseau de Transport d'Électricité (RTE)	TSO	France
Amprion*	TSO	Germany
50Hertz*	TSO	Germany
Transnet BW*	TSO	Germany
TenneT*	TSO	Germany
Mavir	TSO	Hungary
Terna Rete Italia S.p.A. (Terna)	TSO	Italy
AS "Augstsprieguma tikls" (AST)	TSO	Latvia
TenneT	TSO	The Netherlands
Polskie Sieci Elektroenergetyczne S.A. (PSE)	TSO	Poland
Redes Energéticas Nacionais (REN)	TSO	Portugal
EirGrid	TSO	Republic of Ireland
Swissgrid	TSO	Switzerland
CEZ Distribution Bulgaria (CEZ)	DSO	Bulgaria
ELMŰ Hálózati Kft./ÉMÁSZ Hálózati Kft. (ELMU)**	DSO	Hungary
E.ON Hungária Zrt (E.ON)**	DSO	Hungary
Východoslovenská distribučná, a.s. (VSDAS)**	DSO	Slovakia
Yola Electricity Distribution Company (YEDC)**	TSO	Nigeria
Eskom**	TSO	South Africa

*answered jointly. **not included in main analyses because they are DSOs or operate outside of Europe.

Reasons for data collection and partnerships with organisations

Two and five TSOs said that they are not legally required to collect bird data for pre-construction consent and post-construction monitoring, respectively (Fig. 1). Four respondents said they are legally required to collect bird data by regional authorities for pre-construction consent, and three for post-construction monitoring. Seven and five TSOs said they are legally required to collect bird data by national authorities for both pre-construction consent and post-construction monitoring, respectively. Two respondents said they collect bird data for other legal requirements for pre-construction consent and post-construction monitoring (Fig. 1). Comments from two TSOs explained that the legal requirements for bird data collection depends on the scale (and potential impact) of each project. For example, RTE state that the local authority decides whether they should collect data or not; for some projects they are required to do follow-up monitoring of bird markers, for example, yet for others they are not. They state that monitoring is usually only conducted on very sensitive areas, but it is hard to say why some areas are chosen over others as it is the decision of the authority.

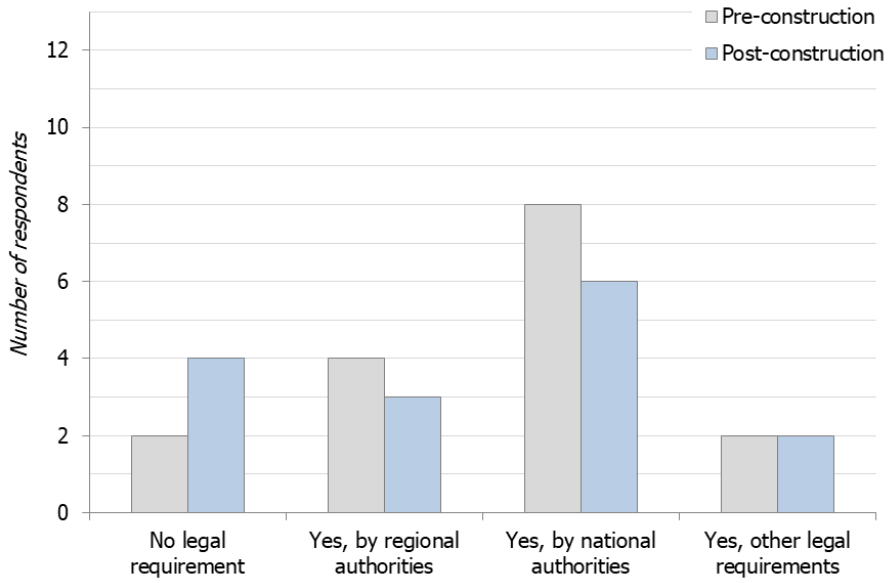

Fig. 1 *The number of respondents to have no requirements, requirements by regional authorities, requirements by national authorities or other legal requirements to collect bird data for pre-construction consent and post-construction monitoring (total n = 13).*

Most TSOs have partnerships with NGOs in some capacity; over half (n = 7) have partnerships on a national level; two TSOs say that NGOs are involved on the ground level, three say NGOs are involved as key stakeholders and two say NGOs are involved in another way (Fig. 2). Some TSOs appear to have strong partnerships with multiple NGOs; for example, Elia and RTE state that they collaborate with different NGOs to develop collision-risk maps (Elia) and to help produce guides on good practices (RTE). Terna usually involve local and national NGOs (LIPU; WWF; Legambiente; Ornis Italica) when planning infrastructure and have worked with some during large scientific projects; for example, Ornis Italica conducted a four year study using radar at Terna's powerlines to monitor the number, duration and altitude of raptors before and after construction of a line in the Strait of Messina (Terna, 2019). REN states that they have had two previous projects involving NGOs on the effectiveness of anti-collision devices. Three of the TSOs have no current partnership with NGOs: AST, Swissgrid and PSE, though Swissgrid state they seek advice if questions arise and PSE state that they are going to cooperate with local NGOs.

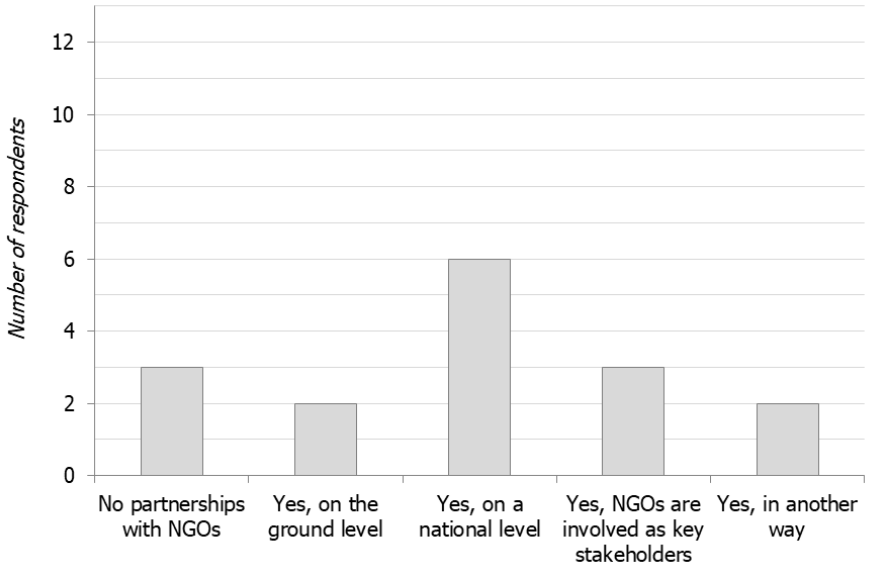

Fig. 2 *The number of respondents to have different levels of partnerships with NGOs (total n = 13).*

Collection of bird collision and electrocution data

The majority (n = 9) of TSOs collect bird mortality or injury data to some degree; four TSOs collect data both routinely (i.e. using a specific method) and opportunistically (e.g. when there is a power outage), four collect data only systematically and one TSO only collects bird mortality data opportunistically (Fig. 3). However, the comments from the respondents suggest that systematic data are collected less frequently than opportunistic data, and are typically collected only on certain projects (e.g. for new lines: RTE, REN), in protected areas (e.g. Important Bird Areas: Fingrid), or when working with NGOs on existing lines (Elia, RTE, REN). Terna state that they are hoping to train maintenance workers to search for carcasses so that all lines will be surveyed in the future; currently they search for carcasses 18m either side of lines when monitoring the efficiency of bird markers, but it can be very difficult to find carcasses. These searches (and the duration of surveys) are instructed by the Environment Ministry. They are experimenting with Bird Strike Indicators, devices that detect a collision, though battery life is currently only 8 months and these are very costly. REN also conduct regular carcass searches under the overhead wires using methods based on (undefined) scientific studies. One TSO commented that bird carcasses are noted during periodic inspections of powerlines (AST). APG use video-monitoring on pylons to assess bird casualties, and in a later comment state they use dogs to search for carcasses. Elia have a close partnership with the NGOs Natuurpunt and Natagora who have developed a website that enables members of the public to mark where dead or injured birds have been found. Mavir do not collect bird casualty data, but comment that NGOs provide some information.

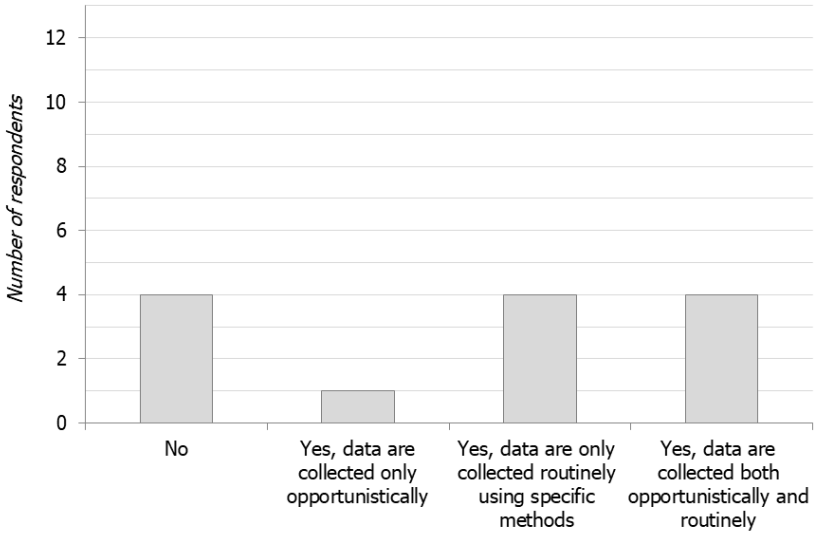

Fig. 3 *The number of respondents to collect bird mortality/injury data in the different ways listed (total n = 13).*

Systematic surveys are mostly conducted by external subcontractors, whilst opportunistic surveys are mostly conducted by staff in the company (Fig. 4). Fingrid note that citizens also collect data.

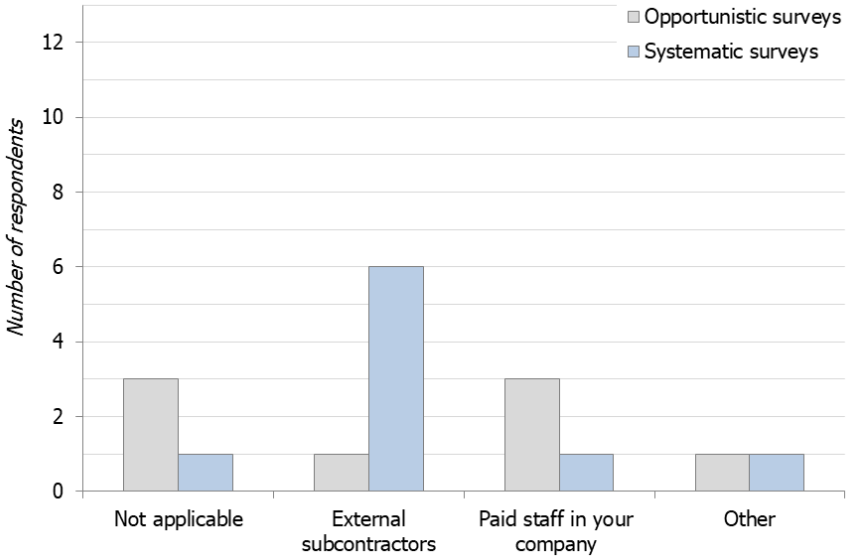

Fig. 4 *The number of respondents to say that external subcontractors, paid staff in the company or 'other' collect bird mortality/injury data during opportunistic and systematic surveys (opportunistic n = 8; systematic n = 9).*

TenneT (Dutch) collect bird casualty data monthly during systematic surveys. Equally two TSOs said that they collect data more than once a year but less than monthly for opportunistic and systematic surveys. One TSO collects data on bird mortalities/injuries annually during systematic surveys. Five respondents state that the frequency of surveys depends on the project, and for opportunistic surveys it is difficult to determine the frequency because they usually occur when there is an incident.

Seven out of the eight companies that answered the question collect data on search effort (e.g. how many pylons are searched per survey) for systematic surveys, with TenneT (Dutch) stating that this is based on the permit. Three collect search effort for opportunistic surveys. RTE state that they request detailed reports from their subcontractors with this information included.

Three TSOs say the proportion of surveyed infrastructure is too little to quantify for opportunistic surveys and five for systematic surveys. Three TSOs survey less than a quarter of their infrastructure for systematic surveys, and one for opportunistic surveys..

Two TSOs do not collect secondary bird casualty data because they do not need to, equally two do not collect secondary data but would like to. Five TSOs collect secondary data from NGOs and two from researchers, though comments suggest this is not regular. Two TSO collect secondary data from another source: RTE collect from park managers and TenneT (Dutch) say they make use of a range of data (e.g. SOVON bird-counts) when it's useful / necessary for a legal nature permit. RTE state that most secondary data comes from NGOs, but in 2012 – 2016 they collaborated with the National Museum of History for academic research; they state that they also collect data from park managers. Elia use the website "waarnemingen.be – observations.be", which allows members of the public to input data.

Collection of live bird presence and abundance data

One TSO (Swissgrid) does not collect data on bird presence/abundance, but relies on existing external data sources on bird presence/abundance for pre-construction consent. Nine TSOs use external contractors to collect presence data for pre-construction consent and six for post-construction monitoring (Fig. 5). None of the TSOs said that bird presence surveys are conducted by their own staff (Fig. 5). All surveys conducted by 'other' were NGOs, as stated by Elia and RTE.

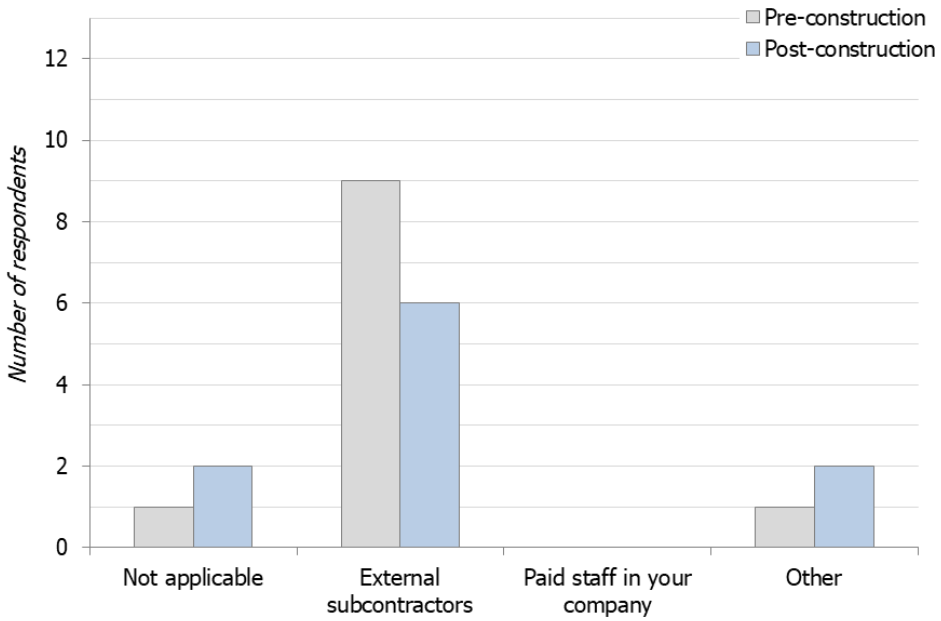

Fig. 5 *The number of respondents say that external subcontractors, paid staff in the company or 'other' collect bird presence data for pre-construction consent or post-construction monitoring (pre-construction n = 10; post-construction n = 8).*

TenneT (Dutch) collect bird presence data on a monthly basis; three TSOs collect data for pre-construction consent and two for post-construction monitoring more than once per year but less than monthly. Two TSOs collect presence data annually for both post-construction monitoring and pre-construction consent (Fig. 6). Both RTE and REN state that the scale depends on the specific project.

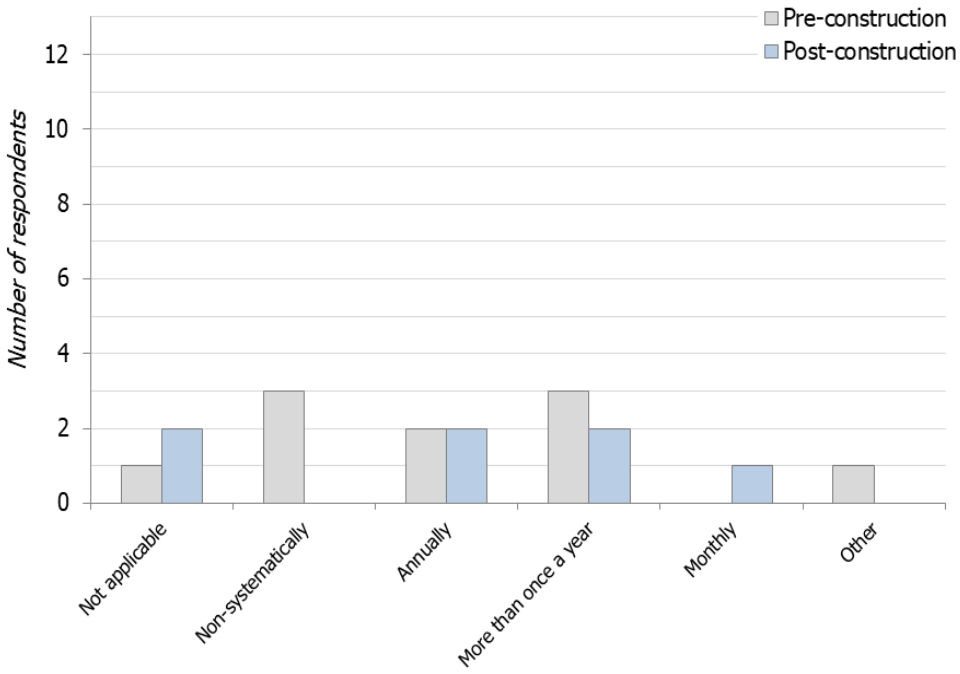

Fig. 6 *The number of respondents that collect bird presence data over the different time frequencies for pre-construction consent and post-construction monitoring (n = pre-construction n = 9, post-construction n =7).*

Over half (n = 7) of the 12 TSOs that answered the question have specific methods for observing birds during presence surveys. A variety of methods were listed by the TSOs including: line transects (APG; Elia), point counts (REN; Terna), vantage point counts (REN; APG), car transects for specific bird groups (e.g. bustards; REN), nestbox observations (Mavir), radar-monitoring (APG). RTE state that bird surveys are conducted throughout different seasons and day and night if necessary.

Four of the 12 TSOs that answered the question do not collect secondary bird presence data because they do not need to, whilst one TSO (AST) does not collect secondary data but would like to. Two TSOs collect secondary data from researchers and six from NGOs. Three TSOs collect secondary data from another source.

Making use of bird data

The majority (n = 11) of the 13 TSOs have modified, replaced or re-designed infrastructure in some way based on their bird data. Of the 12 TSOs that made comments, nine of them state that they deploy bird diverters on existing lines, and Fingrid and Elia also state that they place markers on lines based on predictions of where there will be higher collision risks. Five TSOs state that, before construction, route planning might be adjusted in higher risk areas. Mavir note that artificial nests are installed where required, but it is unclear for which species. Terna do not modify existing lines, instead they take bird interactions into consideration in the designing phases, stating that the positioning of the line is the most efficient mitigation technique. They have worked with the University of Roma for predicting the best location of deflectors so they can be installed proactively, stating that it prevents the need to install devices once lines have been constructed. All designs are sent for approval by the Environment Ministry before line construction.

Again, the majority (n = 8) of the 11 TSOs that answered the question have an inventory of their modifications and 11 know how many pylons or km of powerlines have been modified. Some companies have precise information on the extent of modifications. For example, RTE have annual internal reports about bird actions and state that at the end of 2017, ~2,300km of lines were equipped with line marking devices and 10,700 devices were installed on 7,300 tower and APG state that 80% of the network has been surveyed ornithologically and 10 – 15% of powerlines have been marked. Elia state that since 2015 markers have been placed on over 27km of 5,600km of overhead powerlines, but markers were not counted before then.

Three TSOs do not store data for operational procedures (i.e. standard routine operations), and three store the data via electronic spreadsheets stored on local drives, two by spreadsheets on cloud serves or paper copies, and one TSO (Fingrid) stores data for operational procedures via electronic map storage (Table 3). Six TSOs store data for legal requirements as paper copies and/or as electronic spreadsheets stored on local drive, followed by electronic map storage (n =3) and spreadsheets stored on cloud servers (n = 3; Table 3). Five TSOs do not store data from post-construction monitoring that is not a requirement; a small number of TSOs store this data as electronic spreadsheets stored on cloud server (n = 2) or local drive (n = 1), as paper copies (n = 1) or via electronic map storage (n = 1; Table 3).

Table 3 *The number of respondents to store data collected for operational procedures, legal requirements and/or post-construction monitoring that is not a legal requirement using different storage types.*

	Storage type				
Purpose of data collection	Do not store data for this reason	Paper copies	Electronic spreadsheets stored on local drive	Electronic spreadsheets stored on cloud server	Electronic map storage (e.g. GIS)
Operational procedures (e.g. where bird collisions have caused power outages)	3	2	3	2	1
Legal requirements (e.g. Environmental Impact Assessments)	0	6	6	3	3
Post-construction monitoring that is not a legal requirement	5	1	1	2	1

Sharing of bird data

Just over half of TSOs that answered do not share bird mortality/injury, bird presence, or data on location of bird deflectors with NGOs (Table 4). Four TSOs share mortality data and data on location of bird deflectors with NGOs as a non-legal requirement, and five share bird presence data. No TSOs share data with NGOs as a legal requirement. Over half of TSOs do not share any of the types of data with other power companies, but a small number do so as a non-legal requirement. A small number of TSOs share data to a government-run centralised database, either as a legal or non-legal requirement (Table 4). Terna has in the past shared large amounts of bird presence data to the 'open data' section on their website – the data were collected as part of a project with a local NGO and the data are now publically available. Terna say that they are moving towards a more open-data approach in relation to their bird presence data. REN share their data as part of a collaborative programme, REN's Chair on Biodiversity.

Table 4 *The number of respondents to share data with NGOs, other power companies, government-run databases, or another organisation.*

	Type of data shared								
	Bird mortality/injury data			**Bird presence/abundance data**			**Where insulators, markers or bird deflectors have been installed**		
	No	Yes, as a legal requirement	Yes, but it is not a legal requirement	No	Yes, as a legal requirement	Yes, but it is not a legal requirement	No	Yes, as a legal requirement	Yes, but it is not a legal requirement
NGOs	5	0	4	5	0	5	6	0	4
Other power companies	7	0	1	6	0	2	6	0	3
Government-run centralised database	7	2	0	5	3	2	5	2	1
Other	0	0	1	1	0	2	2	0	1

Two of the 12 TSOs that answered the question state that effective sharing of bird data is already simple (Fig. 7); Elia state that most of the data are in the hands of NGOs that they work closely with and are placed on the website "waarnemingen.be – observations.be". The most common concerns of effective data sharing are that there is no centralised database (n = 7), the lack of resources to do so (n = 6), and it is unclear who to share the data with (n = 5; Fig. 7). Some TSOs also state that their data are confidential (n = 4), with Fingrid commenting that data on endangered species is confidential, and it is unclear what data to share (n = 4). Two TSOs said there are concerns of commercial interest or other reasons to prevent effective data sharing. Terna state that the concerns of commercial interest are related to mortality data; they say that their figures show that few birds are affected by their lines, so sharing collision/electrocution data might be a faux pas for them; however, they would be happy to share bird presence data (as they already do on their website) and note that bird mortality data is already shared indirectly through the Environment Ministry. CEZ (DSO) state that in addition to no centralised database, there is no standardised format. Eirgrid comment that the transmission system in Ireland is managed by two separate companies and so there is added complications with sharing data. Mavir highlight that there are no data to share.

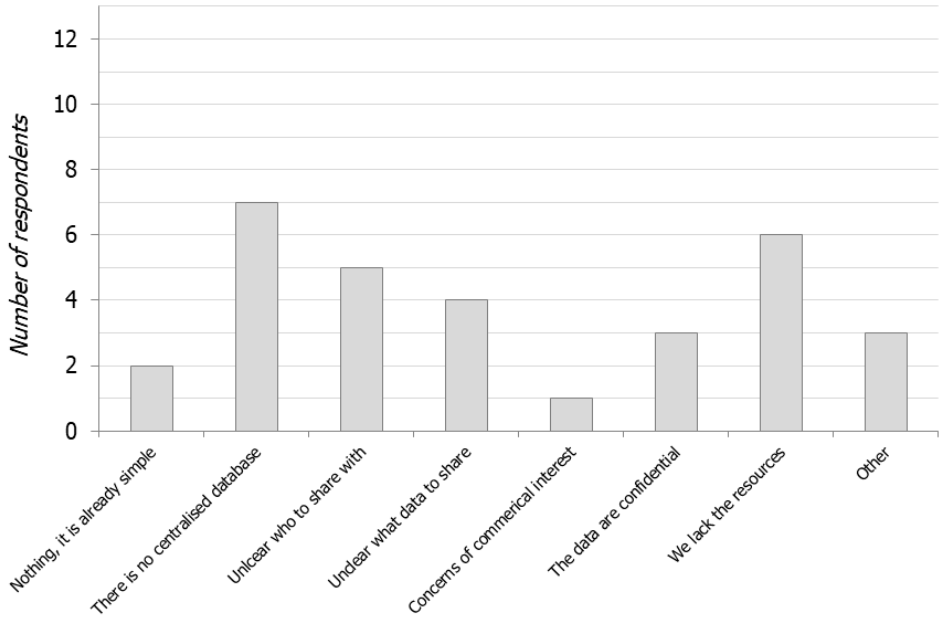

Fig. 7 *The number of respondents that believe the different reasons prevent effective sharing of bird data (total n = 12).*

Seven of the 12 TSOs that answered the question said that they think that a centralised database would help to inform their decision making on reducing bird interactions with powerlines, whilst the other five said such a database would not. REN state that the knowledge on bird-powerline interactions would always benefit from large-scale analysis. Five respondents suggest that a centralised database would not be useful because data concerning bird-powerline interactions are localised and/or may not be very useful to other countries, so it would depend on what data are shared, though Terna suggest that it would be useful for most vulnerable species. APG state that there is already an exchange of information through the environmental impact assessments and RTE state that sharing of good practises is conducted in the working group Cigre C3.16 in addition to the fact that they already have a database on a national scale. Elia state that methods should be comparable so that exchange of information can be improved.

Despite just under half of TSOs saying that a centralised database would not be helpful in informing their decisions on reducing bird-powerline interactions, two said they would either be willing, and six potentially willing, to share their data to a centralised database. The five TSOs that said they would not be willing stated that they have no data to share (Mavir), data on sensitive species are confidential (German TSOs), there is no recognisable benefit (APG) or need (PSE), or that data are already shared with a national database and it is unlikely that this will be done elsewhere (RTE).

Six of the 10 TSOs that answered the question said that industry should finance a centralised database; six said that government agencies should and two said that NGOs should. Elia stated that it should be financed by anyone that is willing to do so, as it has to serve the community. RTE state that it depends on who will benefit from the data, who will enter the data, how it will be used and the level of confidentiality.

Workshop

Under task 2 of the workshop, NGOs, TSOs and other organisations were asked what data / information types in relation to the topics of data collection (see Table 1) were (a) important to them and (b) important to share. Using formal statistical analyses, we tested whether the views of workshop attendees differed consistently between different stakeholder groups, or were broadly consistent between them.

The importance of different data types varied significantly between stakeholders and whether importance was for sharing, or for that stakeholder (significant 3-way interaction $\chi^2_8 = 23.17$, $P = 0.0031$; Fig. 9). Study data were most important to NGOs, but all other types of data were also important to them (Fig. 9a). More than 50% of NGO representatives found it important to share study data, but also found unpublished reports, peer-reviewed literature and meta-analyses important to share (Fig. 9b). The majority of TSOs only wanted access to study data, although at least 40% also wanted access to the results of literature reviews and meta-analysis (Fig. 9c), or to share study data (Fig. 9d). Other stakeholders wanted access to all forms of data, but did not consider it important to share any data in particular, although over 40% thought it important to share study data. Note here, that the sample size of representatives from the 'other' group was small ($n = 4$) so any patterns are difficult to detect.

There was no significant difference between stakeholders and the importance of different topics of data, or how that importance varied between the stakeholder and for sharing. However, there was significant variation between the types of data and the topic of data (significant 2-way interaction $\chi^2_{12} = 30.60$, $P = 0.0023$). This means there was consistency between stakeholders, and between sharing and importance to them, in terms of the sorts of data that are important. The most important data (supported by more than 50% of individuals) were, therefore, 1) study data on the impacts of power-lines on abundance, collision and electrocution (Fig. 9g); 2) published studies on the impacts of power-lines on abundance, electrocution and mitigation effectiveness (Fig. 9g); and 3) the results of literature reviews and meta-analysis on the success of mitigation (Fig. 9g).

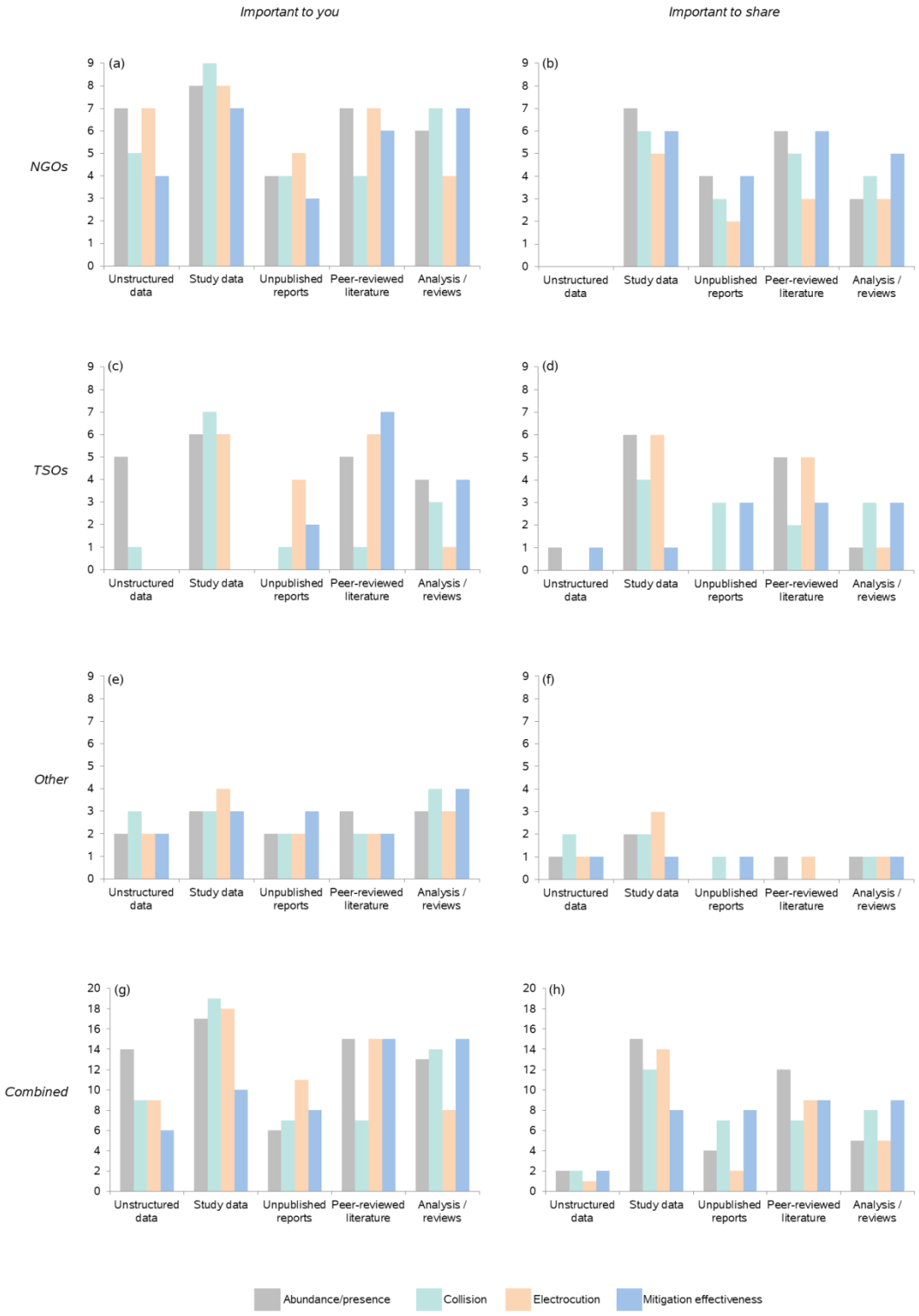

Fig. 8 *Number of participants representing NGOs (a,b), TSOs (c,d), other (e,f) in the workshop and all stakeholder combined (g,h) to say what data/information on birds they think is important to them (left) and important to share (right).*

Discussion

We have divided the discussion into two main sections. The first reviews the conclusions questionnaire survey as reported in the results, drawing on the additional narrative information recorded in some of the responses and in the interviews of specific TSOs. This section reviews current practice by TSOs and provides an initial assessment of the potential for a centralised data repository. The second section is based upon the workshop where the initial conclusions from the questionnaire were presented to a mixed group of TSOs, NGOs and other stakeholders, and subject to further discussion and refinement. Specifically, this discussion identified some priorities for data use and sharing and barriers and opportunities for doing so, and we highlight some of our key recommendations in bold throughout. We then conclude with a short summary of key points that summarise the essence of this report.

Questionnaire

It is clear from the responses of the questionnaire that most TSOs collect at least some data on bird presence and/or mortalities at powerlines, most having legal requirements to do so at some points of the construction and/or monitoring phases. However, the amount of data and frequency of collection differs among companies and is very project specific; powerlines running through protected areas or areas of value to sensitive species might be given more attention. In general, most TSOs survey too little of their infrastructure to approach a representative sample size for extrapolation to represent a wider area, and monitoring is done relatively infrequently (e.g. no TSOs collect data monthly) unless data were collected for a specific reason to inform their own decision making, the results of which typically end with internal reports. A small number of companies have been involved in data collection, financial support and/or guidance for the purposes of academic research that has been published in peer-reviewed scientific papers (e.g. Panuccio et al., 2018; D'Amico et al., 2019; Moreira, 2019). However, for conclusions on a larger European-wide scale using data collected from TSOs, standardisation of methods and frequency of data collection will likely benefit decision making, as has been highlighted in the wind farm industry (e.g. Bernardino et al., 2013). For example, if carcass searches were carried out during particular parts of the day and year, and lines were searched for using the same distance buffer, then this would make for sounder scientific approaches.

The idea of a centralised database for bird data was welcomed by around half of the TSOs, but it was made clear that in order for such a scheme to work the aims need to be made explicit. It needs to be made simple and cost-effective. Indeed, the most common concern of effective data sharing was that there is no centralised database, suggesting that there is scope for such a system. For companies not already collecting large amounts of data and/or have numerous partnerships with NGOs, a centralised database has the potential to capture data that they are not currently storing themselves. For others, the development of more model-based products, or a system that allows them to store data used for modelling approaches, might be more useful to inform decision

making or monitoring. For example, Hernández-Lambraño et al. (2018) used a combination of data collected on raptor carcasses and technical features of pole and powerlines to model the risk of electrocution for various raptor species in Spain, and D'Amico et al. (2019) used data on bird distributions and location of high-voltage powerlines to model collision risk of various avian species across Spain and Portugal. Having a centralised system where TSOs can input data that can be included in modelling studies might be an important avenue to aid scientific research and ultimately reduce risk of population-level impacts on birds. Such a database would also reduce risk of power outages through deployment of appropriate mitigation measures (more efficient and cheaper if done during construction rather than retrofitting) in potential hotspot areas, in turn reducing subsequent costs incurred, and increase likelihood of construction consent. Interestingly, TSOs that already collect large amounts of data and have good partnerships with NGOs appear to be more uncertain about the value of a centralised database (or could not decide before the aims have been made clear), and suggest that ways to make methods comparable and the effective sharing of comparable methods is of higher importance than simply sharing raw data (e.g. observations of birds, number of carcasses found etc.).

Workshop

Importance of data and information

The ultimate reasons for collecting data and information about birds is to lead to improved protection of vulnerable bird populations, and for TSOs, reduced risk of power outages, saving them money, and improved public relations. There may also be potential for positive engagement, such as through 'citizen science', including inputting mortality data into online databases. The workshop identified how data and information is informative for a number of key stages of powerline construction and operation (Fig. 9).

Firstly, appropriate siting of power-lines is achieved through a combination of Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA). These assessments require information about the location and abundance of potentially vulnerable species, habitats, and ideally the movements and behaviour of birds, in order to identify potentially vulnerable routes of movement, and therefore mortality risk. Sensitivity approaches, first developed in relation to wind energy (e.g. Bright et al., 2008) are increasingly being applied to power-lines, where large-scale information on the distribution and abundance of species is combined with information about their risk or vulnerability to collision and / or electrocution (e.g. D'Amico et al., 2019). Not only do such sensitivity maps inform SEAs, potentially minimising the cost and difficulty of securing consent for transmission line construction by avoiding the most sensitive areas, but they can also be used to prioritise the monitoring and marking of existing transmission lines. **Improving Access to data on the occurrence, abundance and movements of birds to inform SEA and EIA assessments was therefore a high priority.** EIAs also require data and information about the potential vulnerability of species to electrocution and collision. There are an increasing number of studies on this topic, which have been

reviewed to provide quantitative assessment of species' vulnerability (Jenkins et al., 2010; Rioux et al., 2013; Bernardino et al., 2018), although with potential to extend these approaches further to develop databases of potential mortality rates (e.g. Thaxter et al. 2017). Information about predicted mortality rates can then be combined with demographic information (e.g. of survival rates, productivity rates and age of first breeding) in order to assess the population-level consequences of power lines (e.g. Schaub et al., 2010; Boshoff et al., 2011). In order to be effective, **this requires the distillation of the results of impact studies using meta-analysis or other approaches to identify the most vulnerable species and locations**, both to improve powerline assessments, and also to help prioritise subsequent mitigation.

Once constructed, surveys to examine potential impacts through collision and electrocution, and even displacement, are important to revise understanding of species' vulnerability. These can be undertaken in a wide variety of ways and approaches, which may affect the results, and **there is a need for the development and communication of guidelines and advice about field methods and protocols to use, and how to analyse such data.** At this stage, it is worth considering whether specific or minimum standards of data capture and structure should be adopted to facilitate data sharing and information exchange (see below).

There was agreement that one of the critical uncertainties is over the effectiveness of different marking approaches. Whilst there is building evidence that marking is effective, the relative efficacy of different approaches is not well understood (Bernardino et al., 2018). Further data and studies on the consequences of marking powerlines in particular, and on measures to reduce electrocution, is required, although in some countries, electrocution is no longer a major issue (e.g. Netherlands, Germany). **Data used to inform the effectiveness of different mitigation techniques was therefore flagged as one of the most important to capture, as this is one of the most important evidence needs that TSOs have** (Fig. 8).

Finally, it should be recognised that different data sources are not exclusive, as shown by the fact that groups found it difficult to rank the importance of different data / information types in the first task of the workshop. It was highlighted by one group that data on bird abundance and distributions can be far better captured by other means, such as Bird Atlases, and may be more appropriate to use for large-scale sensitivity mapping and population level impacts as has been used before (e.g. D'Amico et al., 2019**). The greatest priority in terms of what is derived from data / information is probably the development of sensitivity mapping approaches** because this not only prevents damaging powerlines being constructed, but also informs the prioritisation of marking and monitoring of existing power-lines. Once in existence**, ongoing data collection on mortality rates of species is important to identify remaining problem areas, and to help prioritise mitigation**.

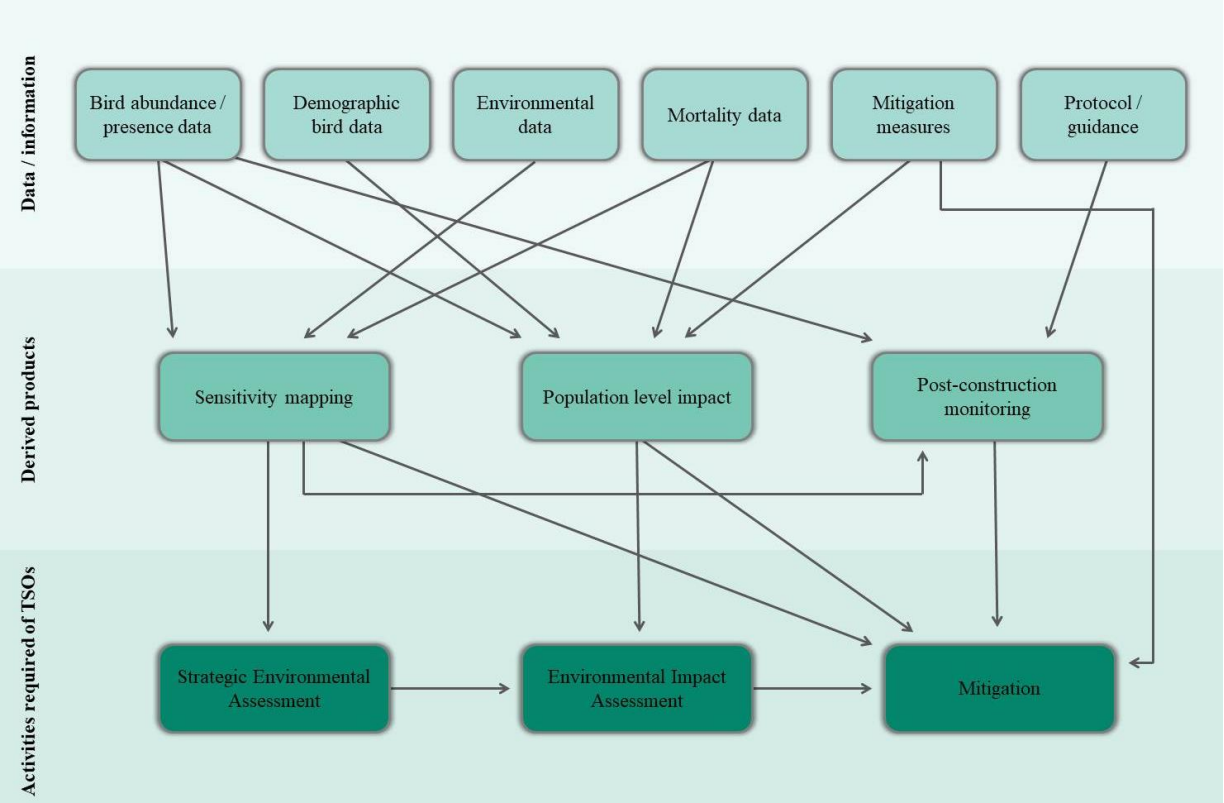

Fig. 9 *Conceptual framework for how data / information (top) informs derived products (middle) and activities required of TSOs (bottom).*

Priority data and information for use and sharing

There was particular interest in all types of unstructured and structured data, and in the results of peer-reviewed studies and reviews / meta-analyses, recognising the particular stamp of quality assurance which peer-review provides. In one group it was highlighted in discussions that the two extremes of data / information are most important to NGOs (i.e. the raw data is important as well as the final outputs in terms of meta-analyses and reviews that bring information together); it can be time-consuming to get to the important outcomes from internal reports and information can be scattered throughout scientific papers, and could also lead to differing conclusions being drawn through duplication of effort.

Raw data was particularly valued by NGOs as a means of being sure of the impacts of power-lines, above and beyond the availability of unpublished reports, which NGOs felt would be at risk of variable interpretation, although TSOs emphasised that local knowledge may be required to fully interpret raw data. It was also highlighted that raw data can be useful for NGOs and researchers to conduct analyses on questions not already addressed or that TSOs do not have the time/resources/inclination to do themselves. **Unpublished reports were also recognised as an important forum for TSOs to address particular issues**, though this was only clear in discussions, rather than what is shown in the statistical analysis; one NGO noted that all

reports they produce for TSOs are made publicly available (e.g. via ResearchGate) and believe this should be adopted elsewhere. Indeed, internal reports from TSOs have been utilised in peer-reviewed meta-analyses (e.g. Barrientos et al., 2018). However, in some instances, it may be important for those to remain confidential to avoid harmful publicity or misrepresentation. For instance, if an open repository was developed it was suggested (by one TSO), that TSOs in general might wish to only make 'positive' reports publicly available, representing a potential reporting bias. The level of sharing, such as exactly what and who to share with, would therefore need to be made clear at the outset before any standardised means of sharing is implemented.

TSOs particularly valued access to raw data on species occurrence and abundance, and on collisions to identify vulnerable species / locations, such as that provided by NGOs. This would be important to inform SEA and EIA and to prioritise mitigation. Increasing the availability of the field data held by TSOs or their contractors to support EIAs could also be a useful step towards greater open data around species' occurrences and abundances.

TSOs also called for a simple (and definitive) answer on the effectiveness of different mitigation measures to inform decision-making, for example from meta-analyses of studies of mitigation effectiveness. To support this, **there was strong support for the sharing of structured data from studies of impacts**, particularly from NGOs, to give them a clear picture of what those impacts are, and in the sharing of unpublished industry reports, which are otherwise not available. Sharing these datasets may be easier to facilitate if organised through a trusted network, although it was highlighted by an academic researcher who is part of the REN Biodiversity Chair that it can still be difficult to get data and information from the TSO partner, despite strong collaboration. Although there was recognition that peer-reviewed studies and reviews were generally available, **some TSOs would value having a simple database of studies and abstracts that they could search to increase awareness of the latest evidence and information**, as has been done on a variety of conservation interventions for all taxa via Conservation Evidence (Sutherland et al., 2018).

Barriers and opportunities

Some of the main barriers to data sharing were around the lack of standard protocols, which introduce significant technical complexities in sharing, as well as a lack of time and funding to support the endeavour. The potential need for the standardisation of methods was mentioned in all three groups of the workshop, in notes from the questionnaire respondents and during telephone calls with some TSOs, as a mechanism to reducing this barrier. As such, standardisation of methods, or at least appreciation that methods across studies are not standardised, should be recognised before attempted collation of data and information. This suggests that **a key next step could be to develop guidance around the field methods and data to be collected for EIAs and studies of impact and mitigation effectiveness** (for example see Scottish Windfarm Bird Steering

Group and associated guidance for wind farm development (www.swbsg.org)), **and to collect information on the metadata and structure of existing databases and studies.**

Confidentiality concerns were also highlighted again as a barrier, relating to data on sensitive birds as well as locations of pylons and lines (despite some further workshop debate that some spatial information on infrastructure would be available via satellite imagery). Concerns of confidentiality also applied to making unpublished reports available, given the potential risk of misrepresentation and adverse publicity**. A potential short-term way forward would be to share meta-information about studies and the data that could be available across TSOs within a trusted network, which could then be followed-up by data requests, if desired.** Similarly, **a bibliography of unpublished reports could be an alternative or complementary solution**, in which meta-data or abstracts could be promoted and made available in the same way, with the potential for those reports to then be requested within the network. As trust develops, more data and reports may become readily available to download through this route. However, concerns of a lack of communication within TSOs and a limited institutional capacity may make this difficult. Indeed, difficulties with internal communication and departmental priorities within TSOs were highlighted as potential barriers to effective data sharing. For example, individuals working on environmental issues for TSOs may be passionate and willing to develop and try different methodologies and ways of data sharing, but they are unlikely to have the final say on such matters. Sharing of internal reports for meta-analyses may also be a potential way forward, though it was noted that these would be written in a variety of languages, depending upon the location of the TSOs (an issue highlighted in the workshop). One solution to this is to share the important numerical outcomes (e.g. means, standard errors, sample sizes etc.) and methods used, perhaps in a standardised format, which can then be combined for meta-analyses after recognition of a potential lack of standardised methods. **In short, to increase awareness of the studies being conducted, and the results, greater sharing of published and unpublished reports, potentially alongside standardised metadata of those studies in a searchable database, would help develop trust across different stakeholders whilst raising awareness of the building data and information available.**

In the longer-term, guidance and standardisation of approaches to studies and data formats would be helpful, ensuring that studies are of good quality and able to contribute to a wider database which may be developed. This is potentially something that form part of a code of practice which TSOs would sign up to, or more strictly, could be mandated by regulators to ensure compliance. The resulting data would then be available through an online platform, either openly, or perhaps on request, particularly in the short-term as a trust-building measure. Some TSOs already contribute to online databases run on a national level in collaboration with NGOs (e.g. Elia, Terna, RTE). Given that the TSOs already allocate time and resources to these databases, it would be useful to have a centralised European (or wider) database that utilises the already existing database structures. Such a method might engage and increase awareness from the public (e.g.

through the use of public reporting), as well as promoting partnerships between TSOs and NGOs and thus potentially higher social acceptance of TSOs. To conclude. once greater guidance around the studies required was produced, and information about existing studies and reports made available, then **the potential for developing a more integrated database, either summarising the results of studies in a standardised way, or closer to capturing raw data, could be developed. This would be most likely to be effective if based on the structure of existing databases used by the industry, which would require a scoping exercise to ascertain.**

Summary / key points

The following are the most important key points distilled across the questionnaire responses and subsequent discussion at the workshop.

- There is wide-recognition of the value of different types of data and information, and a positive attitude to working together across TSOs and NGOs. This was clear from both the questionnaires and workshop.
- There is a shared goal among stakeholders to reduce bird mortalities, whether it be for conservation or economic reasons.
- Key data requirements include: (1) access to bird occurrence / abundance data for SEA and EIA, (2) sensitivity mapping to prioritise risk (e.g. Belgium, Portugal, Slovakia), (3) information on mortalities, either as raw data for NGOs to be sure of impact (e.g. through doing own analyses) or as peer-reviewed studies / reviews for TSOs to identify most vulnerable species, and (4) information on mitigation effectiveness as reviews for TSOs to know what best to do.
- There are significant institutional barriers to TSOs effectively sharing data, as well as limited time available to invest, that would need to be addressed.
- A stepped approach might be adopted to foster increased data sharing and collaboration through time. This would require : (1) the development of guidance around the field methods and data to be collected for EIAs and studies of impact and mitigation effectiveness, (2) the sharing of meta-data / bibliography of studies of powerline impacts / mitigation effectiveness to increasing the visibility of relevant studies being conducted, (3) a scoping study of the structure of data and information already being collected and shared, as a first step to developing a cost- and time-effective way of sharing data / information on a wide scale.

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Appendix 1

Responses from the TSOs and DSOs that were not included in the main analyses (Elmu, Eon, VSDAS, YEDC, Eskom)

Question	Options	TSOs to answer option
Is your company legally required to collect data on birds for pre-construction consent?	No legal requirement	5
	Yes, by regional authorities	0
	Yes, by national authorities	1
	Yes, other legal requirements	0
Is your company legally required to collect data on birds for post-construction monitoring?	No legal requirement	5
	Yes, by regional authorities	0
	Yes, by national authorities	1
	Yes, other legal requirements	0
Does your company have any partnerships with Non-Governmental Organisations (NGO) that focus on bird ecology/conservation, and if so what type of partnership do you have?	No partnerships with NGOs	0
	Yes, on the ground level	1
	Yes, on a national level	4
	Yes, NGOs are involved as key stakeholders	2
	Yes, in another way	2
Does your company (or subcontractor) collect data on bird mortalities (i.e. carcasses) or injuries that occur at your infrastructure?	No	1
	Yes, data are collected only opportunistically	3
	Yes, data are only collected routinely using specific methods	0
	Yes, data are collected both opportunistically & routinely	2
Who searches for bird carcasses or injured birds during opportunistic searches (i.e. when a bird has disrupted transmission)?	Not applicable	2
	External subcontractors	1
	Paid staff in your company	3
	Other	0
Who searches for bird carcasses or injured birds during systematic surveys (i.e. routinely collected data using specific methods)?	Not applicable	2
	External subcontractors	1
	Paid staff in your company	1
	Other	1

How often is data on carcasses or injured birds collected using opportunistic searches?	Not applicable	1
	Annually	0
	More than once per year, but less than monthly	0
	Monthly	1
	Other	2
How often is data on carcasses or injured birds collected using systematic surveys?	Not applicable	2
	Annually	1
	More than once per year, but less than monthly	0
	Monthly	0
	Other	1
Do you collect data on search effort (e.g. how many pylons or km of power line were searched per survey) for opportunistic searches?	Not applicable	2
	No	0
	Yes	2
Do you collect data on search effort (e.g. how many pylons or km of power line were searched per survey) systematic surveys?	Not applicable	2
	No	0
	Yes	3
Roughly over what proportion of your infrastructure is surveyed for carcasses or injured birds annually using opportunistic searches?	Not applicable	1
	All/most of it	1
	Less than half	0
	Less than a quarter	1
	Too little to quantify	2
	Other	0
Roughly over what proportion of your infrastructure is surveyed for carcasses or injured birds annually using systematic surveys?	Not applicable	2
	All/most of it	2
	Less than half	1
	Less than a quarter	0
	Too little to quantify	0
	Other	0
Do you collect secondary data on carcasses or injured birds from an ‘external’ source (i.e. separate to your company or subcontracted consultancy), and if so, where from?	No, do not need to	0
	No, but would like to	1
	Yes, from researchers	1
	Yes, from NGOs	4
	Yes, from other	1

Does/has your company (or a subcontractor) collect data on (live) bird presence/abundance around powerlines?	No	4
	Yes, for pre-construction consent	1
	Yes, for post-construction monitoring	1
	Yes, for other studies or research	1
	Unknown	0
Who conducts/conducted the bird presence/abundance surveys pre-construction consent?	Not applicable	0
	External subcontractors	1
	Paid staff in your company	0
	Other	0
Who conducts/conducted the bird presence/abundance surveys post-construction monitoring?	Not applicable	0
	External subcontractors	1
	Paid staff in your company	1
	Other	0
How often is/was data on bird presence/abundance collected for pre-construction consent?	Not applicable	0
	Non-systematically	0
	Annually	0
	More than once a year	0
	Monthly	0
	Other	0
How often is/was data on bird presence/abundance collected for post-construction monitoring?	Not applicable	0
	Non-systematically	0
	Annually	0
	More than once a year, but less than monthly	0
	Monthly	1
	Other	0
Do you have a specific method(s) for observing birds around powerlines?	No	1
	Yes	0
Do you collect secondary data on bird presence/abundance from an 'external' source (i.e. separate to your company or subcontracted consultancy), and if so, where from?	No, do not need to	0
	No, but would like to	0
	Yes, from academic researchers	0
	Yes, from NGOs	1
	Yes, from other	0

Has your company modified, replaced or re-designed infrastructure based on your data about bird interactions?	No	1
	Yes	5
Does your company have an inventory of the modifications used to reduce bird collisions/electrocution (e.g. insulators, markers, bird deflectors etc.)?	No	1
	Yes	5
Do you know how many pylons or km of powerlines in your network have modifications to reduce bird collisions/electrocution?	No	3
	Yes	3
How do you store the bird data for the operational procedures?	Do not store data for this reason	2
	Paper copies	0
	Electronic spreadsheets - local drive	2
	Electronic spreadsheets - cloud server	2
	Electronic map storage	0
	Unknown	0
	Other	0
How do you store the bird data for the legal requirements?	Do not store data for this reason	2
	Paper copies	1
	Electronic spreadsheets stored on local drive	1
	Electronic spreadsheets stored on cloud server	1
	Electronic map storage	0
	Unknown	0
	Other	0
How do you store the bird data for post-construction monitoring?	Do not store data for this reason	4
	Paper copies	0
	Electronic spreadsheets stored on local drive	1
	Electronic spreadsheets stored on cloud server	1
	Electronic map storage	0
	Unknown	0
	Other	0
How do you store the bird data for other purposes not listed?	Do not store data for this reason	1
	Paper copies	0
	Electronic spreadsheets stored on local drive	0

	Electronic spreadsheets stored on cloud server	0
	Electronic map storage	0
	Unknown	0
	Other	0
When carcasses or injured birds are searched for by subcontractors who owns the data?	Not applicable	0
	Your company	0
	The government	0
	Subcontractors	0
	Unknown	0
	Other	0
When carcasses or injured birds are searched for by staff in your company, who owns the data?	Not applicable	0
	Your company	4
	The government	0
	Subcontractors	0
	Unknown	0
	Other	0
When carcasses or injured birds are searched for by other not listed here, who owns the data?	Not applicable	0
	Your company	1
	The government	0
	Subcontractors	0
	Unknown	0
	Other	2
When bird presence/abundance surveys are conducted by subcontractors, who owns the data?	Not applicable	2
	Your company	0
	The government	0
	Subcontractors	0
	Unknown	0
	Other	0
When bird presence/abundance surveys are conducted by staff in your company, who owns the data?	Not applicable	2
	Your company	2
	The government	0
	Subcontractors	0
	Unknown	0
	Other	0

When bird presence/abundance surveys are conducted by other not listed here, who owns the data?	Not applicable	0
	Your company	1
	The government	0
	Subcontractors	0
	Unknown	0
	Other	2
Do you share your bird mortality data with NGOs?	No	1
	Yes, as a legal requirement	1
	Yes, but not as a legal requirement	4
Do you share your bird mortality data with other companies power companies?	No	3
	Yes, as a legal requirement	0
	Yes, but not as a legal requirement	1
Do you share your bird mortality data with a government-run centralised database?	No	1
	Yes, as a legal requirement	2
	Yes, but not as a legal requirement	1
Do you share your bird mortality data with other not listed here?	No	3
	Yes, as a legal requirement	0
	Yes, but not as a legal requirement	0
Do you share your bird presence data with NGOs?	No	3
	Yes, as a legal requirement	1
	Yes, but not as a legal requirement	1
Do you share your bird presence data with other companies power companies?	No	3
	Yes, as a legal requirement	0
	Yes, but not as a legal requirement	1
Do you share your bird presence data with a government-run centralised database?	No	3
	Yes, as a legal requirement	0
	Yes, but not as a legal requirement	0
Do you share your bird presence data with other not listed here?	No	3
	Yes, as a legal requirement	0
	Yes, but not as a legal requirement	0
Do you share your bird marker data with NGOs?	No	1
	Yes, as a legal requirement	1

	Yes, but not as a legal requirement	3
Do you share your bird marker data with other companies power companies?	No	2
	Yes, as a legal requirement	0
	Yes, but not as a legal requirement	2
Do you share your bird marker data with a government-run centralised database?	No	1
	Yes, as a legal requirement	0
	Yes, but not as a legal requirement	2
Do you share your bird marker data with other not listed here?	No	3
	Yes, as a legal requirement	0
	Yes, but not as a legal requirement	0
What do you think prevents the effective sharing of bird data?	Nothing, it is already simple	0
	There is no centralised database	3
	Unlcear who to share with	1
	Unclear what data to share	2
	Concerns of commerical interest	2
	The data are confidential	3
	We lack the resources	3
	Other	1
Do you think a centralised database, where many power companies could input their bird data in to one single system, would help to inform your decision making on reducing bird interactions with powerlines?	Yes	4
	No	1
Would you be willing to share your bird data to a centralised database where other power companies also share their data?	Yes	2
	Potentially, given that the use of data benefits our company and data will not be publicly shared	3
	No	0
Who do you think a centralised database could be financed by?	Government agency	3
	NGOs	2
	Industry	0
	Other	0