BID-REX
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Better data, better decisions: increasing the impact of biodiversity information

BID-REX - From biodiversity data to decisions: enhancing natural value through improved regional development policies

Better data, better decisions: increasing the impact of biodiversity information

This publication is the final technical report summarising the main results of the Interreg Europe project BID-REX - *From biodiversity data to decisions: enhancing natural value through improved regional development policies* (PGI01505)

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1. Executive summary

Without understanding something it is impossible to effectively manage it. In terms of biodiversity and environmental conservation, data and information on species or habitat extent or range, populations, trends over time, and the pressures and threats to these are essential to such understanding and management. Decision makers are wholly reliant on accessing or being presented with this data and information, and using their knowledge and experience to make reasoned, rational, and objective choices.

Whilst various gaps remain, great quantities of data and information are available, covering many facets of life and our environment. Yet many challenges and barriers exist that prevent the effective flow of this data from those that collect and manage it, to those that need to call upon it to inform decision-making processes. These can be as simple as a lack of communication or understanding of where to find or submit the data, to format issues whereby the necessary infrastructure isn't in place or suitable to support the system, or more complex issues including data gaps, or scepticism in the data itself, leading to its lack of use.

The importance of data is recognised in various global conventions and European processes (e.g. Convention on Biological Diversity's Aichi Biodiversity Targets, and the EU Biodiversity Strategy), acknowledging its role in developing our understanding of, and ability to monitor, manage, and ultimately halt, biodiversity loss.

Despite the multitude of data and information that exist, and the political and legislative measures in place, biodiversity continues to be threatened and is in various stages of decline. Many conservation and sustainability targets and goals are not on track to be achieved. The inefficient flow of data to inform decision-making processes contributes to this situation, by creating uncertainty about situations on the ground and the ability to track progress.

The Interreg Europe project *'From biodiversity data to decisions: enhancing natural value through improved regional development policies' – BID-REX* – aims to bridge the gap between biodiversity data and decision-making, linking the two to create improved regional development policies for the preservation of nature.

By demonstrating how the use of available, evidence-based biodiversity data can guide, benefit, and improve decision-making processes, BID-REX also seeks to promote budget prioritisation for conservation efforts in funding allocations.

This report is the output from the first phase of the project. It aims to provide guidance collated through the experience and lessons learned from project partners and their key stakeholders across Europe. Recommendations from these experiences are set out, demonstrating how best to provide, obtain, and use biodiversity data for use in decision-making contexts, and ultimately increase their impact, and that of the funds allocated to them for European natural heritage preservation.

Through five interregional thematic workshops, a range of site visits, and many stakeholder engagements, a wealth of experience has been shared and collated, and can be summarised in the following key messages:

Key messages

1. Knowledge of the main data stakeholders and their respective roles and competencies is important in the management, supply, and use of data.
2. Understanding end users' (e.g. decision makers) needs is the crucial first step in the delivery of useful and impactful data and information.
3. Feedback and communication from decision makers to data suppliers, of the decisions taken and impacts achieved, provides context, motivation, and guidance on what data is needed and in what format to be of most use and make it fit-for-purpose.
4. Developing an environment of mutual trust between data providers and users promotes supply and uptake.
5. To effectively match data to needs, it is essential to establish what information is relevant for each need, what data collection and analysis are required to meet these needs, and identify any obstacles preventing its flow through the data value chain – i.e. understand the question being asked, the data needed to answer it, and the audience whom it is for.
6. Access to high-quality data and information, and effective decision-making, are not explicitly linked.
7. To support decision-making processes, information should be directly and easily accessible and useable.
8. New data sources are continually developed and made available. Keeping up-to-date and aware of these new sources, understanding their integrity and potential, and ultimately using them to inform decisions, is a significant challenge to their uptake.
9. Data can have many lives – it can be repurposed, adapted, and applied for multiple functions – 'collect once, use many times'.
10. Policies, methods, and tools are constantly changing, it is therefore important for all groups in the data value chain to continue developing – by learning from what has worked well, and what has not, adapting to successes and mistakes to meet decision makers' needs.

2. Introduction and outline

2.1. Context: data and decision-making

In the business world there is a saying, 'you can't manage what you can't measure', effectively underlining that measurement and metrics are key to success in business operations, and that data and information are central cogs for the whole system.

This adage is equally applicable to the conservation world (and many other sectors for that matter); simply put, without understanding something we cannot begin to know how best to manage it.

In the context of conservation, this means having information about species or habitat extent or range, populations, trends over time, and the pressures and threats to these. But being presented with data and information alone does not provide the complete picture. As set out by Cleveland[1], Zeleny[2], and Ackoff[3] amongst others, the Data Information Knowledge Wisdom (DIKW) hierarchy (Figure 1) shows the relationship between data (raw figures or facts without relation to other things), information (data, given meaning by way of relational connections to other things), knowledge (the collection of information), and wisdom (systemic understanding of fundamental principles embodied within knowledge).[4] Effectively, therefore, without data to bring together to form information, there is no knowledge upon which to make wise and informed decisions.

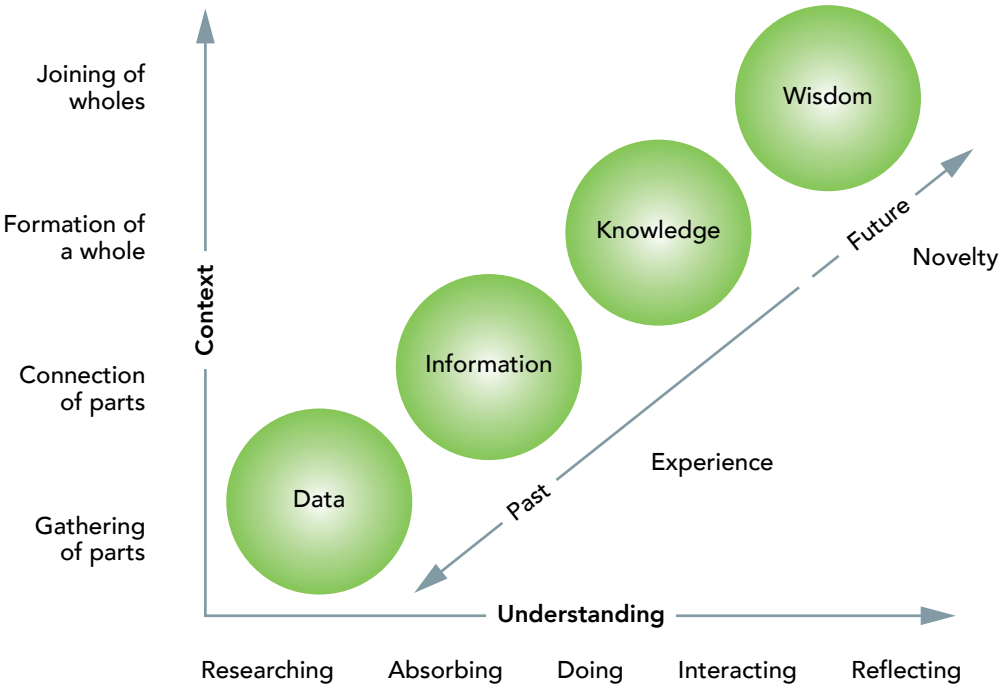

Figure 1: The Data Information Knowledge Wisdom hierarchy (SMU, 2012).[5]

[1] Cleveland, H. 1982. Information as Resource. The Futurist, December 1982, 34-39.
[2] Zeleny, M. 1987. Management Support Systems: Towards Integrated Knowledge Management. Human Systems Management, 7 (1), 59-70.
[3] Ackoff, R. L. 1989. From Data to Wisdom. Journal of Applied Systems Analysis, 16, 3-9.
[4] Bellinger, G., Castro, D. and Mills, A. 2004. Data, information, knowledge, and wisdom. Systems thinking. Available online at: http://www.systems-thinking.org/dikw/dikw.htm (accessed 22/01/19).
[5] https://wiki.smu.edu.sg/is480/IS480_Team_wiki:_2012T1_The_A-Team

Those tasked with decision-making, both in the public and private sectors, are therefore wholly reliant on the data and information available and presented to them. Very often, these decision makers are not technical experts in the subject matter in question, but they have the knowledge and wisdom to be able to look at the data and information, and make reasoned, rational, and objective choices. Their decisions and choices can only be as good as the data that supports them. So if there are gaps in the data for any reason, this can lead to extrapolation, estimation, and the use of proxies, introducing inaccuracy and uncertainty.

Decision-making processes often carry great responsibility and consequence, and the implications of making decisions based on imperfect data or without the whole picture can be catastrophic – for instance, in the business world, the well-known example of the Lehman Brothers investment bank.[6]

2.2. Biodiversity data

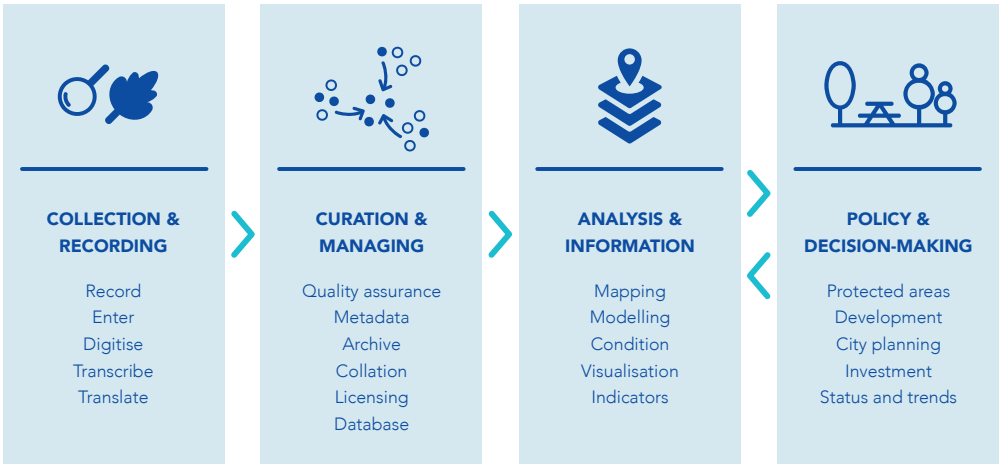

Figure 2: Biodiversity data flow and processes in the data value chain

2.2.1. Collection and recording – what is biodiversity data?

Biodiversity data is comprised of collections of hundreds, thousands, or even millions of single recordings of species, habitat, or other related information that, if collated, make up a database. There are many pathways through which data can flow from the point of collection to helping inform decision-making.

For instance, a citizen scientist, farmer, or field ecologist might spot a Marsh Fritillary (*Euphydryas aurinia*) in a field, and record its scientific or common name, along with the location, date and time of recording. That recording can then be submitted to a local database, used in a research project, or logged in a national, regional, or global repository, such as the online UK Butterfly Monitoring Scheme. Data from schemes such as this can then be passed to data management organisations, such as the National Biodiversity Network, the largest nature partnership in the UK, collaborating to exchange biodiversity data and information to support decision-making. An example of this flow of biodiversity data is presented in Figure 2.

[6] The collapse of the Lehman Brothers Holdings Inc. investment bank due to widespread poor decision-making at the board level, is widely regarded as a significant contributing catalyst to the 2008 global financial crisis.

By itself, a single recording of a butterfly is not very useful, but datasets of thousands of these recordings, spanning an entire region over a number of years, can provide large-scale and detailed information about distribution, condition, status, and trends in the conservation and spatial distribution of species and habitats. This can then be used by decision makers to inform policy or management decisions relating to species' conservation for example. Increasing access – preferably online – to biodiversity data in usable formats for producing policy-relevant information, is therefore crucial to supporting effective decision-making at multiple scales.

2.2.2. Curation and managing – who looks after data?

Biodiversity data is curated by a range of data providers, from citizen scientists to nationally- or privately-funded bodies, such as environment and nature agencies, universities, and a range of wildlife organisations. Effective data curators establish large networks of collaborators, experts and monitoring sites, and, critically, assure the quality of the data; for example, as carried out by ALERC in the UK (see Good Practice 6, and Annex 1). They can also provide the stamp of approval, stating that all submitted data is standardised and comprehensive, with documented methods of data collection, analysis, and provision, as recommended by the INSPIRE Directive.[7]

Biodiversity data is increasingly published online, and is available for download and use by anyone as "open data", thanks to initiatives like the Global Biodiversity Information Facility (GBIF), for example. This is partly because of the rise in scientific journals requiring open data as a condition of publication, but perhaps more so due to national regulations and international specifications, such as the INSPIRE Implementing Rules[8] and Technical Guidelines.[9] Measures such as these increasingly advise data creators, curators and owners to use standardised and machine-readable licenses for example, such as "Creative Commons" which offers several levels of accessibility (from completely unrestricted, to a non-commercial use restriction). They also seek to ensure that data are interoperable, and therefore enable and allow the combination of data from different sources.

The EC, supports an open data policy, recognising that much data in the region is publicly funded through one form or another, and should therefore be made available for use.[10] For example, all projects funded through the Horizon 2020 programme were required to guarantee that resulting publications were issued as open access, without associated access costs.[11]

Archives of open data can allow users to access current and historical data, particularly important in the conservation world where data can be costly to collect. Greater access to biodiversity data can support more robust analyses and the provision of information of greater relevance to decision makers.

[7] https://inspire.ec.europa.eu/
[8] https://inspire.ec.europa.eu/Legislation/Data-Specifications/2892
[9] https://inspire.ec.europa.eu/Technical-Guidelines/Data-Specifications/2892
[10] https://ec.europa.eu/digital-single-market/en/open-data
[11] https://ec.europa.eu/research/openscience/index.cfm?pg=openaccess

2.2.3. Analysis and information – from data to knowledge

Biodiversity data need to be accessible and fit-for-purpose, and at the moment they are often highly complex and difficult for non-experts to understand. Translation (or packaging) of data into useful information is key, and by deriving information products from modelling and analysis it is possible to highlight trends over space and time, such as a change in species' migration patterns, a decline in habitat extent such as saltmarsh, or population increases – numbers of farmland birds for instance. These trends can be visualised in maps, graphs, diagrams, reports and other products to meet decision makers' needs.

2.2.4. Policy- and decision-making

This data can then be a core foundation of good policy- and decision-making. Information products such as habitat maps, for example, can inform decision makers about the location of critical habitat that needs protecting, provide the expertise required to minimise impacts of development on biodiversity (e.g. fish ladders to allow the bypassing of dams, or amphibian tunnels under roads), or inform city planning around the location of habitats associated with the supply of essential ecosystem services.

The management of biodiversity data, in particular those data used for analysis and producing information products, has an important role to play in the decision-making process. Effective biodiversity information products are those which have a clear policy mandate, and are often developed in collaboration, and iterative consultation, with key policy- and decision-making stakeholders, for use in indicators, or other national government processes. It is also important that the development of these products is ongoing, with input from both the science and policy sides so they remain up-to-date. Investigating numbers around the use of each product can be a useful measurement to ensure that the product is still relevant.

The potential of data to inform decision-making is now greater than ever, with the internet sparking a revolution in biodiversity data collation, management, and accessibility. Data can now be uploaded and shared from all over the world, and collated by giant data management organisations – Figure 3, for example, shows the distribution of the Marsh Fritillary butterfly in Europe.

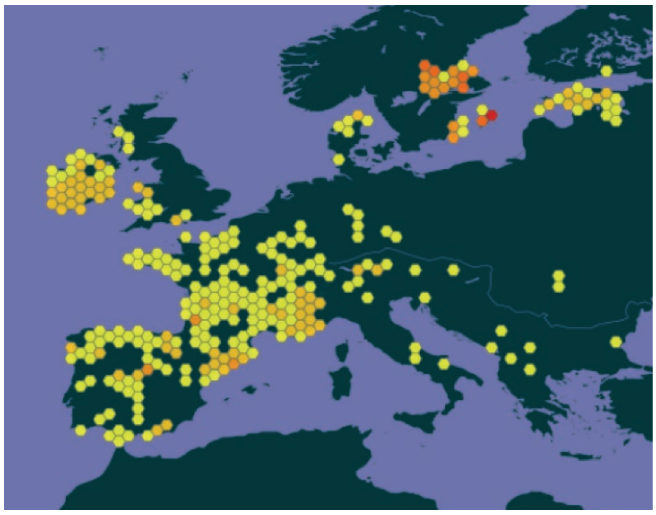

Figure 3: Recorded observations of the Marsh Fritillary butterfly (Euphydryas aurinia), which have been submitted to the Global Biodiversity Information Facility (2016-2018).[12]

Such advances in biodiversity data provision and use are exactly what BID-REX sets out to build upon, by demonstrating where and how data is being applied in decision-making processes to achieve the best outcomes for natural capital protection and enhancement.

2.3. The data 'value chain'

Throughout this report, the data 'value chain' is referred to. This term is used to reflect the passing of data between each of the constituent groups of stakeholders in the chain that fund, produce, supply, rely upon, interpret, analyse, and use data and information. The analogy is akin to supply chains in business, whereby raw materials might be sourced from various producers and suppliers, and there may be multiple levels of processing and distribution along the way, until ultimately you end up with the final ready-for-market product. An example of this might look like: citizen scientist records occurrence of a Marsh Fritillary butterfly in the Netherlands (data recorder); they submit this information via an online species recording form to Dutch Butterfly Conservation (data collator); this is then submitted to GBIF (data processor/data provider); an official at the Dutch Ministry of Agriculture, Nature and Food Quality accesses this data to compile a report on land use and management options on agricultural land for species conservation (data user).

Data value chains can be complex and are not always simple and linear in nature, as data can flow from a complex web of suppliers and sources. They will also be situation and context specific, with data being generated, requested, and used to address individual research or policy questions.

[12] https://www.gbif.org/species/4535809

2.4. Data challenges

There are, however, also numerous barriers and challenges that stifle the efficient flow of data and information to decision makers. These can be grouped into a number of broad categories: data accessibility, referring to the ability of users to find and use data; infrastructure, around the need to sufficiently support the organisations producing, supplying and managing data; quality, which is essential to establishing credibility and reliability; and capacity issues relating to the ability of stakeholders at all stages of the data value chain to be able to call upon and use data.[13]

Specific data challenges and barriers include: clear gaps where biodiversity data do not exist for certain species, habitats, regions, or timeframes; too much data and insufficient capacity to process or analyse it; incompatible data types or formats; data licensing restrictions by third parties or data locked behind paywalls; or, data without clear quality assurance attributes.

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2.5. Conventions, policies and data

The importance of data in supporting biodiversity-related decision-making is featured in many international policies, legislative instruments, and goals. One of the Convention on Biological Diversity's Aichi Biodiversity Targets, for example, states that "*All countries need information to identify threats to biodiversity and determine priorities for conservation and sustainable use. While nearly all Parties report that they are taking actions related to monitoring and research, most also indicate that the absence or difficulty in accessing relevant information is an obstacle to the implementation of the goals of the Convention*"[14]; and asks that: "*By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.*"

[13] https://wcmc.io/_DataInfoFlow
[14] https://www.cbd.int/doc/strategic-plan/targets/T19-quick-guide-en.pdf

The target also recognises that data and information generation continues to develop at pace, and that major gaps still exist, including incomplete, inconsistent, and outdated datasets.

The EU Biodiversity Strategy[15] also recognises the critical role of data in halting biodiversity loss. Reflecting commitments entered into at the 2010 Biodiversity Summit,[16] it sets out to "*halt the loss of biodiversity and improve the state of Europe's species, habitats, ecosystems and the services they provide over the next decade, while stepping up the EU's contribution to averting global biodiversity loss*".[17] The mid-term review of this strategy revealed that some progress was made, but generally species and habitats continue to be in poor levels of conservation and protection.[18] The EC, recognising that one of the significant challenges faced in understanding attainment of the targets of the Strategy is how to capture and track data to demonstrate progress, have included specific focus on building the 'Biodiversity Knowledge Base' in order to underpin policy with accurate and up-to-date data and information.

Similarly, the Sustainable Development Goals (SDGs), as adopted by all United Nations Member States in 2015, recognise that a central factor in tracking progress against the goals and targets is through monitoring data.

At the recent fourth United Nations Environment Assembly (UNEA-4) a Ministerial Declaration also recognised the importance of environmental data, with Ministers deciding to "*ambitiously scale-up efforts to overcome common environmental challenges through.. promoting the use and sharing of environmental data and… working towards comparable international environmental data*".[19]

When considering the role that data plays in the context of conventions, policies, and targets, it is important to distinguish exactly how it is used to provide support. Almost always, data is the basis for monitoring, tracking, and understanding progress. Invariably it is not the data, or more specifically, the lack thereof, that leads to species' decline or environmental degradation, or conversely the achievement of conservation targets. Where targets and goals are not on track to be met, action on the ground is where and how actual progress is realised, not through data gathering or provision. Conversely though, data plays a central role in informing the whole system and guiding decision makers to commit action where needed to help in this realisation of goals and targets.

[15] http://ec.europa.eu/environment/nature/biodiversity/strategy/index_en.htm
[16] https://www.cbd.int/cop10/
[17] http://ec.europa.eu/environment/nature/info/pubs/docs/brochures/2020%20Biod%20brochure%20final%20lowres.pdf
[18] http://ec.europa.eu/environment/nature/biodiversity/comm2006/pdf/mid_term_review_summary.pdf
[19] http://wedocs.unep.org/bitstream/handle/20.500.11822/27701/Draft%20Ministerial%20Declaration%20Fifth%20Draft%20as%20of%2014.03.2019.pdf?sequence=1&isAllowed=y

2.6. The project

Data and information are hugely significant components in decision-making processes, and the importance they play in underpinning regional and global conventions, strategies, targets, and actions is well understood. However, there are challenges and barriers preventing the flow of data and information to support decision makers. As a result, many of these targets and goals are not on track to be achieved[20, 21] and globally biodiversity continues to decline at alarming and unsustainable rates.[22]

The Interreg Europe project 'From biodiversity data to decisions: enhancing natural value through improved regional development policies', or 'BID-REX', sets out to address the disconnects between data and information, and effective decision-making in Europe through improving and strengthening regional development policies.

By demonstrating how the use of available, appropriate, and evidence-based biodiversity and environmental information can guide, benefit, and improve decision-making processes, BID-REX seeks to promote budget prioritisation for biodiversity conservation efforts in funding allocations (e.g. European Regional Development Fund (ERDF)).

2.7. The approach

BID-REX is a partnership that brings together nine partner organisations from seven European regions across six countries: Catalonia (Spain), Basque Country (Spain), Norfolk (UK), Marche Region (Italy), Ljubljana Marsh (Slovenia), North Great Plain Region (Hungary), and Wallonia (Belgium). Five of the project partners are public authorities (Government of Catalonia, Basque Government, Norfolk County Council, Marche Region, Public Service of Wallonia, General Directorate of Agriculture, natural resources and Environment (DGO3)), and four are research institutions (Forest Sciences Centre of Catalonia, University of East Anglia, National Institute of Biology, University of Debrecen).

Phase 1 of the project, which ran from 2016 – 2019, brought project partners together for the 'Interregional learning process' component at a series of thematic workshops. This allowed for the exchanging of lessons learned from regional challenges and solutions that centred on biodiversity information and policy delivery.

The workshops were focused on the following themes:

- Information needs for decision makers (Wallonia, Belgium – 2017);
- Matching information to needs (Bilbao, Spain – 2017);
- Improving data flows (Budapest, Hungary – 2018);
- Capacity building for decision makers and data providers (Norfolk, UK – 2018); and
- How the learning process has impacted our action plans (Ljubljana, Slovenia – 2019).

[20] http://biodiversity.europa.eu/mtr/biodiversity-strategy-plan
[21] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/729713/UKBI_2018v2.pdf
[22] https://www.wwf.org.uk/updates/living-planet-report-2018

Project partners also rolled out local learning processes in their regions. This provided targeted opportunities to convene local stakeholders at meetings, workshops, and site visits to share best practices and understanding on the successful use of tools and methods.

Each of the seven project regions defined a policy instrument that it seeks to improve as a result of the BID-REX project; these are:

- ERDF 2014 - 2020, Catalan Operational Programme. PI6 – Protecting environment and promoting resource efficiency;
- ERDF 2014 - 2020 Operative Program for the Basque Country. PO6 – Conserve and protect the environment and promote resources efficiency;
- ERDF 2014 - 2020 for England. PI6d – Protecting and restoring biodiversity and soil and promoting ecosystem services, including Natura 2000 and green infrastructure;
- Marche Region Ecological Network;
- Regulation on Ljubljana Marsh Nature Park;
- Hungarian environment and energy efficiency operational programme 2014 – 2020; and
- The Regional policy statement for Wallonia 2014 – 2019.

The final step in the first phase of the project is the development of regional action plans. These will detail how lessons learned from the interregional learning process can be implemented to improve the corresponding policy instruments, as above. In consultation with project partners and local stakeholders, these action plans will be reviewed to ensure they adequately set out their biodiversity data needs, and associated activities for satisfying them.

The second phase of BID-REX will run from 2019 – 2021. It will focus on implementing the knowledge gained and developed during phase 1 in order to enact positive policy change through steps defined and set out in each regional action plan.

To bring about significant improvement of the targeted policy instruments, the project aims to:

- Identify regional strengths and weaknesses in the use of biodiversity data;
- Identify, exchange, and implement Good Practices of biodiversity data use at different stages in decision-making processes;
- Improve local governance by creating and improving discussion forums, developing synergies, and through coordination among relevant stakeholders;
- Increase the capacity of regional stakeholders to manage biodiversity information and data flows;
- Improve workflows leading to effective decision-making to support better and more efficient regional development policies, particularly regarding the allocation of funding; and
- Enhance the social acceptance and credibility of decision-making processes through the use of objective and reliable information.

During phase 1, a number of Good Practices from across the project regions were identified; these Good Practices seek to inspire positive change in other regions. All Good Practices identified throughout the interregional learning process are presented in Annex 1.

This report is the output from the 'Interregional learning process' component, bringing together the lessons learned as shared in the thematic workshops and through regional stakeholder engagement. It sets out how the use of biodiversity data can better support decision-making processes and increase the impact of allocated funds for European natural heritage preservation.

It is designed with two main goals: to build the capacity of relevant stakeholders in relation to biodiversity information management, and to consequently benefit European citizens through improved funding allocation for natural heritage preservation.

3. Biodiversity data use and uptake across Europe

To gain insight and understanding into data managers' and decision makers' biodiversity information needs across Europe, the project conducted a series of surveys of key stakeholders. Electronic surveys were distributed to representatives of European institutions and organisations involved in the collection, collation, management, use, and interpretation of biodiversity data at a European, national or regional (sub-national) scale.

The surveys centred on the accessibility and availability of robust and structured biodiversity data, and sought to understand how biodiversity information is used in decision-making processes. Through analysing these results, the project set out to build an evidence base to support the development of a better data infrastructure across Europe.

As one of the intended outcomes of BID-REX is to achieve greater impact from ERDF allocation across Europe, survey consideration was also given to the use of biodiversity information in decision-making processes related to the management (including allocation) of ERDF funds.

3.1. Survey key findings

Across the range of surveys, 203 individuals submitted responses (data managers' survey: 122; decision makers survey: 44; general biodiversity data survey: 37); many identifying themselves as members of public body organisations, with good representation from academic and research institutions also. The majority of respondents stated that they work at the national scale, but less than half exclusively.

Most confirmed that they use biodiversity-related data in some capacity and that it is critical for them to carry out their work (Figure 4).

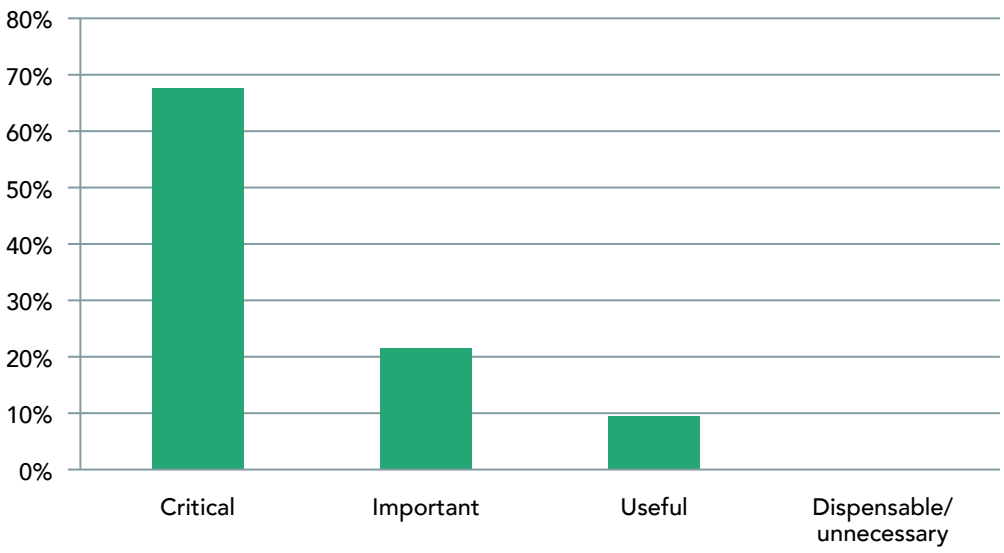

Figure 4: Survey responses to the question 'How necessary is data in order for you to carry out your work?'

Biodiversity data were reported to be most widely used for presentation and communication, interpretation, mapping, and reporting, while data use in the context of decision-making was only selected by half of respondents. Of the data being used to support decision-making in Europe, this mostly takes place at the national scale. Almost universally, it was agreed that the use and uptake of biodiversity data into decision-making processes improves their credibility and acceptance.

National Government data sources were reported to be the most commonly used providers of biodiversity data, with local or regional biological records centres also being of importance.

Mapping, interpretation, reporting, presentation and communication, and modelling were all perceived to be strengths in terms of biodiversity data use across Europe. The completeness of data, time series' availability, and quality/resolution were seen as being of particular benefit in this regard.

Good practice one: SITxell

SITxell[23] is an example of an Open Data Infrastructure which provides biodiversity information to the municipalities of the Barcelona Provincial Council, for incorporation into local planning and policies. With a user-friendly design, the information provided considers the responsibilities of the municipalities and gives information to facilitate its interpretation. Its successful uptake and resulting impacts allow for the identification and procurement of long-term funding.

Conversely, weaknesses relating to biodiversity data use included decision-making, indicator development, and baseline inventories. Poor data availability and accessibility, along with data management/infrastructure problems, were stated as contributing to these weaknesses. By addressing these weaknesses – for example, by having more complete datasets – the data landscape would be improved and would better meet the needs of users'.

An analysis of the viewpoints from the perspective of both decision makers and data managers was also conducted (Figure 5), looking at the strengths and weaknesses regarding regional biodiversity information management processes. High costs, lack of capacity (staff resources, time, and expertise), and access (e.g. bureaucratic processes, disparate sources, and inconsistent formatting and storage) were common weaknesses reported from both stakeholder groups. Perceived strengths included use of consultants and citizen scientists, standardised data formatting, effective relationship management and communications throughout the data value chain.

[23] http://www.sitxell.eu

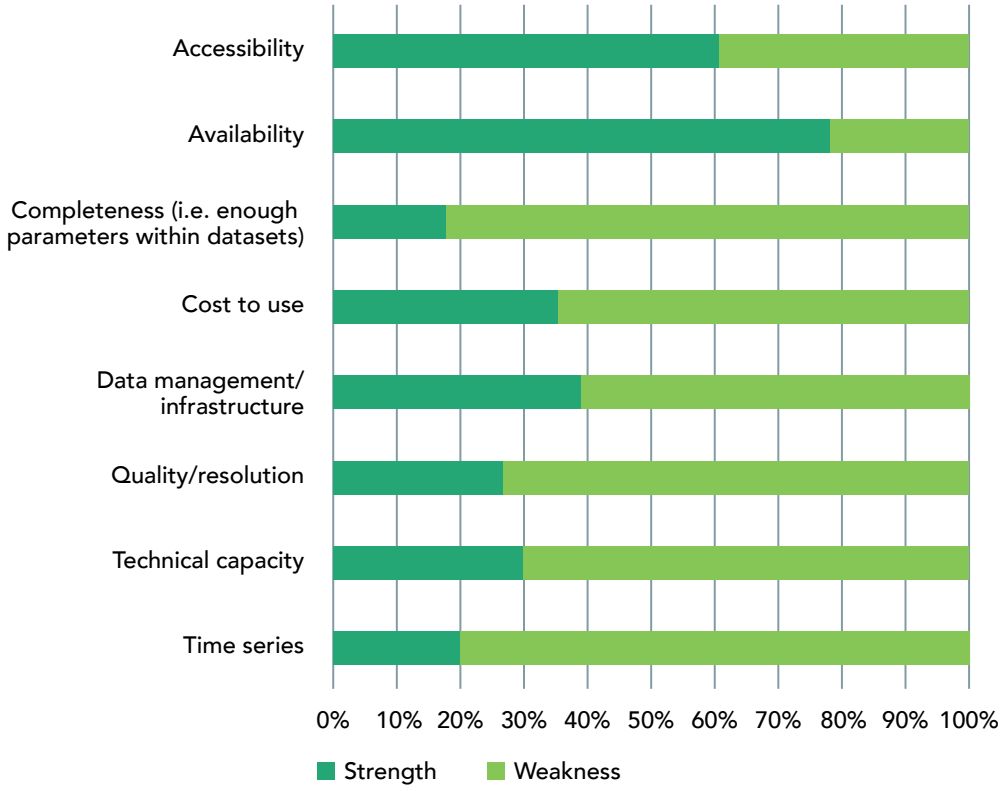

Figure 5: Respondents identification of the strengths and weaknesses in terms of characteristics and properties of data.

Data relating to habitats, taxonomy (i.e. species), protected areas, spatial distribution, and temporal trends make up the majority of data types being used by those surveyed (Figure 6). Biophysical and trade data were not reported to be widely used, most likely due to the stakeholder groups solicited.

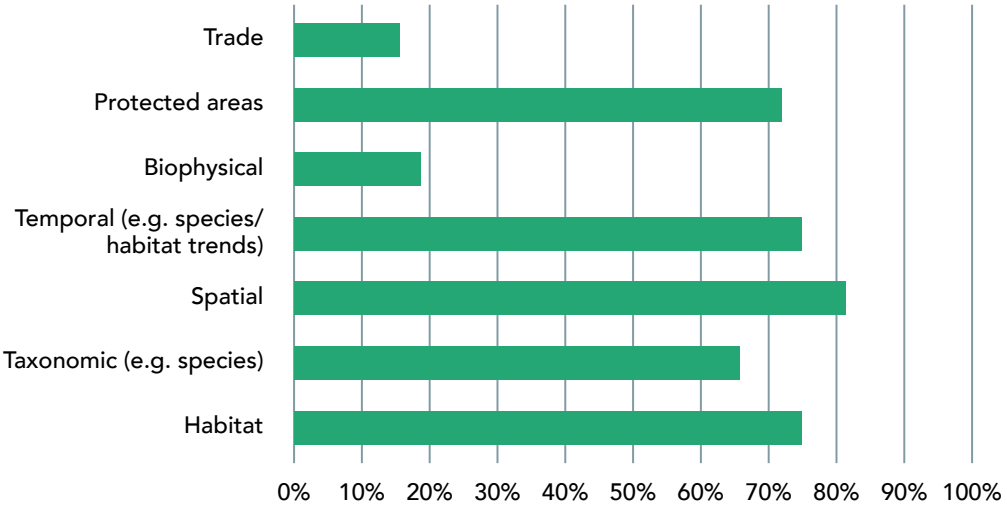

Figure 6: Survey responses to the question 'What type of data do you work with?'

Comments and results from the surveys indicate that relationships between data providers and decision makers are not always straightforward, and there can sometimes be misunderstandings. In order to manage these relationships, clear communication, feedback and transparency can lead to the development of mutual trust and greater uptake of data into decision-making. Further opportunities to ensure effective working relationships, and therefore flow of information through the data value chain, can be achieved by bringing the different actors together, including data providers, collators, and users such as decision makers.

The surveys found that customer satisfaction and dissatisfaction, when it comes to biodiversity data, are heavily influenced by factors including: objectivity, reliability, completeness, accessibility, cost, gaps in time series or delays in updates, and lack of transparency (e.g. of quality assurance processes). Data providers can assess to what extent their products meet with users' needs through satisfaction surveys, allowing direct feedback as to what they're doing well, and any areas for improvement.

Full results of the biodiversity data and decision-making survey can be accessed via https://www.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1553517938.pdf.

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4. Building bridges to extend impact

This section presents the key findings and outcomes resulting from the interregional learning process, including recommendations for both data managers and decision makers, as well as potential solutions and opportunities for the future.

4.1. Recommendations for data managers

4.1.1. Defining the question

When determining the scope and focus of a new project, the first step must be to comprehensively and systematically consider why the information is needed – i.e. what will the data and information be used for? Decision makers, for example, may require data to evaluate policies and progress towards strategic goals and regulations, or for understanding the links between biodiversity, ecosystem health, and their benefits for people. They may even wish to conduct a horizon scan, understanding past and potential future changes in a key thematic or sectoral field.

Each of these would require a very different set of data, presentation tools, and resources, and so establishing an understanding from the very beginning is critical to ensuring that the information is fit-for-purpose.

Understanding and defining the research or policy question therefore, will require the establishment of a clear set of priorities to ensure that it can be answered or supported within the available resources. Here it may be helpful to consider if the decision maker has any legal mandates and responsibilities – these might even be inextricably linked to biodiversity-related information:

- the legal and conservation status of the habitat or species of interest, including its IUCN status and their presence on a regional red list of endangered, threatened, or endemic species;
- location of habitats/species, including consideration of range, population, and area;
- information on data availability, quality, and relevance;
- assessment of the impact of the proposed actions on the conservation status of the habitat/species (and related indicators) and on the consequences of non-action; and
- the technical feasibility of the project, including the definition of its duration, and the timing for results.

Good practice two: IAIA (the Tool of Supporting Information for EIA)

IAIA is an online tool which facilitates scientific information about protected species, habitats and sites to support the Environmental Impact Assessment (EIA) of future projects. The project aims to connect EIA officers with the biodiversity information stored by those responsible for natural heritage conservation in Catalonia. Moreover, IAIA translates scientific information to qualitatively estimate the likely effect on species and habitats occurring within the area impacted by a project. To do so, the tool links the threats and pressures associated to every project type with the susceptibility of the species and habitats spatially overlapped. This information allows users to improve the assessment using scientific information to identify which project elements could impact on biodiversity.

The steps set out in Figure 7 below highlight some of the main aspects that should be considered to ensure information is fit-for-purpose and relevant to users' needs.

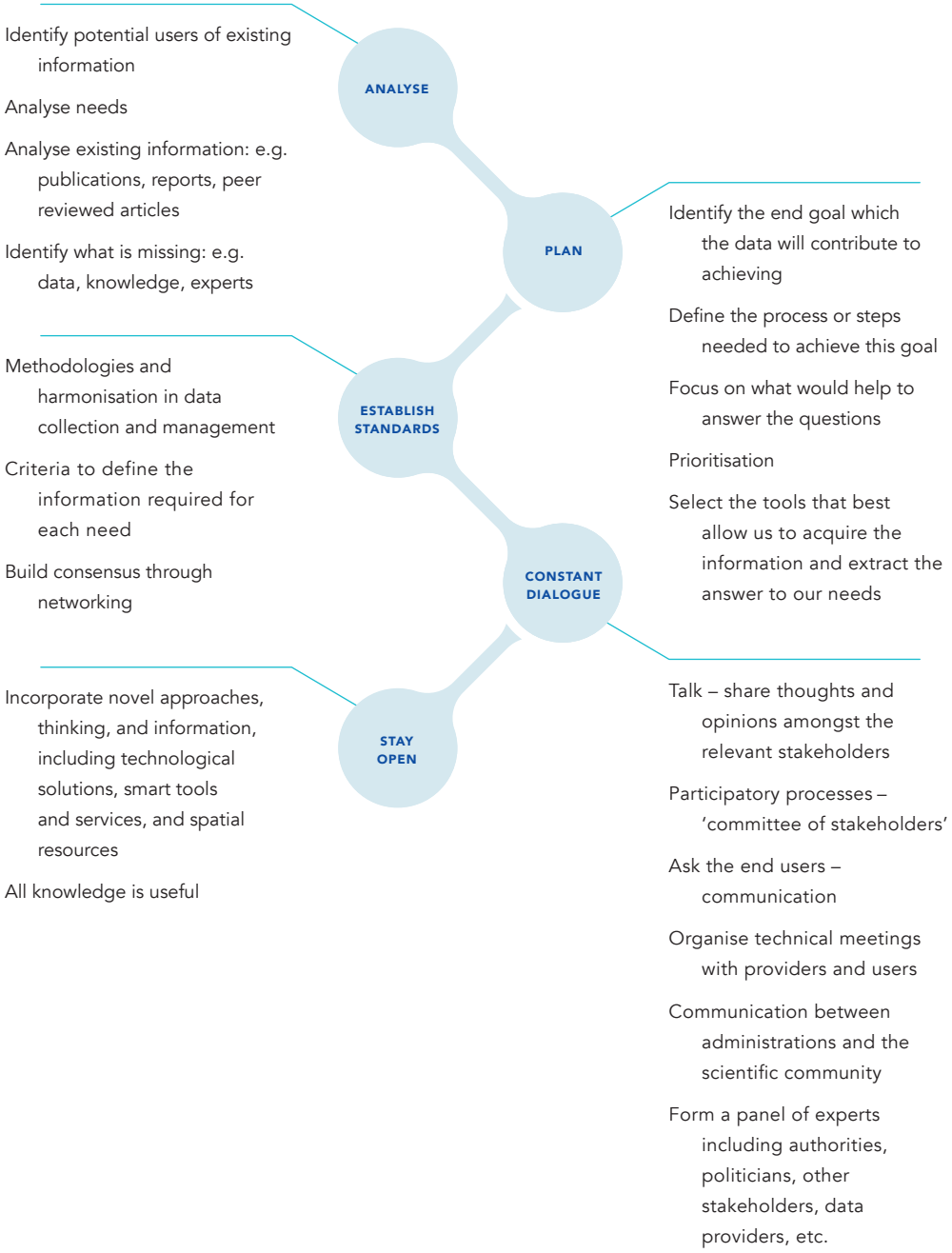


Figure 7: Some of the main aspects to make information fit-for-purpose and relevant to users' needs.

4.1.2. Collecting and presenting the data

Once the question is defined, there is then the task of designing the best data approach to support it – essentially, how to collect and analyse the data, and how to present it to best meet the needs of the users.

Data managers should ensure that their data is standardised from the very beginning, ideally with a time series and covering the entire territory concerned. In addition, they should document the methods of data collection and analysis, and include details of the quality assurance processes employed – as well as ensuring its longevity and accessibility, this will also help it to be scalable and user-friendly.

At this early stage, it can also be useful to begin considering plans and approaches to secure the relevant technical and financial resources if data is needed in the long-term to support ongoing user needs. The ability to maintain and update the dataset to supply users into the future will ensure the data achieves the most impact. This is a factor that should not be underestimated; for example, it has been reported[24] that three of the major global biodiversity-related datasets cost USD 6.5 million annually to manage, and are still under-resourced and heavily reliant on support from volunteers.

4.1.3. Data sources and selection

Data is collected in huge quantities, almost constantly, to underpin almost every action and process in modern life. For example, through societies' greater reliance upon and use of the internet and smart technology, we are constantly generating data on our movements, our likes and dislikes, what we view, what we buy, and what we might like to buy but might never have thought of. This is collected and presented as tabular or hierarchical data, and is found in documents, e-mails, metering data, financial data and so on. These vast data resources are available and accessible to be used in support of decision-making processes at many levels for multiple applications. In the context of biodiversity and natural capital, the array of data is no less abundant – consisting of, for example, qualitative, quantitative, primary/measured, modelled, estimated, proxy, and monetary data derived from, and in relation to, all aspects of our natural environment.

Figures 8 and 9 below set out some of the data sources and tools of use and relevance to biodiversity, and present some of the strengths and weaknesses associated with each.

[24] Juffe-Bignoli, D., Brooks, T.M., Butchart, S.H.M., Jenkins, R.B., Boe, K., Hoffmann, M., et al. 2016. Assessing the Cost of Global Biodiversity and Conservation Knowledge. PLoS ONE 11(8): e0160640. https://doi.org/10.1371/journal.pone.0160640

Figure 8: Potential data sources relevant to biodiversity, and some of their perceived strengths and weaknesses.

Figure 9: Tools and approaches relevant to biodiversity, and some of their perceived strengths and weaknesses.

Good practice three: Citizen Science in the dark – acoustic monitoring for the masses

Norfolk Bat Survey[25] aims to improve understanding of local patterns of occurrence and activity of all bat species, utilising volunteer networks.

Technological advancements and the development of analytical techniques, coupled with reduced costs of hardware, has made large-scale acoustic recording of several taxa of bat increasingly feasible, opening up new approaches to monitoring, research and engagement. The project was initially set up to improve the understanding of local patterns of occurrence and activity of all bat species. The approach involved setting up a network of centres to allow a large number of volunteers to carry out surveys using expensive recording equipment. This resulted in a far larger and more comprehensive dataset than could have been achieved with alternative models.

After the success relating to the study of bats, collaboration with the Paris Natural History Museum and Natural England, enabled algorithms to be developed for the semi-automated sound identification of UK bush-crickets. And with continued collaboration, this work was extended to build a classifier for a suite of nocturnal birds.

The plethora of data and tools that are available can sometimes act as a barrier in assessment and decision-making processes – seeming like an overwhelming task to identify and locate the most relevant data for specific contexts. Significant challenges can also be encountered when trying to obtain this information; it is not always enough simply to know what data and information is needed. As such, being connected to key people, networks, activities, and projects can help to provide direction to the data and information needed, and facilitate its access.

[25] http://www.batsurvey.org/norfolk/

4.1.4. Data supply - key considerations

When it comes to supplying data, there are a number of considerations that can help to increase its usability and uptake by decision makers, many of which revolve around communication. For instance, is the data in a usable and understandable format? If the data has been interpreted or analysed and is being supplied as an information source, is it clear and concise, using common language and avoiding jargon and an overreliance on technical terms? Including an executive summary or summary of key findings or messages could be helpful. Setting out the major areas of interest and relevance into sub-sections in bullet-pointed text can also help understanding and the delivery of clear messages.

The individual decision maker's own background and understanding of biodiversity is also a factor to consider from the data managers' point of view. They may have a general understanding around the value of habitats, species, and ecosystem services, or they may be from an entirely unrelated background. As such, it may be useful to include extra information to supplement key points or areas of interest. For example, if the data or information relates specifically to ecosystem services, restoration projects, compensation or mitigation measures for biodiversity loss, it could be worthwhile to provide additional information or explanatory notes if it is felt they will add value.

When presenting data, it can be useful to include information surrounding the data itself, such as providing indicators or trends, as well as explanations for any absence of data, and details of verification and validation steps that have been implemented. Presenting the whole picture in this way will add clarity and aid understanding, especially where there may appear to be gaps in the data. For example, where data is presented spatially, it could be useful to add a footnote to clarify that empty or blank patches on maps indicate an absence of data, not an absence of the species.

Supplementary information could even go as far as including accompanying risk analyses relating to the data. For example, if the data is focused on a particularly sensitive species or habitat, it might be considered prudent to include a breakdown of the likely factors or actions that may bring about negative (and positive) impacts, and any suggestions around how to manage risks.

The supporting infrastructure is a core element of robust data and information. Part of this infrastructure includes the protocols, standards, and guidance on data collection and use. Providing manuals and guides for understanding and interpretation can be critical to ensuring that the data is used to its full potential.

Good practice four: Natagriwal

Natagriwal[26] is a non-profit organisation whose main mission is to inform, advise, and supervise farmers, foresters, and public or private landowners in the implementation of agri-environment schemes and the Natura 2000 European ecological network in Wallonia, Belgium. They facilitate the sharing of easy-to-understand and use information, in order to reconcile human activities with nature conservation. This information covers: where the Natura 2000 network is, which species and habitats are of interest, where they are, and how to manage them within the territory for conservation in line with agri-environment schemes. Advice and supervision provided via Natagriwal helps thousands of landowners and managers to bring their activity in line with EU Biodiversity Strategy targets.

Data quality is another core element that will determine the level of use and uptake into decision-making processes. Quality includes the credibility of the data itself, and the data provider, the completeness of the dataset, in terms of geographic and temporal scale, the update frequency, and the application of validation and assurance processes. If the correct steps are taken at an early stage to ensure that these quality related criteria are factored in and met, it will lead to greater levels of impact being achieved.

For example, when considering long-term monitoring and inventories of species or habitat, the data will more likely be considered as high quality if: a defined survey protocol is followed (and made available); the age of data is clearly presented; there are regular updates; the geographic scale and accuracy (systematic versus opportunistic) is detailed; and, validation processes are used (and made available). Such processes will in turn affect the perceived credibility of the data provider.

[26] https://www.natagriwal.be/

4.2. Recommendations for decision makers

4.2.1. Expressing your data needs

As set out earlier, the clear expression of data and information needs from decision makers to data providers will facilitate the supply of fit-for-purpose resources and products. Poorly-expressed or imprecise definition of these needs may lead to misunderstandings, delays, unusable products, lack of trust in the data and information, and ultimately the decision to not use it.

Decision makers should consider opening dialogue and building relationships with key data suppliers at the earliest opportunity. By doing so they may be able to actively input into and help shape the way data is collected, processed, and provided. It may be possible to adapt inventory methods and data analysis approaches, as well as tailoring the desired level of precision and the degree of interpretation required, contributing to data and information that is finely attuned to the decision or policy context.

These clear channels of communication between data providers and decision makers build mutual trust and confidence. The development of understanding and good working relationships will instil trust in both directions – data managers will be satisfied their data is being used and reported accurately and in a representative way, whilst decision makers will have faith in the data and be willing to use it to support their actions. Regular evaluation of the data supply and use processes, and the clear communication of any problems encountered, should form a key part of such communications and relationships.

4.2.2. Data-related considerations

Decision makers on the other hand, have a different set of considerations to think about when using data and information to carry out their roles and responsibilities. The primary concern of decision makers will be to answer the questions relating to their area of work. As such, they will need to ensure they have sourced all of the necessary, relevant, and pertinent information available to make a fully reasoned and objective analysis of the situation. But they should also consider factors including data sensitivity (i.e. does the information they have sourced relate to sensitive species or habitats) and using the data in the manner it was intended (i.e. not misinterpreting it or spinning it for any political advantage or ulterior motive). In addition, there may be socio-economic or socio-political factors to consider, such as: the level of public interest in, and acceptance of, the outcomes of decision-making processes – especially in relation to the natural environment which can be quite emotive; the local and regional economic context; employment opportunities; and any pertinent legal factors.

4.3. Feedback

Feedback, from both data managers and decision makers, can form an important part in the effective supply and use of data and information.

From the data manager's perspective, knowing how the data is actually used in decision-making processes is an opportunity to continuously improve data gathering systems, helping to adapt and customise to better meet decision makers' needs. This is critical to the data actually achieving impact, and sharing these experiences could lead to increased financial resources and development for data providers.

Good practice five: Collaboration between Elia and Natagora

Elia,[27] Belgium's electricity transmission system operator, and Natagora,[28] an environmental non-governmental organisation, collaborated to minimise the environmental impact of high voltage overhead lines in Belgium. After a wide dialogue, Natagora provided maps of bird's collision risk to Elia, who thanks to these maps, added devices to enhance the visibility of the overhead lines in priority areas of bird's pass to reduce bird's collision risk. The feedback from Elia to Natagora's birdwatching community, about the impact of its information, encouraged birdwatchers to collect new data.

[27] http://www.elia.be/
[28] https://www.natagora.be/

From the decision maker's point of view, providing feedback, along with suggestions for improvements, is also critical to ensuring that their decisions are based on the best data, as well as creating useful datasets for future use.

Understanding how best to solicit feedback, therefore, is an important component in the data value chain. Systematically planned public events and targeted satisfaction surveys were highlighted by the project partners to be particularly helpful, especially when including expectation assessments.

Additional elements that can help to establish or reinforce mutual trust between the parties, and facilitate effective feedback include:

- Person-to-person relationships, especially when they are maintained and stable over time (e.g. within administrations)
- The sharing of a common technical or cultural vocabulary between suppliers and decision makers
- Development of international networks of experts
- Transparency, validation, and communication on the procedures used to generate the data and its recognition by the decision maker
- The use of official accreditation systems for data management and analysis, and details of their use provided to the decision maker
- The status of the supplier guaranteeing its independence (e.g. the creation of an independent observatory)

4.4. Evaluating the data

Central to robust data and information is quality. For data to be considered as being high quality it must be credible and come from authoritative and reliable sources. To demonstrate these criteria are met, it can be useful to provide (or request) supporting details of how the data has been evaluated. There are a number of criteria that can be considered in such evaluations, as set out below in Figure 10.

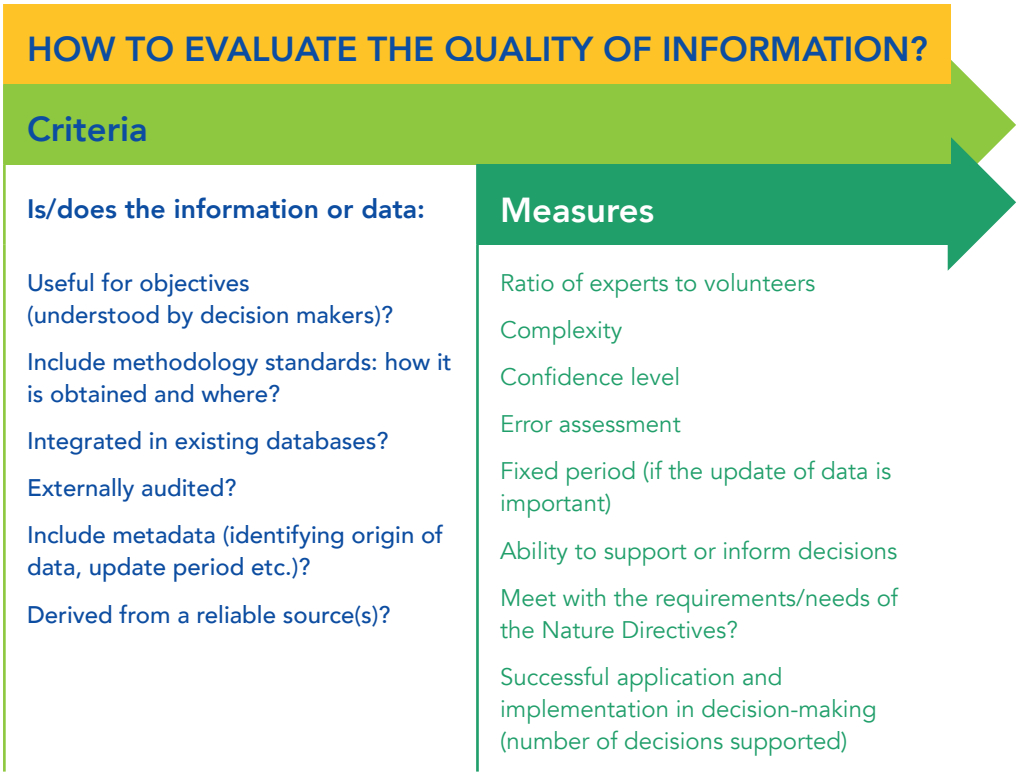


Figure 10: Approaches and criteria for evaluating the quality of data and information.

4.5. Barriers and opportunities

The interregional learning process included the sharing of lessons learned on the barriers and opportunities that exist in the data value chain that either help or hinder the effective flow of data and information from source to end user.

To facilitate the identification of the key traits that make biodiversity data suitable and useable by decision makers, a set of key questions were established to frame the issues, challenges, constraints, and potential solutions. These are set out below.

How can capacity be built to gather data effectively?

- ***Clear data-flow pathways*** – it should be clear where data needs to go. This is often easier for specific projects than general biodiversity data collection. Processes should be well advertised to ensure that data providers know how, and where, to submit data. Equally important is that data providers and users know where it will end up, and how to access it.

- ***Good systems*** – aim to provide easy-to-use ways of gathering data. These should work for both data providers and managers. The data should be easy to submit, with standardised formats and intuitive interfaces. It should also be easy to extract from the system for publication and sharing.
- ***One-stop-shop*** – ideally, data for a region should have a single end-point. This could be where all data is stored in its original state (full capture resolution, all attributes). Or it could be a public facing portal with lower resolution, open data that acts as a way of signposting users to the information available from the data providers. Either way, there should be a clear mechanism for users to acknowledge the data provider and gain access to the underlying datasets and metadata.
- ***Data licencing*** – any potential restrictions on the use of data need to be considered at an early stage. Will the data be open and freely available for any user? Or will it be shared with restrictions on use, such as for non-commercial purposes only? These questions will often be answered by the original collectors of the data or the funders of that collection. Clear metadata and licences for data users are needed.
- ***Identifying the skills required*** – to improve the quantity and quality of the data available, an assessment of the skills gaps is needed. Regions may have existing groups to collect data and as a result have a base to build capacity from. In other areas, it might be a case of starting from nothing. The resources needed will be very different, as will the time taken to reach the desired end point.
- ***Identify the gaps that need filling*** – are there data that are missing? Is there sufficient spatial, temporal, and taxonomic coverage to meet user needs? There can often be spatial biases based on the location of populations or favoured locations for recording, and taxon biases due to the popularity of certain groups (e.g. birds) or the difficulty of identification or need for specialist equipment and techniques (e.g. beetles). Policies around protected species can also create biases in the taxonomic coverage of data. Is there a bias and focus only on the rare species rather than building comprehensive datasets that can detect changes?
- ***Find the lost data*** – data is often collected and used for a limited purpose, such as Environmental Impact Assessments during infrastructure developments. As such, there is a need to develop mechanisms that ensure that this data is collected and made available. Likewise, data collected for academic purposes should be made more easily available. There should be a presumption of publication of all data, particularly that which is being funded by the public. Investigate if it is possible or appropriate to move towards a system of making data publication for certain purposes compulsory.
- ***Move to open data approaches*** – where possible, embrace open data systems. This does not mean that all data can or should be open but there should be an emphasis on making as much of it available, for as wide a range of uses, as possible. Often it may be appropriate to provide coarse resolution open data, based on the full resolution data, with access to the latter bringing a charge that supports its collection and maintenance.

- ***National and local recording schemes and societies*** – the UK for example, has a model of national and local recording groups that can offer an example for other regions. Mid- to long-term, aim to invest in groups starting from a well-supported, centralised baseline, and building to create independent groups that can do things independently.

Good practice six: ALERC Accreditation

The Association of Local Environmental Records Centres[29] (ALERC) collects, collates, and manages environmental information provided from a national network of Local Environmental Records Centres in the UK.

Meeting a set of 20 standard criteria allows LERCs to demonstrate they adhere to best practice across three areas. Within these areas, specific aspects of LERC work are assessed, such as whether the organisation is steered by stakeholders, whether it has a verification system to check data accuracy, and what data services it can offer. The network of LERCs provides UK citizens with a dedicated environmental data service that is located in close proximity and that understands their local environment.

[29] http://www.alerc.org.uk/alerc-accreditation.html

- ***Show the benefits of data sharing*** – in some regions, the common benefit of sharing data is better understood and embraced more widely. In others, there are less altruistic approaches to data sharing. Communicating the benefits of making data more available will help to change this mentality and create change within the recording community. Publicising the benefits to get people to contribute to the collective.
- ***Work with partners*** – a culture of working with partners from other organisations and the wider public can help to build a community and provide a support network. This needs to include empowering the people to see the value of what they can achieve. It also needs to work the other way and demonstrate to specialists, who are often reluctant to trust the quality of the data collected, the value and abilities of the volunteer network.
- ***Using the local to understand the global*** – local recording can inform global decisions. Often, volunteer recorders are involved because they have an interest in their local area rather than a desire to record wildlife for the greater good. They often feel a geographic identity and a sense of pride and interest in "their" nature. Leveraging this sense of ownership can help the understanding of volunteers' motivations and to help bring together these individuals into a network that can provide more and more data.

How is it possible to increase the ability to verify data and ensure accuracy?

The accuracy of data used to inform decisions is key. Properly informed decisions require trust in the data, and as such, it needs to be of a recognisable quality. The way in which this quality can be assured is largely dependent on the type of data, so it is important to understand its origin. If the data has come from citizen science with a wide range of unknown and potentially unskilled recorders, then this poses a different challenge to structured, systematic recording by experts. The size of the dataset being gathered is also relevant to the ability to verify the information. For instance, large and varied datasets may need a range of taxonomic experts to undertake the verification.

With robust systems in place to validate and verify the quality of data, it is more likely that decision makers will trust the data and its providers.

Many methods to effectively verify data prior to its use exist, including:

- ***Use standardised data formats*** – these ensure that all required fields are captured and can be transferred easily between systems.
- ***Use well-designed data capture methods*** – ensure that recorders know what information is needed to make sure records are valid and verifiable. Apps and online recording systems can ensure that all necessary information is provided before data can be submitted. Digital recording can also allow images, sound recordings, and other useful information to be provided.
- ***Use clear verification processes*** – it is important that users are able to see the process that has been followed to ensure the accuracy of the data. This should be a key part of any metadata statement.

- ***Train and support data providers*** – it is particularly relevant to beginners, but important for all recorders, to understand how to capture data effectively and accurately. This should include support with identification.
- ***Build a network of verifiers*** – access to taxonomic experts who can confirm the accuracy of data is essential. However, there is a need to build tools to help them to process large volumes of data. They need to focus on the difficult to identify, rather than widespread, species that can be easily recognised.
- ***Use the data to check itself*** – large datasets can "check" themselves. If distributions of species can be determined from existing data, then species' records falling outside of the known range can be flagged for verification. Likewise, temporal data can be used to flag incorrect identifications based on the time of year.
- ***Provide feedback and show the value of providing good quality data*** – thank those who gather the data. Engage with recorders to show the value and uses of the data that is collected. Demonstrate the use of data and how its application has a direct impact on decisions. Adding context and sense to the data will engender ownership and buy-in.
- ***Publish best practice*** – devise and publish guides (e.g. for 'Bio-blitzes') to ensure that all data collected can be used. These should give clear guidance on how to gather information, how to verify it, and where it should go.

How is it possible to build trust in data?

As discussed above, the trust that decision makers have in data is largely dependent on its accuracy. Verification provides a means to ensure that accuracy, but that is only part of the process in building trust with users. Alongside this there is a key role for data managers in explaining and communicating the ways in which data can be used. This should include clear messages on the quality, quantity, and coverage of any datasets. It should also provide information on why and how the data was collected.

The key actions identified for effective capacity building can be summarised as follows:

- ***Produce metadata statements*** – clear information should be available on the coverage – taxonomic, spatial, and temporal – of the dataset. This should be regularly updated for long-term datasets. The reasons for data collection and the type of survey should also be included (e.g. Bio-blitz, citizen science, academic).
- ***Provide clear messages on what the data can do*** – it should be clear that the data is fit-for-purpose. It is also important to be clear what the data does not do. For instance, a blank spot on a map means 'no data', not necessarily 'no species'.
- ***Show that all data is valuable*** – experts and academics sometimes query the role of citizen science data. Communications about the vital role of different providers in producing quality data is important in building an efficient recording network.

How can the engagement of data providers be ensured now and into the future?

Regardless of the systems in place to gather and verify data, the long-term supply of high quality information is, at present, largely dependent on citizen science and volunteer recorders. Whilst funded recording does take place, this is often restricted to key protected species, habitats, or sites. In order to ensure large-scale, widespread, multi-taxa recording, engagement with these volunteer networks in effective ways is needed to support and nurture their efforts.

Key ways in which inputs and support from citizen scientists and volunteers can be built and maintained include:

- ***Recruitment*** – encouraging people to get involved is key to building the available resource for recording and data collection. Volunteer capacity can be increased or improved by involving people in specific projects. Often volunteers are involved because of an interest in their local area. Support and investment at the local level can develop interest in wider-scale networks.
- ***Keeping people motivated*** – this is the most important factor. In order to keep people actively recording, it is often necessary to offer them opportunities to take part in new projects. However, if the aim is to develop a long-term recording network, then there need to be ways of maintaining their interest and offering something that keeps their involvement.
- ***Offer a "career" path*** – offering volunteers a way to develop their skills with support from data managers and taxonomic experts can help to maintain their interest and also help to develop the experts of the future. Provide volunteers with mentors who can support and encourage them as they build their abilities.
- ***Create ownership*** – it is important that data recorders feel a sense of ownership. Data managers are reliant on their ongoing support and they should not be taken for granted. If they can see the benefits to them and the environment, then they are likely to be more engaged. They should also feel that they are equally important to, and in control of, the project.
- ***Provide ongoing feedback*** – people need to know that what they are doing is worthwhile. Is their data being used? What difference has it made? This feedback should occur at all stages, not just during the collection phase. Citizens and volunteers can be encouraged to share if they get timely feedback.
- ***Demonstrate benefits*** – to encourage data sharing or increase capacity to pool data, you need to identify benefits to data providers. For example, professionals tend to share their data if they can become co-authors on scientific journal articles.
- ***Promote the need for support from key data users*** – data users, such as governments and planning authorities, need to understand the costs involved in supporting a network of volunteer recorders. There is a major role for data managers to communicate this to decision makers and data users, and where possible, negotiate agreements to fund long-term data provision.

Good practice seven: Biodiversity information flow in the Basque Country

In the Basque Country, a bottom-up approach is used to enhance collaboration and networking, improving the knowledge and data flow between different systems/communities. This is integrated in a public, open data infrastructure known as the Nature Information System of the Basque Country.[30] It is also linked to other public repositories of data, including GBIF, and to citizen science platforms (e.g Ornitho Euskadi[31]).

This approach aims to:

- unify standards, criteria, and tools to incorporate in the specifications of public contracts, in the calls for grants, and in agreements with data providers;
- work with local data providers, using leading entities, to organise and coordinate local groups of data providers, and to train volunteers in the collection of primary data;
- make visible the work of all partners; and
- convene relevant data providers, especially from other public administrations.

How is it possible to ensure access to taxonomic expertise now and into the future?

An increasing lack of taxonomic expertise has been identified by the project partners as a key factor in ensuring that the right sort of data is available to answer the questions posed by policy and research.

Priorities for building capacity to address this include:

- ***Encourage identification*** – the easiest way to develop a new cohort of taxonomists is to encourage identification and understanding of the process. There are many ways to do this, including easy to use, but reliable and comprehensive, identification resources, training frameworks, or mentoring schemes. For the future it is essential to train beginners, by working with universities and schools, and by promoting certain taxa.
- ***Promote the importance of taxonomy*** – in particular, schools and universities should be encouraged to emphasise the importance of taxonomy and the important role it plays for government and decision makers, and that it creates employment opportunities. Explain the essential nature of taxonomy within ecology and conservation. Show that it is the basis for a lot of understanding.

[30] http://www.euskadi.eus/natura/
[31] http://ornitho.eus/

- ***Look to citizen scientists*** – developing the skills of volunteers and citizen scientists could be used to offset the loss of taxonomic experts from academia.
- ***Work with recording groups*** – linking up with national schemes and societies, such as Butterfly Conservation UK, can provide a way to develop the skills of recorders. It can also foster vital links between data providers and decision makers.

Good practice eight: FSC BioLinks project

The FSC BioLinks[32] is a project developed by the Field Studies Council, which brings together existing volunteers with skills in biological recording and identification, and new volunteers. The aim is to unite them in a community with a shared vision and sense of purpose, by providing training and learning opportunities. This in turn aims to increase the quality of invertebrate species data being submitted to UK national biodiversity datasets, and develop individuals to become more highly skilled biodiversity volunteers.

BioLinks will provide courses and resources to support volunteers, including:

- species identification workshops focusing on difficult and under-represented taxa (e.g. beetles and earthworms);
- use of, and access to, high quality resources to help build confidence and knowledge (e.g. microscopes and identification guides); and
- create schemes to involve volunteers in long-term surveys to help provide structured learning and involvement in meaningful projects (e.g. creating a county-level shield bug atlas).

[32] https://www.field-studies-council.org/about/fsc-projects/current-projects/biolinks.aspx

How can capacity be increased to deliver data to decision makers?

Effectively meeting the needs of decision makers is key to the outcomes of BID-REX. To achieve this there is a need for interpreted and well-presented data. In most cases, finding ways and means to successfully engage decision makers is contingent on the ways data is presented, using technology to deliver a clear message.

During the presentations and discussions, the following priorities were identified:

- ***Have a clear objective*** – is the focus on a single policy or research question or contributing to something bigger? Is there a need for a simple project website, or complex online system to hold a national species dataset? The limitations of any system need to be considered. Resources will dictate what is possible, and being clear what users want and how their needs can be met is important.
- ***Customise products to the objective and user*** – the final product should be adapted to the decision makers' needs and also their abilities to understand the outputs. It is important to communicate and explore this in order to understand what level of data they need but also to give them better awareness of the type of data that are available.
- ***Same data, many products*** – the same data can be packaged in multiple ways. Different users will have different needs that can all be served on the same platform, using the same data, but presented in different ways. For example, commercial fee-paying users, may have access to higher resolution data than that available to members of the public seeking to view freely available data.
- ***Develop new skills and technology jointly with users*** – this can help to facilitate data understanding and use. Working closely with decision makers to build skills and develop technology together ensures that realistic approaches are taken and that both parties are invested in the outcomes.

How can data interpretation capacity be built to answer questions?

In most cases, decision makers are more interested in the outputs of data interpretation than the raw data itself. For example, ecological network maps, habitat opportunity maps, or predictive species models. In order to build capacity to meet this need, there is a need to ensure that data products and staff skills are developed appropriately.

In order to do this, the following should be prioritised:

- ***Understand the question*** – the first step is to understand what the decision maker needs. In many cases it is not the data itself, but an answer to a very specific question. It is often the case that the data exists to answer the question and it just needs the right interpretation. It is important to elicit feedback from decision makers to ensure an understanding of what they are asking and their expectations.

- ***Understand the context to the question*** – questions raised by decision makers are often the result of policy drivers. For instance, the need to protect significant species from development, or the development of ecological network maps for use in strategic planning documents. An understanding of the underlying policies and legislation can help in the understanding of the research or policy question and design products to provide answers. An understanding of these policy drivers can also help to understand the data needs and to design data collection appropriately. It can also help to ensure that decision makers have asked the right questions, or that they are framed in the right context.
- ***Answer clearly*** – even when providing answers based on interpreted data, remain factual. It is important to be mindful of the questions that are being answered. Any caveats need to be clearly stated and all answers should be clear and transparent.
- ***Be clear on terminology*** – there is often a problem of translation between data holders and decision makers. Be sure that all parties understand what the product will be and what it can and can't do.
- ***Provide a matchmaking service*** – consider providing a single point of contact for decision makers. Additionally, the provision of a catalogue of available services or existing tools could serve to facilitate efficient product development, preventing the need to "reinvent the wheel". It would also offer the opportunity to build relationships, understanding, and trust between parties. The work can then be directed to those with skills most suited to delivery.

How is it possible to ensure that data and tools can help decision makers to make the right choices now and in the future?

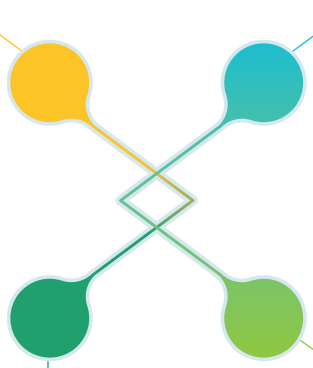
In order to foster effective decision-making and develop tools that are fit-for-purpose, there is a need to ensure that the needs of users can be met, both today and in the future. There are no guarantees that decision makers will make the "right" choice, as that is a subjective concept, and in many cases politics will have an influence. However, it is possible to develop and provide high-quality, relevant, and usable data and information to support informed decision-making (as also illustrated in Figure 11).

The following priorities were identified during the interregional learning process:

- ***Data for interpretation*** – access to robust and appropriate data is needed long-term. Measures outlined above provide methods for developing the means to ensure this, but strategies should be developed by data providers to ensure that they can meet the needs of their decision makers.

- ***How much data is enough*** – those providing services to decision makers need to be realistic about what they are able to do when it comes to data gathering and supply. It may not always be possible to develop and present comprehensive datasets, so it is important to have an understanding of the limitations of what can be done with the resources available. This could mean compromising on the detail that can be produced in interpretive maps or modelled predicted species distributions. It could also mean compromising on the amount of data collected for a particular project. This all needs to be clearly communicated to the decision maker.
- ***Adapt to new questions*** – be smart about developing technologies and tools in order to answer new questions with "old" data. Aim to 'collect once, and use many times' when it comes biodiversity data.
- ***Policy*** – this can and will change, and stakeholders should be prepared to answer new questions based on these changes. Ensure that data is leveraged wherever and whenever possible to maximise its potential to inform policy.
- ***Information-management-evaluation cycle*** – data providers should assess the effects and impacts of the decisions that have been made based on the data they supplied. Did the tools developed and provided by data managers assist or influence a decision-making process, and if so what was the outcome? Was it negative or positive? Was the decision maker properly informed by the information supplied? What could have been done better? Do projects that use the same information but produce different products have different impacts on users? This evaluation will help to ensure that data providers can adapt and improve tools and support to build positive relationships with decision makers, and to achieve better outcomes.

Figure 11: Ways to facilitate access to, and use of, information.



Be sure that the information provided is the information needed:

Encourage dialogue between producers and users

Public administrations should inform scientific institutions about the species/habitats they are interested in

Information should be provided as an interpreted product that meets the needs of the users/authorities

Dissemination and communication:

Public promotion

Open/public data repositories

Raise awareness on the importance of biodiversity knowledge

Usability comes first – user experience approach:

User-friendly interfaces and appropriate portals (websites/apps)

Create simple tools for involving citizens in biodiversity knowledge

The development of apps allows citizen scientists to record observations and experts to validate them

Web portals for biodiversity data

Unify structures, standards and methodologies:

Make data compatible by unifying data structures as much as possible

Metadata and structured data standards

Ensure quality of information

Unify methodologies

Databases gathered/managed in one place (or at least as few as possible)

Make clear the intended limits of use of the data: identifiers for citation/reuse of information

Public administrations should share information and maps openly

5. Summary

By bringing together stakeholders from across the data value chain and across Europe to share insights, lessons learned, and experiences of biodiversity information supply and use in decision-making contexts, commonality can be seen in the challenges and barriers, and the enablers, opportunities, and solutions.

An immediately clear and consistent message, both up-and-down the data value chain, is that communication is key. Without effective communication to express what data is held, its capabilities, attributes, and limitations, the range of possible analysis and processing, and the needs, demands, and context of the questions requiring answers, challenges and barriers will occur. Communication facilitates the development of effective working relationships, and engenders mutual trust and respect – essential factors in assuring data managers and decision makers that information products or data packages will be used in good faith, and that they can be reliably called upon to underpin decisions and actions.

Collaboration between data managers and decision makers is mutually beneficial. The clear expression of needs from decision makers to data managers enables the identification of data gaps, allows for specification and customisation, and ensures data use, uptake, and eventual impact – bringing with it the likelihood of continued funding. Benefits realised by decision makers are possibly even more clear-cut – they receive data and information products that they can trust and rely upon. This potentially saves time-consuming research and reliance upon incomplete or partial datasets, or use of proxies, estimates, or assumptions that can lead to errors and inaccuracies.

In this technological age, data is available for almost every facet of life, and where there are data gaps, technological approaches can be adapted or applied in novel areas and ways to obtain it. As discussed in the introduction to this report, it is widely acknowledged that biodiversity is in decline, with many global conventions and processes setting goals and targets to help address this. Therefore, the opportunity exists to increase the use and impact of data to support decision-making processes, and in doing so, contribute to the attainment of conservation goals and halt ongoing species and habitat losses and degradation.

BID-REX sets out to assist in this aspiration by identifying and addressing the disconnects that exist between data and information, and effective decision-making in Europe.

6. Annexes

6.1 Annex 1: Good Practices

The following pages contain all of the Good Practices resulting from the Interreg Europe BID-REX project.

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GOOD PRACTICE

20 years of biodiversity data collecting in Slovenia – lessons learned

Description

20 years of biodiversity data collecting at Ljubljana Moor, Slovenia, demonstrated that biodiversity data gathering is not a sprint but rather a marathon.

During the last decades, the amount of data on species occurrences has been rapidly increasing. Accordingly, a strong need for data digitalisation and user-friendly data organisation was apparent.

The Centre for Cartography of Fauna and Flora (CKFF) was established with the aim to collect and organise data and information about occurrence of plant and animal species in Slovenia in a single database, and to further disseminate this to different end users. Approximately 20 years ago, CKFF identified there was a huge amount of data in Slovenia that was scattered between different data collectors and public organisations, most of which was not digitised. At first, CKFF organised accessible data on dragonflies and amphibians in GIS supported databases. Soon afterwards, data on plants and most animal groups was included. Now, more than 1,750,000 records have been accumulated in the database. The database is constantly developing and improving.

The CKFF also developed an interactive interface between the users and the database – BioPortal. The content of the CKFF database is partially accessible through BioPortal (http://www.bioportal.si/).

The data from the CKFF database can be used to prepare species atlases or national species lists. These can support research questions, the development of management schemes for protected areas, nature conservation efforts in general, or environmental impact assessments.

Resources needed

- So far (up to 2018), 30 years of work was required to develop and maintain the CKFF database. Over 2,000 individuals have participated and are still active in providing data for the CKFF database.

Evidence of success

Using the CKFF database, the Atlas of Lepidoptera: *Rhopalocera* (2012), Atlas of *Chiroptera* (2009), Materials for the Atlas of Flora of Slovenia (2001), and Atlas of *Odonata* (1997) were produced for Slovenia. Two national species lists, for micro moths (*Microlepidoptera*) and spiders (*Araneae*) were also published. Additionally, several scientific publications are based on data from the CKFF database, as well as an array of environmental impact assessments at local, regional or national level.

Difficulties encountered

Societal and political attitudes to the environment and nature protection play an important role in the process of data flow and use. The first phase in this process (i.e. data collecting) should remain independent of these factors.

Potential for learning or transfer

The lessons learned during the past 20 years of data collecting, organising and disseminating, can help to inform on efficient technical solutions when working with enormous biological datasets. Additionally, this experience can also inform on how to improve the data flow from data collectors to end users, and how to avoid pitfalls.

Location	Main institution	Start date	End date
Zahodna Slovenija, Slovenia	Centre for Cartography of Fauna and Flora (CKFF)	January 1998	Ongoing

http://www.bioportal.si/

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Biodiversity information flow in the Basque Country

Description

To improve data flows in the Basque Country, three key aspects are focussed on: data, relationships, and people.

The information on biodiversity is complex, with an important and specialised scientific knowledge base. Many stakeholders produce high quality information that can be used for decision-making. Much of this information has been financed with public money. As such, there is a responsibility to use it efficiently and make it available to the public such that others can also use it, generating additional value.

In the Basque Country, a bottom-up approach was used to enhance collaboration and networking. This sought to improve the knowledge and data flow between different systems/communities. The result was an integrated public, open data infrastructure – the Nature Information System of the Basque Country. This also links to other public repositories of data, like GBIF, and to citizen science platforms such as http://ornitho.eus/

The key aims of the Biodiversity Information Flow are to:

- Unify standards, criteria and tools to incorporate in the specifications of public contracts, in the calls for grants, and in agreements with data providers.
- Work with local data providers using leading entities to organise and coordinate local groups of data providers and to train volunteers in the collection of primary data.
- Make visible the work of all partners.
- Incorporate relevant data providers, especially other public administrations.

Location	Main institution	Start date	End date
País Vasco, Spain	Basque Government	October 2012	Ongoing

http://www.euskadi.eus/natura

Resources needed

- Approximately EUR 25,000/year to hold stakeholder workshops.
- We have the technical support of Innobasque, a non-profit, public interest association which helps us to meet social needs and create new social relationships or collaborations.

Evidence of success

We have signed agreements with the Society of Sciences Aranzadi, the University of the Basque Country, and AMBAR, and the Society for the Study and Conservation of Marine Fauna, in order to incorporate the information generated by them in the Nature Information System. We have incorporated quality criteria and standard formats for the delivery of information in monitoring programs for common birds, butterflies, water bird censuses and in the call for subsidies for the generation of knowledge.

Difficulties encountered

The need to improve inter-institutional coordination is one of the biggest problems. This is difficult because of the multi-layered nature of institutional organisations in the Basque Country, which reveals a complex interplay of different forces at all levels.

Potential for learning or transfer

This bottom-up, collaborative approach can be applied to any region, simply by adapting it to the particular characteristics of the local stakeholders. Under the BID-REX project, a guide on this approach is being prepared, which may be used by any public authority or local stakeholder to:

- Establish priorities in the allocation of budgets and monitoring the impact of actions financed by public funds in order to finance those actions that provide relevant information on biodiversity, ensuring that, in addition, the information generated can be reused to provide new public value.
- Promote and improve sectoral forums that involve key stakeholders (authorities, NGOs, professionals, researchers, etc.) in favour of integrating data on biodiversity.
- Improve the skills related to the production, management and use of biodiversity information of all the stakeholders involved.

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Building capacity in data providers: Invertebrate Recorders of the Future (FSC BioLinks Project, UK)

Description

Volunteer training and support for recorders to record invertebrates. Data collated and fed into Pantheon to undertake site quality assessments.

There is a recognised lack of field and identification skills within the UK biodiversity sector, with a generational skills gap forming that threatens the future resilience of its biological recording network. Some taxa are particularly well studied, while other groups, such as invertebrates, are often neglected due to the difficulty in identifying species.

The FSC BioLinks project aims to improve the record holdings of a selection of difficult-to-identify and under-recorded invertebrate taxa in both the short- and long-terms, by providing a range of identification training courses and recording events. These are designed to improve recorder knowledge, skill, motivation, and confidence, and form part of a single structured training plan, providing learning opportunities for new invertebrate recorders at all competency levels.

Project activities are open to all (though has a targeted approach to attracting young adults, aged between 18-25, to ensure that the generational skills gap is addressed). This includes measures such as utilising a range of social media platforms and targeted advertising, as well as ensuring that the career value of acquiring field and identification skills is showcased.

More than 100 training courses and/or events will be delivered across the West Midlands and South East England, per year, in partnership with various existing recording schemes, environmental education centres, Local Environmental Record Centres, and natural history societies. These will aim to integrate into existing networks.

Location	Main institution	Start date	End date
Bedfordshire and Hertfordshire, United Kingdom	Field Studies Council	January 2018	Ongoing

http://www.fscbiodiversity.uk/biolinks

Resources needed

- GBP 1.6 million through grants and funding (Heritage Lottery Fund, Esme Fairbairn grant, FSC funds), and non-cash contributions (including volunteer time).

Evidence of success

The project is only in its first year, so evidence of success is limited. However, the five-year project was preceded by an in-depth, one-year consultation, which set the ground work and won sector-wide support and praise, particularly for the publicly available Development Plan For Training Provision.

At the end of year one, the project has already exceeded participant targets, with courses proving popular, and participants already beginning to undertake species recording of the project focus species.

Difficulties encountered

Attracting young adults (18-25-year olds) has been the biggest challenge to date. Actions are currently in progress to tackle this, which include using age-targeted advertising through social media, and working with existing young naturalists to reach this hard-to-reach demographic.

Potential for learning or transfer

The FSC BioLinks project has much potential for transfer, building capacity in other organisations and regions. Many aspects of the project lend themselves to replication in other regions, as the problems being addressed are likely to be present elsewhere also. Using the frameworks established, lessons can be transferred and replicated to fill skills gaps where they exist.

Successes and challenges will be presented at sector conferences and through publishing a variety of guidance. Two documents from the consultation phase are already publicly available: (i) FSC BioLinks Consultation Report, and, (ii) FSC BioLinks Development Plan For Training Provision. Furthermore, the project has collated and published previous FSC Biodiversity project evaluation reports on its website in order to share learning from the projects that preceded and informed the current project.

The FSC BioLinks project is a developmental project and methods/products will evolve, culminating in a Legacy and Resilience Conference.

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Cartography of habitats in Catalonia: a useful tool for making decisions in nature conservation

Description

The purpose is to provide cartography for habitats in order to improve land management, knowledge and conservation of the natural environment.

The main motivations that led to the map of habitats were to: i) improve land management, ii) generate reports for monitoring habitats, and iii) assess their evolution over time. To achieve these goals it was essential to have a map showing the distribution of habitats in the territory in order to be able to locate and quantify them.

Habitats projects in Catalonia (information available online):

- List of Catalan Habitats. Obtained from an adaptation of the CORINE Biotopes Manual. This corresponds with EUNIS classification.
- Manual of Catalan Habitats. The need to clearly establish the content and specify the boundaries for each habitat led to the creation of a manual.
- Legend and the Interpretation Manual for the cartography
- Cartography of Catalan Habitats (1:50,000)
- Cartography of habitats in protected areas (1:10,000)

The main applications are:

1. Management
   (public administrations, private companies etc.):
   a. Delimitation of protected areas
   b. Monitoring the state of conservation of natural heritage
   c. Planning and management of activities in the natural environment
   d. Provide environmental information to citizens
2. Education and dissemination:
   a. Teaching at university and schools
   b. Introducing the natural environment to citizens and creating new opportunities for sustainable socio-economic activities
3. Research:
   a. Knowledge of biodiversity
   b. Testing new methodologies
   c. Basic information for the study of habitats dynamics over time

Resources needed

- Mapping of habitats in protected areas (1:10,000) approximately EUR 4/ha. More than 12 people, covering between 3,000 and 8,000 ha/year.
- Mapping of habitats (1:50,000) approximately EUR 400,000 over five years. About 35 people involved.
- Manual of Catalan Habitats (eight volumes): approximately EUR 34,000 and 15 people involved.

Evidence of success

Both the list and the cartography of habitats have become standard tools used in most of the management, study, and conservation of the natural environment. They are tools widely used in local administrations, regional communities, natural protected areas, research centres, private consultancies, higher education centres, and so on. As an example, the first paper edition of the Habitats Manual, of which 1,000 copies were made, was sold out in a few years and the second edition is currently underway.

Difficulties encountered

One of the most important difficulties to develop the project is to have highly qualified technicians with broad knowledge of habitats, vegetation and species. Universities have not prioritised naturalistic knowledge, which is essential for the development of management and conservation policies.

Potential for learning or transfer

We believe that a detailed cartography of the habitats is an essential tool for the correct management of the natural environment, so we strongly recommend it to any territory that does not yet have it. According to our experience, on a regional scale it is probably enough with a scale of 1:50.000 or 1:25.000, but for smaller areas it is necessary to work with more detailed scales (at least 1:10.000). Likewise, it is highly recommended to have precise protocols on the mapping methodology, and on the interpretation manuals of the habitats that make it easier to recognise it in the field.

Location	Main institution	Start date	End date
Catalonia, Spain	University of Barcelona	January 1998	Ongoing

http://www.ub.edu/geoveg/en/semhaveg.php

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GOOD PRACTICE

Citizen science in the dark: acoustic monitoring for the masses

Description

Improved understanding of local patterns of occurrence and activity of all bat species utilising volunteer networks.

Technological advances and development of analytical techniques, coupled with reduced costs of hardware, has made large-scale acoustic recording of several taxa of bat increasingly feasible, opening up new approaches to monitoring, research and engagement. The project was initially set up to improve our understanding of local patterns of occurrence and activity of all bat species. The approach of setting up a network of centres to allow a large number of volunteers to carry out surveys using expensive recording equipment resulted in a far larger and more comprehensive dataset than could have been achieved with alternative models. These data feed into county reporting, to help make decisions, including planning decisions at a local level for bats.

Research and development has focused on quantifying likely impact of planned housing development on the distribution and activity of bats. The findings of this work were published in the journal Landscape and Urban Planning. The influence of different mitigation measures for reducing the negative effect of new housing were explored, along with implications for wider impacts of new housing on bats, and ways in which these could be mitigated. Working with the Paris Natural History Museum and Natural England, algorithms were also developed for the semi-automated sound identification of UK bush-crickets. With continued collaboration, this work was extended to build a classifier for a suite of nocturnal birds also.

Resources needed

- The Norfolk Bat Survey was set up in 2013 with funding from the People's Trust for Endangered Species (PTES) and Defra (Department for Environment Food and Rural Affairs) Fund for Biodiversity Recording in the Voluntary Sector
- 1,500 volunteers
- On-going funding required is approximately EUR 25,000/year

Evidence of success

A strategic review by the Bat Conservation Trust (BCT) on the future of bat monitoring in the UK, decided that the Norfolk Bat Survey was an ambition that they would like to see scaled up to a national scale. The ambition is to set up a British Bat Survey as part of the National Bat Monitoring Programme to run from 2020. Discussion on this led to a Natural Environment Research Council (NERC) funded project led by University College London on species classifiers, affordable static detectors and an online interactive survey.

Difficulties encountered

The main challenge has been securing on-going funding for tool maintenance to continue the project. Since setting up the project, a lot of the infrastructure and tools needed to run a large-scale acoustic project have been developed, so the cost of running the project has been reduced significantly.

Potential for learning or transfer

There is huge potential to consider the approach, the infrastructure and tools that have been developed to provide robust data on bats (and some other species groups) to help inform good decision-making. Our work in Norfolk has influenced the future direction of national bat monitoring in the UK, but there is clearly potential for transfer of knowledge more widely.

Location	Main institution	Start date	End date
East Anglia, United Kingdom	British Trust for Ornithology (BTO)	April 2013	Ongoing

http://www.batsurvey.org/norfolk/

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GOOD PRACTICE

Data: collection to use – ALERC Accreditation

Description

ALERC Accreditation is a system for assuring the quality of the work provided by Local Environmental Records Centres (LERCs) in the United Kingdom.

Meeting a set of 20 standard criteria allows LERCs to demonstrate they adhere to best practice across three areas. Within these areas, specific aspects of LERC work are assessed, such as whether the organisation is steered by stakeholders, whether it has a verification system to check data accuracy, and what data services it can offer. The network of LERCs provides UK citizens with a dedicated environmental data service that is physically close to them and that understands their local environment. High resolution and high quality data is collected and made available for many purposes. The difficulty is that there are many organisations (c. 50) across the UK that are doing this work. A system is needed that brings some level of standardisation across LERCs and could provide assurance to those using LERCs in different parts of the UK that they are adhering to accepted best practice.

The ALERC Accreditation system was created to address this. The scheme consists of two levels of accreditation, standard and advanced, but the advanced level criteria are still in development. To achieve standard level accreditation, LERCs need to demonstrate how they confirm to twenty criteria. These criteria are divided into three sections: 1) the way the LERC is constituted and how it ensures that it is steered by its stakeholders; 2) data custodianship; and, 3) services. At all moments, data suppliers (i.e. the recorder) and the users (i.e. environmental decision makers) are considered.

Location	Main institution	Start date	End date
North Yorkshire, United Kingdom	Association of Local Environmental Record Centres (ALERC)	April 2011	March 2020

http://www.alerc.org.uk/alerc-accreditation.html

Resources needed

- To produce the criteria, and pilot them by assessing two LERCs, a project was created to a value of approximately GBP 30,000. The system is run by ALERC, with additional voluntary contributions from LERCs, with the approximate value of GBP 10,000/year. Replication costs would depend on number of LERCs.

Evidence of success

The overall measure of success is to have all ALERC member LERCs accredited by 2020. It is harder to measure what the effect will be of achieving this, but it is hoped that there will be greater use of environmental data, which will be shown by an increase in the number of data requests from the commercial sector and members of the public, as well as an increase in agreements with the public sector.

Difficulties encountered

The main challenge is simply finding the time to go through the criteria and compile the evidence to show that the LERC is compliant. However, LERCs cannot be forced to do this, and they are already very busy.

Potential for learning or transfer

It is not known how many regions outside of the UK have LERCs, or anything similar. However, many of the principles of good environmental data management are universal and it is very beneficial for any organisation involved with environmental data to be able to show that it conforms to good practice. Therefore, an accreditation system of some type should be applicable everywhere. Some aspects are simple and easily transferable, such as the need to conform to a specific taxonomic dictionary, since this will use Latin (universal). Other aspects will be specific to individual regions, such as ensuring that data is handled in accordance with local legislation (although much of this legislation originates from the European Union and so should be very similar across Europe). Once set up, the ALERC accreditation has been altered slightly to reflect technical developments as well as changes in legislation and policy. This is easy to do and simply requires an annual review.

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Ecosystem services assessment in the Basque Country

Description

This science-policy approach generates knowledge on ecosystem services to create tools for sustainable landscape management and the improvement of human well-being.

This practice responds to goals established in the EU Biodiversity Strategy to 2020, highlighting the need for knowledge in order to maintain and restore the natural environment and preserve ecosystem services as our life insurance. Focusing on ecosystem services is an enriching manner of perceiving the relationship between nature and human well-being, and for understanding the need to maintain and restore our natural heritage.

The ecosystem services perspective contributes to the development of sound land-use policies and planning actions in the Basque Country; such as: Strategy for Basque Land Management (Directrices de Ordenación territorial/ DOT), and Planning for the Metropolitan area of Bilbao (Plan territorial Parcial/PTP).

The project team was made up from the collective participation of researchers, social organisations, administrative personnel, and policy makers. This interdisciplinary group has made it possible to integrate scientific methodologies with policy-making practices, in order to create useful tools for the sustainable management of the Basque Country.

Many people from different institutions were involved in this project. These included: the University of the Basque Country, the Basque Government, and the County Council of Biscay.

This project is interconnected to other national assessments, as well as to the Sub-Global Assessment (SGA) Network.

Location	Main institution	Start date	End date
País Vasco, Spain	UNESCO Chair on Sustainable Development and Environmental Education. University of the Basque Country	January 2012	Ongoing

http://www.ehu.eus/cdsea/web/index.php/research/ecosystem-services-basque-country/?lang=en

Resources needed

- The practice required the work of two full-time people and eight others working *pro gratis* (including students, technicians and NGO members). Basque Government contributes EUR 95,000/year.

Evidence of success

The most important success is the inclusion of methodological approaches and results from the practice in public plans and management strategies. These results had influence on the implementation of policies such as: Strategy for Basque Land Management, and Planning for the Metropolitan area of Bilbao. The development of useful technical tools – including mapping and indicators – have also been achieved.

Difficulties encountered

Regular contact among all practitioners is necessary and useful. Stakeholders' participation, and collaboration between researchers, technicians, and politicians are central factors for the practices' success. The ecosystem services approach can act as a bridge between research and application.

Potential for learning or transfer

This practice responds to the goals established in the EU Biodiversity Strategy to 2020, highlighting the need for knowledge in order to maintain and restore the natural environment and, specifically, to preserve ecosystem services as our life insurance.

The ecosystem services practice in the Basque Country contributes to improve nature conservation and land-use policies, with the participation of stakeholders. In this sense, sharing a common conceptual and methodological approach with other regions can help to develop suitable practices in other areas of Europe.

In addition to sharing the results, it is also important to share the conceptual framework and newly applied methodologies, as well as the examples of plans and strategies based on the results of the practice, that have been implemented in the Basque Country.

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Global monitoring programme for biodiversity in Catalonia (SISEBIO)

Description

SISEBIO is a tool to aid the understanding of changes in biodiversity over time, and to improve the management of the natural environment.

Decision makers need to know if their management and biodiversity conservation instruments are effective and sustainable. Biodiversity monitoring programmes can become tools for the improvement of decision-making, and for improving the knowledge of the public in general, if they are optimally related to environmental policies. SISEBIO is a knowledge tool for biodiversity in Catalonia. It is based on the monitoring of changes in the composition and structure of communities, and long-term, regional-scale habitats. SISEBIO allows the analysis of cause-effect relationships between the factors of change and the dynamics, processes and functioning of ecosystems, to be examined.

SISEBIO's main product is the generation of a set of universal indicators of biodiversity changes, based on Essential Biodiversity Variables (EBVs) of communities representing the trophic levels in the most representative habitats of Catalonia. This task is developed by the coordination of various monitoring programs. In SISEBIO, several programmes have been implemented to monitor birds, butterflies, forests, and habitats. Biodiversity monitoring as a result of compliance with the Water Framework Directive is also taking place. At the same time, SISEBIO is promoting the creation of new biodiversity monitoring programmes where gaps currently exist.

Location	Main institution	Start date	End date
Catalonia, Spain	Government of Catalonia	January 2017	Ongoing

Resources needed

- The annual budget of the project is approximately EUR 400,000. In addition, the project uses data from other projects, such as those derived from forest inventories, or the monitoring of water quality and control, financed by other administrations.

Evidence of success

Partial datasets obtained from the monitoring of birds or butterflies, indicate the usefulness of monitoring groups with great bio-indicator potential. This enables the development of broad trends of natural heritage in Catalonia. Specifically, these data indicate the alarming decline in specialised species in open spaces, or the constant loss of populations, mainly due to the impact of droughts.

When the global project becomes operational, a broader view of these trends will be possible.

Difficulties encountered

The biggest challenge in this project has been the selection of what elements of natural heritage need to be monitored. Because it is clear that all elements of natural heritage cannot be monitored, for reasons of budget, but also for reasons of practicality.

Potential for learning or transfer

As mentioned above, SISEBIO is a knowledge tool for biodiversity in Catalonia, based on the monitoring of changes in the composition and structure of communities, and long-term, regional-scale habitats. The observation and analysis of these changes through the development of a set of indicators may be of interest for other regions for several reasons. Firstly, in order to be able to respond to the questions of politicians and society in general (e.g. '*How are our ecosystems responding to global change?*') Secondly, this knowledge should facilitate the implementation of public and private policies that can correct the negative trends observed. Finally, the project can also help to answer the data needs as requested by the European Commission, for example in the assessment of the state and monitoring of the European Directives of nature (Article 12 of the Birds Directive, and Article 17 of the Habitats Directive), and Natura 2000 network. This aspect, obviously, can also be of interest to other regions.

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GOOD PRACTICE

IAIA: biodiversity information supporting Environmental Impact Assessment

Description

IAIA facilitates scientific information about protected species, habitats and sites to support the Environmental Impact Assessment of future projects.

The project aims to connect Catalan administration officers in charge of performing Environmental Impact Assessments (EIA) and the biodiversity information stored by the unit responsible for natural heritage conservation. To save bureaucracy and time, the Forest Sciences Centre of Catalonia (CTFC) collaborated with these governmental units, developing the Tool of Supporting Information for EIA (N.B. tool's Catalan acronym: IAIA).

IAIA is a user-friendly online server which facilitates biodiversity information, responding to user-defined queries, specified by project type (e.g. road, urbanisation, ski slope etc.) and location. The tool integrates information about site locations, habitats, and species distribution, which can all be overlaid with future project locations and extents using GIS. This spatial information allows the EIA to clearly identify which species, habitats, and sites are potentially impacted within project areas.

Moreover, IAIA translates scientific information to qualitatively estimate the likely effect on species and habitats occurring within the area impacted by a project. To do so, the tool links the threats and pressures associated to every project type with the susceptibility of the species and habitats spatially overlaid. This information allows users to improve the assessment using science-based information to identify which project elements could impact on biodiversity.

IAIA's outputs are ready-to-use, downloadable and easy to interpret.

Location	Main institution	Start date	End date
Catalonia, Spain	Forest Sciences Centre of Catalonia	January 2015	Ongoing

Resources needed

- EUR 43,000 during the first and second year to create the tool – (two administration officers, three researchers, and one software developer)
- EUR 5,000/year for its maintenance (information update and servers) – (one administration officer, two researchers, and one software developer)

Evidence of success

The tool has demonstrated its ability to facilitate biodiversity information between Catalan Government departments, saving bureaucracy and time. Moreover, it adds interpreted scientific information in support of the assessment.

Currently, all officers of the Catalan Government that are working on EIAs, are IAIA users. The tool is also of interest to other Catalan Government departments, and some similar tools adapted to other needs are being developed.

Difficulties encountered

The main threat is the need of long-term resources to maintain and improve the tool, allowing for frequent information updates and maintenance of servers.

Furthermore, some information might need to be reviewed to improve the interpretation of impacts and the mismatch between data and user needs at different scales.

Potential for learning or transfer

In Europe, it is mandatory to conduct Environmental Impact Assessments before project approval and implementation. IAIA could be useful for those in charge of EIA implementation in any region because it's conceptual scheme and user-friendly interface is fully transferable.

To adapt IAIA to any region, the basic information contained in the tool should be replaced by regional biodiversity data. The most elaborate process would be the translation of species and habitats pressures and threats to typical regional project impacts, and the identification of pressures and threats which affect species and habitats, if these are different from those currently integrated into the tool.

Other regional authorities involved in BID-REX have been inspired by IAIA and there is willingness to import it in the future. Moreover, interoperability has already been demonstrated within Catalonia, as other government units with biodiversity information needs are creating new tools based on IAIA.

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Improving biodiversity data flows in Catalonia

Description

Natura 2000 reporting, and planning of protected areas in Catalonia: nature information methodologies responding to information needs - two case studies.

The first case study relates to Article 17 (Habitats Directive) and Article 12 (Birds Directive) reporting. The European Union requires Member States to report every six years on the progress made with the implementation of these directives. The main focus of the directives is on maintaining and/or restoring favourable conservation status for habitats and species – with particular focus on some communities of interest and birds. Monitoring and reporting data are incorporated into a standard methodology enabling the conservation status for each element to be determined.

In order to be able to accomplish this task, relevant scientific actors involved in the process, the necessary data sources, and the information flows are identified. This allows the task to be planned effectively and information gaps and problems to be spotted and solved.

The second case study focusses on the planning of protected areas. Legal frameworks (regional, national and European) require that protected areas managers provide protection and management plans. In Catalonia, a biodiversity data flow methodology was developed to structure and articulate all of the elements in the planning process for protected areas in the region.

The methodology combines scientific data and information and applies it within a logical framework for planning and adaptive management. This allows the generation of operational objectives, reports, zonation maps, action plans and management guidelines for the protected areas network. It also enables the evaluation of the achievement of actions against objectives.

Location	Main institution	Start date	End date
Catalonia, Spain	Government of Catalonia	January 2017	Ongoing

Resources needed

- Natura 2000 reporting: approximately EUR 50,000/six year reporting period.
- The production of a protected area plan with this methodology is approximately EUR 120,000.
- Both projects use data from other projects that are financed by other administrations, or that have other applications also.

Evidence of success

Natura 2000 reporting has been improved by incorporating more complete and up-to-date information.

A new model of flow-data to take into account for future reporting of Natura 2000 has been identified, and a new plan to implement this was obtained thanks to the elaboration of the Natura 2000 reporting for the last period (2013 – 2018).

- Increase in the consistency and quality of the data used for each report and plan.
- Increase in the coherence between the data of every report and plan.
- Adaptive planning: more agile and easier periodic review of documents enabled.

Difficulties encountered

The challenge has been to discern the best sources of information and set the criteria for using it. Another important factor is to define the relation between different data sets. Finally, the last challenge is structuring and storing results such that the processes are repeatable and understandable.

Potential for learning or transfer

These two case studies could be used by other Member States, since all share the common task of identifying and collecting available biodiversity information and discerning what is most appropriate for developing their Natura 2000 Network to carry out reports or elaborating protection plans for their protected areas.

These examples can help organise the flow of data to Member States of the European Union, or the regions that have delegated the task of informing the EU about how to organise the basic information to prepare these reports.

Likewise, since all countries and regions are committed to developing protection plans for their natural protected areas, it may be very useful to have a data flow model for the elaboration of the different parts of the plans and in the decision-making process.

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Increasing natural resilience in Norfolk

Description

Utilising high quality biodiversity information, alongside other contextual data, to provide well-designed green infrastructure plans.

Housing growth in Norfolk increases visitors to Natura 2000 sites. Many proposed housing developments are close to sensitive sites, and two thirds show adverse impacts from recreation and access.

Green infrastructure (GI) can be used to mitigate this, and effective planning is key to this process.

Information on biodiversity is important for targeting GI, but equally important is data on how visitors are using sites. Understanding where they come from and what they do, ensures effective on-site measures and suitable alternative natural greenspace delivery elsewhere.

Visitor surveys at Natura 2000 sites give information of the home addresses and on-site activities of visitors. This allows assessment of the likely increase in visitors and activity from planned housing growth, and allows appropriate site management and targeting of GI delivery.

Using biodiversity data to provide the basis for modelling to identify existing ecological networks and potential opportunities, maps have been produced to guide GI delivery in Norfolk. This has culminated in a strategic GI map identifying target corridors and core habitat areas for delivery. This map is now being used in Local Plan documents in Norfolk to provide a strategic approach to GI delivery.

On behalf of eight Local Planning Authorities and the Norfolk Wildlife Trust, Norfolk County Council has produced maps to be used at a strategic and site level to guide GI delivery to mitigate the impacts of development on Natura 2000 sites.

Resources needed

- A good baseline of biodiversity data and information is needed, as are visitor surveys of Natura 2000 sites.
- Data is held by Norfolk Biodiversity Information Service, which has running costs of approximately GBP 80,000/year.
- Visitor surveys = GBP 30,000
- Ecological network and opportunity mapping = GBP 15,000

Evidence of success

The outputs from the work are now being used by all eight Local Planning Authorities in Norfolk to guide delivery of GI.

The maps are now being used to develop a Norfolk GI strategy that will target local and strategic level GI provision. They will also guide the development of a potential funding system for GI, utilising a levy on new developments to target appropriate mitigation measures.

Difficulties encountered

Throughout the process of developing the maps, it has been essential to ensure that stakeholders understand the potential of the outputs. Equally important is an understanding of what the products cannot do.

Potential for learning or transfer

The work to deliver effective GI targeting maps for Norfolk forms a potential model for other regions by showing how high quality biodiversity data can be used to provide an effective resource for decision makers. It also illustrates how data can be used to deliver the requirements of policy, such as the National Planning Policy Framework for England.

Alongside this, it shows that by involving additional contextual data, such as visitor surveys, effective tools can be produced.

Valuable lessons have been learned about stakeholder engagement and expectation management which could be applied in other regions.

Location	Main institution	Start date	End date
East Anglia, United Kingdom	Norfolk County Council	September 2017	Ongoing
http://www.nbis.org.uk/			

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Marche Region Ecological Network (REM) in the territorial and urban planning tools

Description

Implementation of the Marche Region Ecological Network (REM) in local spatial planning policies via a "downscaling" process.

Marche Region, under Regional Law 2/2013, approved the Regional Ecological Network and landscape protection, in order to: encourage the protection of biodiversity; to reduce the fragmentation of natural and semi-natural habitats; to increase the quality of the region and promote ecological functionality; and to contribute to the enhancement of the landscape. The presence of a regulatory framework to support environmental policies, aimed at greater knowledge, better accessibility, and usability of territorial information and environmental data between the different managing authorities (e.g. regions, provinces, municipalities, park authorities, mountain unions, and municipalities). This facilitated the identification of actions focused on economic and sustainable development, through the protection of biodiversity, ecological systems, and the strengthening of green infrastructure. The aim of the operation is the improvement of the local authority's policy instruments by the process of downscaling the REM from regional 1:50,000 scale, to the provincial and municipal levels, respecting and deepening the structure and objectives of the regional ecological network.

The information contained in the REM and in the regional and local environmental databases, are the first elements in the process of downscaling, and contribute greatly to improving the quality of the plans.

Location	Main institution	Start date	End date
Marche, Italy	Regione Marche	May 2013	Ongoing

http://www.regione.marche.it/Regione-Utile/Ambiente/Rete-Ecologica-Marche-REM

Resources needed

- The process of analysis and interpretation of the available mapping data, and the identification of potential areas of action, required the work of a technical team costing EUR 20,000.

Evidence of success

The experimental process of downscaling for the integration of content, objectives, and aims of the REM into the tools of territorial planning has been successfully adopted in territorial contexts including in five municipalities.

As an example, Porto St Elpidio officially adopted REM in a masterplan for the new municipal plan where natural values were included. The constituent elements of the ecological networks were identified and mapped on a scale of 1:10,000.

Difficulties encountered

- The lack of information is made even more serious by the fact that the information available, collected from different subjects, due to the lack of common standards, is often difficult to compare and cannot, as a whole, provide a complete picture of the biological systems.
- Lack of technical staff.

Potential for learning or transfer

The methodological approach to the identification of the constituent elements and management objectives of the REM at the various territorial scales are replicable, reproducible, and repeatable in any regional territorial context, and for different habitats and land uses (e.g. coastal, river, agriculture, settlements, etc.).

The Marche Regional Council issued approved guidelines for the implementation of the Ecological Network of the Marches, an important turning point for the improvement of the policy instrument to the provincial and municipal levels, while maintaining the structure of the network. This simplifies the task of local authorities, and facilitates coordination and integration between different local authorities with similar problems and programmes, for example mountain municipalities, coastal municipalities, etc.

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GOOD PRACTICE

Monitoring of agri-environment schemes in Wallonia: data management and sharing

Description

Biodiversity data from agri-environment scheme monitoring was made available for other purposes, such as EU biodiversity indicators and Habitat Directive reporting.

The EU funds many projects and policies to improve the environment and status of biodiversity in Member States, including through agri-environment schemes. To demonstrate the value of its agri-environment scheme, the not-for-profit association Natagriwal implemented monitoring actions. Beyond its initial purpose, data from this monitoring may also be used for other objectives, e.g. research projects, evaluation of Natura 2000 habitat conservation status, and implementation of EU biodiversity indicators. This however, implies that monitoring data can be easily transferred from one database to another.

Natagriwal's data is saved in a structured online database called BIOGEOnet.[33] Starting in 2015, other database managers with similar mandates were contacted in order to share data, and achieve the greatest value from it. The main challenge in this exercise was to establish a correlation and conformity in the metadata between the donor database (here, BIOGEOnet) and the receiving one. Data extraction was then performed in order that data could be directly imported into the receiving database.

Currently, Natagriwal is sharing data in a structured way with:

- Walloon Public Services – General Directorate of Agriculture, natural resources and Environment (DGO3), in order to achieve general monitoring of Wallonian biodiversity status, including Habitat Directive "Article 17" reporting
- Butterfly Conservation Europe, to support implementation of the "Grassland Butterfly Index", and other research projects
- GBIF, to make data available for decision makers

[33] https://www.biogeonet.ulg.ac.be
[34] https://www.gbif.org/occurrence/charts?country=BE
[35] https://www.researchgate.net/publication/310447552_The_European_Butterfly_Indicator_for_Grassland_species_1990-2015

Resources needed

This practice requires a trained database manager to be designated to the team, requiring approximately 25% of a full-time equivalent to be allocated.

Evidence of success

To date, 34,064 species' occurrence data have been transferred to GBIF[34] and to DGO3. Data have also been contributed to the European Butterfly Indicator for Grassland species, for the period 1990-2015.[35] Data from Natagriwal will also be included in the next Habitat Directive "Article 17" reporting, especially concerning grassland habitats and the Annex II species *Bromus grossus*.

Difficulties encountered

The main challenge was to achieve correspondence between metadata of the different databases.

Potential for learning or transfer

This practice emphasised two main issues:

- Biodiversity data are generally collected for a single purpose, but can potentially be used for multiple ones.
- Biodiversity data owners should save their data in well-structured databases, excluding Excel files and other local formats. This will assist any future potential data transfers.

Additionally, large data owners, such as administrations or national research centres, should promote such practices in smaller organisations and approaches also.

Location	Main institution	Start date	End date
Antwerp Province, Belgium	Natagriwal	June 2015	Ongoing
https://www.natagriwal.be/			

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Nature information system of the Basque Country

Description

Tool for the integration, consultation and analysis of information, which allows the reuse of data and the collaboration of people and entities.

It is a tool for the integration of available scientific and technical knowledge necessary for the proper development of public competencies in planning, management, monitoring and evaluation processes.

The information is organised in interconnected elements: species, habitats, sites, references, occurrences, indicators, institutions, and people of the network of knowledge.

The main principles on which the system is based are: open access and reuse culture, for making data sharing the norm; data standards, for ensuring data can be understood and used across systems and across disciplines (DwCA, Plinian Core); persistent storage in Basque Government servers; easy-to-use for anyone; and, recognition and acknowledgment of contributions.

Resources needed

- Approximately EUR 1 million was needed during the period 2006-2010 to establish the infrastructure and EUR 80,000/year over the period 2011-2016 to consolidate it. Since 2016, EUR 200,000-400,000/year has been invested to update information through public contracts, subsidies and investment programs and agreements.

Evidence of success

More than 950,000 occurrences, 3,600 references, 8,000 multimedia, 9,800 taxon, 1,000 collaborators records, and 50,000 visits to the website this year.

Difficulties encountered

We must make a more agile and collaborative tool and offer web services so that all the stakeholders involved feel a sense of ownership of the tool.

Potential for learning or transfer

The data model we use to integrate information from multiple sources, and that relates the different objects to legal protection frameworks and conservation objectives, can be exported to other regions, since we use international data and metadata standards.

Location	Main institution	Start date	End date
País Vasco, Spain	Basque Government	February 2006	Ongoing

http://www.euskadi.eus/natura

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Norfolk Biodiversity Information Service

Description

Norfolk Biodiversity Information Service (NBIS) is the Local Environmental Records Centre (LERC) for Norfolk. It acts as a "one stop shop" for biodiversity and other environmental data and information.

NBIS holds over 3.5 million species records, maps of habitats and protected sites, records of geodiversity, and other information. Accuracy of the information is ensured by working with a network of local experts – county recorders – who validate and verify records to ensure that they are fit-for-purpose.

NBIS provides data to a wide range of users, including government agencies, planning authorities, NGOs, consultants, developers and the public. Commercial users are charged for services used.

As well as delivering data locally, NBIS also publishes data to the National Biodiversity Network (NBN) Atlas, from where it is published to GBIF.

Most data is provided and verified by volunteers, and NBIS actively supports this network by providing funding, training and other services.

NBIS has been accredited by the Association of Local Environmental Records Centres (ALERC), recognising that it has met a specified set of criteria, ensuring high quality services to users.

NBIS led the development of the East of England standard service for commercial enquiries. This service operates across the six counties of East Anglia and their neighbouring counties. This specifies a minimum standard for content, quality, and speed of response to enquiries in the region. This was designed following consultation with customers.

Location	Main institution	Start date	End date
East Anglia, United Kingdom	Norfolk County Council	January 1972	Ongoing

http://www.nbis.org.uk/

Resources needed

- NBIS: approximately GBP 80,000/year to cover staff costs and other expenses.
- More importantly, an effective support network is needed. NBIS relies on the volunteers who provide the data that forms the basis of the service. This is dependent on the building of good relationships.

Evidence of success

NBIS continues to grow its resource of data and information, demonstrating that there is an effective network of data providers.

Commercial income is growing year on year.

Customer satisfaction is high, with many commenting on the speed and quality of responses to enquiries.

NBIS has taken part in a number of Defra (Department for Environment Food and Rural Affairs) funded studies, piloting new approaches to data gathering.

Potential for learning or transfer

NBIS can be a potential model for how to develop an effective central point for biodiversity data, either at a local or regional level.

Valuable lessons about building relationships and developing support networks can be transferred to other regions.

The use of a recognised accreditation system to demonstrate quality can act as a model for others.

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Of birds and high voltage overhead lines: how feedback from decision makers is helping data providers

Description

In Belgium, Elia (the national electricity transport system operator) takes biological information into account in their operations to reduce impacts on bird populations.

Elia is committed to reducing bird collisions with high voltage power lines. In total, Elia manages a network of 5,700 km of overhead power lines. Bird collision risk can be reduced by fitting special diverters on the cables. These diverters are able to increase visibility of the lines such that flying birds can detect and avoid them more easily. Diverters need to be placed on high risk sections of power line. To identify these black spots on the power lines, Elia uses biological information brought together by Natagora and Natuurpunt, two important nature conservancy associations. In order to prioritise the placement of diverters on the 5,700 km network, Natagora (in Wallonia) and Natuurpunt (in Flanders) mobilise bird distribution data through citizen science, with two complementary approaches. First, bird data collected by birdwatchers and submitted through a citizen science portal, are used to build high-resolution maps of bird density across Belgium. Specific attention is given to the bird species identified as being sensitive to power line collisions. Second, through mobilisation of observer networks and the use of different media, birdwatchers are encouraged to actively record the precise locations of bird casualties resulting from power line strikes, in the global biodiversity recording portal https://observation.org/.

Location	Main institution	Start date	End date
Antwerp Province, Belgium	Natagora	June 2016	Ongoing

http://www.aves.be/

Resources needed

- A data portal to manage bird recording, and a database structure able to mobilise large quantities of data.
- Bird experts from NGOs (for map production from raw data, field checks).
- Steering committee meetings between Elia and the nature NGOs.

Evidence of success

Good cooperation level between Elia, Natagora, and Natuurpunt.

Evidence of reducing of bird mortality with power lines in Belgium. At the moment there are few examples where mortality has been reduced. But in one example where large numbers of Black-Headed Gull (*Chroicocephalus ridibundus*) casualties were encountered (1-3 corpse/day), diverter placement helped to reduce the numbers to only a few individuals per year.

Difficulties encountered

Constructive interaction with decision makers, building common knowledge and understanding about the problem.

Potential for learning or transfer

The same methodology and data mobilisation approaches could be used with electricity companies in other countries.

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OpenBioMaps: sustainable data management platform for biodiversity research, conservation and education

Description

The OpenBioMaps (OBM) was founded in Hungary in 2011 to provide a technical solution for biodiversity-related data management in areas such as conservation (e.g. National Parks) and scientific research (e.g. universities and research institutes). Previously, there were no links between biodiversity data producers, curators and users, and there was no common platform to create bridges between conservation, science and education. Those requiring such platforms and infrastructure made their own biodiversity data management systems, at their own cost. Often, however, these were less able to be maintained. Therefore, some of the concerned institutions established a cooperation to create a biodiversity data management platform that included free services and free, open source software components.

This data platform is becoming increasingly popular in Hungary and other countries. Users are mostly researchers and conservation projects; including small projects where there is no material coverage for building and maintaining their own systems; and also large projects where there were no previous data management systems or there was a reliance on costly solutions.

Resources needed

- Approximately EUR 90,000 required in the period 2011-2019, to develop web applications, mobile applications, and set up servers. Running costs are now EUR 10,000/year to maintain error tracking and server operations.

Evidence of success

It used by six National Parks and around 20 research projects. Approximately 300 people use OBM-based tools in their everyday work. Additionally, new citizen science projects have started, taking advantage of the free OBM tools. New connections have also formed, creating a new community of biodiversity data producers, curators, and users.

Difficulties encountered

In the first few years, in the absence of central support and management, and a community of practitioners, the system was built very slowly. Without a central budget, there were no permanent developers, only volunteers who were able to be paid occasionally. However, this solution slows down some long-term developments.

Potential for learning or transfer

Thanks to the open source approach, and the flexible concept, this sustainable data management infrastructure is easily adaptable for use in other regions and countries.

Location	Main institution	Start date	End date
Hungary	OpenBioMaps Consortium	January 2011	Ongoing

http://openbiomaps.org

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The Biodiversity Audit Approach

Description

The Biodiversity Audit Approach provides an innovative, landscape-scale, evidence-based, integrated approach to strategic delivery of biodiversity conservation at the regional level.

A key element has been the development of an evidence-based approach to understanding the requirements of priority species and providing guidelines for their conservation. Ecological requirements of priority species for conservation have been collated, and synthesised, integrating numerous individual priority species, to produce management guidance for multi-species assemblages.

The approach:

- collates and examines available evidence to understand what species are present;
- objectively defines the suite of conservation priority species; and
- assesses the recent or current status of priority species.

A key objective of the approach is to provide land managers and conservation advisers with guidance on how to enhance and sustain important biodiversity. Effective management is best achieved by providing prescriptions based on sound evidence. The novel element of this approach is the identification of multi-species assemblages, and associated flagship invertebrate and plant species, requiring similar ecological processes and conditions ('guilds'). This has the aim of integrating prescriptions for multiple species into habitat-based approaches, but through an evidence-based approach that is rooted in an understanding of the requirements of individual species.

Resources needed

- Access to all available biodiversity data for the region being audited.
- Staff time to undertake analysis.
- Local expertise to identify conservation priorities and understand the collated data.

Evidence of success

Biodiversity audits undertaken in Norfolk have led to radical changes in the management of Natura 2000 sites, with resultant demonstrable gains for biodiversity.

For instance, the Breckland Biodiversity Audit showed that current site practices were failing to deliver effective management for the species identified by the audit as being regional specialists, including those found nowhere else in the UK.

Difficulties encountered

It is sometimes difficult to access all data needed. It is also often difficult to discover what data is available.

Potential for learning or transfer

The approach can be readily applied in other regions.

The concepts utilised around the development of an evidence-based approach to understanding the requirements of priority species, and providing guidelines for their conservation, can be applied to a number of questions raised by decision makers.

Location	Main institution	Start date	End date
East Anglia, United Kingdom	University of East Anglia	January 2009	Ongoing

https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/j.1365-2664.2012.02174.x

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The NBN Atlas

Description

The National Biodiversity Network (NBN) Atlas shares data aggregated from multiple sources and made available online, allowing users to interrogate species records and download distribution maps.

The NBN Trust promotes the sharing and use of biodiversity data, which is achieved through our digital data sharing infrastructure, the NBN Atlas. The previous infrastructure, the NBN Gateway, had limited functionality and was no longer fit-for-purpose. A replacement was needed to provide a stable platform for integration of species and ecosystem data, with environmental data layers, and an improved user interface. After reviewing the options, the NBN Trust decided to adopt the Atlas of Living Australia (ALA) infrastructure, as it provided much of the required functionality.

The core functionality of the NBN Atlas includes:

- the ability to display species and ecosystem data together
- interoperability with spatial and environmental layers
- uploading data via web services
- the ability to hold image libraries and bibliographies
- a powerful interactive mapping tool with multiple filters
- a spatial portal that allows detailed analysis and modelling of data

The NBN Atlas was developed using open source code developed by ALA, which has multiple implementations, delivering a range of products and services. The code has been adapted to include functionality required by the UK's biodiversity sector, and will continue to be adapted and upgraded in the future. The main stakeholders and beneficiaries are data providers and data users, including government agencies, wildlife and conservation NGOs, museums, academics, volunteer recorders, local environmental record centres, and members of the public.

Resources needed

- Implementing the ALA infrastructure with amendments cost GBP 250,000, further development will cost extra. Annual running costs are GBP 125,000. Servers to host the site and database are the largest cost. Staff resources required include a systems developer, data manager, support officer and project manager.

Evidence of success

The NBN Atlas currently holds over 220 million species occurrence records and approximately 100 spatial layers. There are over 4,000 registered users, and an average of 500 user-visits to the site each day.

Difficulties encountered

While the NBN Atlas is based on the ALA open source infrastructure, significant amendments had to be made to adapt the site to a UK audience. This has led to some issues when implementing updates from ALA. Detailed documentation of source code and amendments are essential.

Potential for learning or transfer

Key success factors for transfer and learning include:

- The NBN Atlas revolutionises the use of UK biodiversity data, enabling it to be shared, analysed and researched
- The NBN Atlas is an online tool that educates and informs people about the natural world
- The NBN Atlas holds data on marine and terrestrial species
- The NBN Atlas allows users to interrogate species records and download distribution maps
- The NBN Atlas makes UK biodiversity data compatible with other countries' biodiversity data, and allows users to compare and share data globally

Location	Main institution	Start date	End date
Derbyshire and Nottinghamshire, United Kingdom	National Biodiversity Network (NBN)	April 2015	Ongoing
http://www.nbnatlas.org/			

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Use of biodiversity data in decision-making: the SITxell Project

Description

GIS scheme based on scientific information to be used in land planning at different scales to ensure conservation of natural values and sustainable use of land.

The aim of the initiative is to foster a new territorial analysis and organisational strategy based on a multidisciplinary view of the territory, its potential and its fragilities, incorporating existing knowledge. Also to develop a cascade planning model (territorial organisation plans, master plans, town plans and management plans) based on a new concept and basic common information.

The SITxell project promotes the use of information related to territorial analysis (geology, hydrology, botany, zoology, ecology, socio-economics, agronomy, town planning) both from independent groups of experts (university research centres, private consultants social organisations, etc.) and inside the administration itself, for the socio-economic development compatible with the preservation of ecosystem services essential for the maintenance of human well-being. Nowadays, we are channelling these planning purposes through the implementation of green infrastructure at local and regional scales.

The ultimate aim is to transform this expert information into knowledge that can easily be applied to territorial analysis, planning and management, to be used by all competent public administrations. So, the application of a concept and common information at the different levels and areas of territorial organisation promotes governance through concurrent, agreed planning mechanisms, and substantially increases the effectiveness of public administration and the sustainable use of the territory.

Location	Main institution	Start date	End date
Catalonia, Spain	Barcelona Provincial Council	November 2003	Ongoing

http://www.sitxell.eu/en/default.asp

Resources needed

- Approximately EUR 2 million needed during the period 2003-2010 to acquire information through agreements with research centres. Subsequently, EUR 50,000/year needed to update information. One internal GIS expert in charge of the system.

Evidence of success

SITxell has been used in land planning in more than 100 municipalities. Recent plans have been used to define local green infrastructure. For protection purposes, it has been used in spatial plans for protected areas and for strategic plans (hydrology, agriculture). In regional planning, SITxell analysis has been the basis for the definition of areas of special protection. The SITxell website receives more than 50,000 visits/year, and thousands of downloads of data layers of information.

Difficulties encountered

The main difficulties were related to lack of basic information, and the existence of many different administrations involved in decision-making. We have learned that the combination of scientific information with strong political support are key for the success of the project.

Potential for learning or transfer

Because of its flexible, adaptable nature, the concept behind the project can be applied to any region, simply adapting it to the particular features and information available. This is why the SITxell initiative has been used as a reference for territorial analysis with direct application to planning throughout Europe. For this reason, the project has been presented at many seminars, congresses, and degree programmes in Europe, as well as at international organisations, such as IUCN. It was nominated as a finalist for the EPSA 2011 awards, and has won first prize of the United Nations 2012 awards in the category "Improving knowledge management".

SITxell has also been used as an example of good analysis and territorial planning practices by the European Union as part of the "Green Infrastructure" initiative (Interreg Project Greeninfranet).

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GOOD PRACTICE

Using different types of data for creating protected area conservation priorities

Description

During the designation of the Ljubljana Marsh Nature Park, three zones with different protection status were established to conserve its natural and cultural heritage.

The zonation was prepared by the Institute of Republic of Slovenia for Nature Conservation (IRSNC). IRSNC used data on birds' distribution and habitat mapping. These two expert studies were, at the time, the only available systematic surveys of the area, enabling rough determination of protection zones. For finer delineation, other available data sources were used (e.g. scientific papers, university theses, and other reports). These provided mainly geographically restricted data on butterflies, dragonflies, and plants. Finally, zonation borders were fine-tuned with land cadastre (i.e. land records and registry relating to real estate). The whole area of the Nature Park is now composed of three protection zones. Within the first (33% of the total area), valuable natural features, plant and animal species, and their habitats are protected, and adapted agricultural practices safeguarded. The second (19% of the total area) is important for nature conservation and protection of valuable natural features, biodiversity and landscape diversity, and sustainable forms of both agriculture and the use of other natural resources in a way that minimises environmental impact. The purpose of the third (48% of the area) is to conserve landscape diversity and promote sustainable development. The zonation provides a means for sustainable spatial planning and efficient nature conservation. The beneficiaries are local inhabitants, municipalities, NGOs, and government.

Resources needed

- All work, including communication, approximately 50% full-time equivalent staff over 2.5 years.

Evidence of success

For the first time, most of the relevant biodiversity data for this area was pulled together, on the grounds for the designation of the Nature Park, led by the competent ministry. The proposal was approved by municipalities and government. With a Decree (OG RS, 12/08), the Park was founded in 2008. Intensive communication made nature conservationists a recognisable stakeholder in this area. The adopted protection status successfully regulates construction, interventions, and most activities within the Park.

Difficulties encountered

The protection status, established on the basis of existing biodiversity data, cannot fully assure that suitable agricultural practice will be used by farmers.

Potential for learning or transfer

Within the Natura 2000 Network, biodiversity data for the management of protected areas are mostly gathered for Natura species and habitats. These are usually provided in standard digital formats. However, in the case of data needs for prioritisation of protected zones, additional sources of biodiversity information, besides governmental databases, such as research or NGO data on rare or endemic species, or non-Natura species in general, can provide high quality information in high spatial or temporal resolution. Although use of such data requires some processing, these data should be included into the process in order to provide relevant outputs.

Location	Main institution	Start date	End date
Zahodna Slovenija, Slovenia	Institute of Republic of Slovenia for Nature Conservation	April 2006	Ongoing

http://www.ljubljanskobarje.si/en/nature-park-designation/history

6.2 Annex 2: Contributors

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