Taxonomy of Digital Preservation:

A Study of Digital Biodiversity & Ecological Collections

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Abstract

This paper covers the metadata standards, digital curation practices, and data organization approaches of three major biodiversity-focused digital libraries in the U.S.: the Biodiversity Heritage Library, the American Museum of Natural History, and the U.S. Fish and Wildlife Service Digital Library System. A key finding shows that these libraries primarily organize their records by using general metadata standards such as Dublin Core (DC) and MODS, rather than ecology-focused standards like Darwin Core (DwC), which help organize and link records within their taxonomic and environmental contexts. This study also shows that when libraries opt for general over specialized metadata standards, important ecological data becomes difficult to share across global biodiversity research networks and tends to remain isolated within individual institutions. To improve interoperability and discoverability, the findings of this research suggest that the digital libraries in this study (and similar collections), could benefit by adopting DwC metadata standards or by switching to a hybrid integration model that combines DC and DwC. Overall, this study is relevant for the following reasons: biodiversity loss and climate change are real threats, the web of life remains incomplete, and library collections play a role in preserving important ecological data that can help support global conservation efforts.

Keywords: Artificial Intelligence, Biodiversity, Climate Change, Data Curation, Darwin Core (DwC), Digital Libraries, Digital Preservation, Dublin Core (DC), Ecological Data, Endangered Species, Interoperability, Metadata Standards, Natural History, Taxonomy

Introduction

While the precise number of total species remains an ongoing effort to catalog, evolutionary models by Larsen et al. (2017) estimate that Earth is home to between 1 and 6 billion species, which includes not just animals, but also bacteria that make up 70%-90% of the total number of species. Current estimated figures of total species cover 86% of terrestrial and 91% of marine species that lack formal scientific descriptions and identification data (Hald-Mortensen, 2025, p. 6). Despite the lack of complete descriptive and identification data, there are taxonomic efforts to increase the number of formally cataloged species to approximately 2.3 million, which is a figure derived from taxonomists and compiled by the *Catalogue of Life* (COL) index of species (Bánki et al., 2025); and although the COL strives to be the authoritative index for tracking species on earth by compiling data from over 20,000 global datasets from peer-reviewed sources (Catalogue of Life, 2026n.d.), there still remains an impeded effort and major challenge to find datasets that are appropriately curated and discoverable.

Overcoming this data bottleneck is critical today because, as Wieczorek et al. (2012) notes, "concern over global loss of biodiversity has resulted in widespread demand for quick, reliable access to high-quality data on the spatio-temporal occurrence of species and their relation to the environment" (p.1). As technology advances, there is an expectation by scientists, researchers, educators, and librarians that all valuable data is accessible through digital platforms—and digital libraries/archives play a pivotal role in providing ease of access to ecological data. Because of this demand, the focus of this research will be on ecological data collections of digital libraries and archives across the U.S. rather than the entire world, but the knowledge of how environmental data is curated and cataloged in other parts of the world could be worth exploring, especially if such data helps examine the methods used to organize ecological data in digital archives.

This research is crucial, since 49,600 known species on Earth are endangered of becoming extinct (IUCN Red List, 2026)—and scientists estimate that we are currently witnessing the sixth mass extinction of the Anthropocene epoch (Cowie et al., 2022; Hald-Mortensen, 2025). Access to ecological data is more critical now than ever, as the Earth faces pollution, climate change, and the destruction and exploitation of natural habitats that leave various species with no place to thrive or survive. The future of all living species on Earth is shaped by how humans interact with the natural world, including observations of ecological data that indicate how environmental shifts influence speciation and extinction rates. Librarians can directly support global conservation efforts, since some library collections play a key role in preserving and curating ecological data, as well as making sure that data is also discoverable and accessible to everyone.

Scope

Three digital libraries will be analyzed for their digital curation techniques, methods of organizing collected data, data creation practices, and methods of data management. These three digital archives are the *Biodiversity Heritage Library,* the *American Museum of Natural History*, and the *U.S. Fish and Wildlife Digital Library System*. The digital libraries that have been selected were chosen because all three encompass substantial and impressive digital collections with access to ecological data. Since the focus is on ecology and biodiversity rather than other fields of study, such as paleontology or a generalized emphasis on natural history, some of the digital libraries within these organizations will not be included in this research. For example, the *American Museum of Natural History* is a vast institution providing information for many digital libraries and digital museums incorporating multiple areas of natural history. Still, for the sake of focusing on ecology alone, this research will only emphasize AMNH's *Research Library Digital Repository.*

It is also important to refer to the *Catalogue of Life* (COL), which is a global comprehensive index that pulls from multiple peer reviewed sources. The COL attempts to compile and track taxonomic data with an emphasis on the discoverability of all species on Earth. However, this emphasis differs from the focus of this paper, which is digital libraries that preserve biodiversity information through indirect taxonomy, while providing open access to data with the potential to highlight environmental changes and biodiversity decline.

Literature *Review*

Data curation and conservation have a lot in common with ecology, including the established scientific methods of taxonomical classification for ecological and non-ecological data (Choudhury, S., 2010). Biological taxonomy is "the science of naming, describing, and classifying organisms and includes all plants, animals, and microorganisms of the world" (Convention of Biological Diversity, 2010). Comparable to biological taxonomy, there is a taxonomy of digital curation that also names, describes, and classifies various object files (including documents, images, videos, sounds, and embedded collections of text) for dynamic and evolving data organization—a process not to be confused with the digital preservation, which focuses on passive, long-term protection of files through a data lifecycle model—much like the circle of life and the taxonomical trees of life for all single and multicellular organisms. The taxonomy of digital preservation includes the evolution of data from its simplest form to ever more complex and interconnected structures, with systems of metadata standards to the eventual departure of outdated, obsolete, or no longer valuable data. Data curation is also comparable to the conservation of nature and wildlife, which includes a shared determination to protect, preserve, and maintain data while establishing an archive of all information available to be accessed via a digital library.

Preservation of nature and wildlife is important work, but it is also critical that natural history libraries maintain and preserve taxonomic information for current and future access (Pilsk et al., 2010, p.139). Librarians and Digital Curators can learn a lot from ecological and taxonomic methods of general data curation by analyzing ecological data with a purely environmental lens, or in this case, metadata standards.

Most librarians are aware of Dublin Core (DC) metadata standards, but in biodiversity studies, it is Darwin Core (DwC) metadata standards that many who deal with such ecological data utilize for digital curation purposes. DwC metadata standard "was originally conceived to facilitate the discovery, retrieval, and integration of information about modern biological specimens, their spatiotemporal occurrence, and their supporting evidence housed in collections (physical and digital)" (Burke, 2011, p. 9)—hence DwC and DC serve the same purpose, and that is to make digital information easier to discover and access via retrieval systems.

While DwC shares a common ancestor with DC, DwC has evolved from the general metadata elements of DC to include hundreds of specific ecological and taxonomic metadata terms not found in DC—and in order to organize this massive vocabulary, DwC expanded from the fifteen metadata elements of DC (DCMI Usage Board, 2012) into a highly structured model organized into broad categories (or classes). According to the foundational architecture of Darwin Core, the standard started off originally with nine classes. Six of these classes "cover broad aspects (event, location, geological context, occurrence, taxon, and identification) of the biodiversity domain" and the remaining categories cover "relationships to other resources, measurements, and generic information about records" (Wieczorek et al., 2012, p. 2). The evolution from DC to DwC continues to expand today with newly added classes like MaterialEntity, MaterialSample, MaterialCitation, and Organism, to which these changes had to occur so that biologists and other ecological researchers could start creating digital libraries that focus specifically on taxonomy and the biodiversity of species (Darwin Core Maintenance Group, 2026).

The fundamental purposes of Dublin Core (DC) and Darwin Core (DwC) share similar DNA, since both standards align with the FAIR data principles, which is one of the ways the data becomes findable and useable, as well as optimized for both human access and machine readability (Ostermann et al., 2025, p. 30). To make effective use of biodiversity data for broad-scale analyses, Wieczorek et al. (2012) emphasize that "information must be in digital form, accessible, discoverable, and integrated" (p.1). While DC is heavily utilized for general networked electronic information and document-type resources, its limitations become apparent when faced with specific scientific needs. To enrich the range of environmental research, DwC provides a flexible framework that plays a fundamental role in the sharing of open-access biodiversity data (Wieczorek et al., 2012).

Because both DC and DwC share this metadata DNA, utilizing metadata interoperability allows different systems to exchange descriptive data that is consistent with the interpretation of the original creator. For example, the Institute of Marine Sciences (ISMAR-CNR) of Venice created a thriving digital herbarium repository, the Archivio di Studi Adriatici (ASA), by integrating DC and DwC standards "to create a metadata set that would be important to biologists and librarians" (Minicante et al., 2017, p. 116). Given the clear advantages of such integration found in ASA, it is valuable to examine how other major repositories currently manage their ecological data.

Methodology

The methodology will focus on three digital libraries and their policies, copyright issues, software platforms, content management systems, and metadata standards. Each of these libraries exhibit both shared and distinct components that are present and visible through their archival methodologies. This study will examine how various ecological data are available for biodiversity research and classified for general scientific research. All three digital libraries will be discussed individually to emphasize the specific attributes of each digital library. The major intersecting and contrasting features will be presented in the results and findings section.

Biodiversity Heritage Library

The *Biodiversity Heritage Library* (BHL) is one of the largest digital libraries that provides open access to a vast volume of historical and present-day biodiversity literature and other biodiversity resources. Since 2006, when BHL was founded, it has served as a standard for taxonomic and biodiversity research endeavors and digital archive models. BHL continues to model their mission as an "ongoing collaboration, technical innovation, and an enduring commitment to open access" and "to advance global research and ensure that everyone, everywhere has access to the knowledge needed to study, explore, and conserve life on Earth " (Biodiversity Heritage Library, n.d.-a). The open-access nature of BHL means that the library maintains a strong emphasis on copyright standards that allow content to exist in its collection that "is freely and openly available for access and responsible reuse either under the public domain or a Creative Commons license" (Biodiversity Heritage Library, n.d.-c). BHL proposes ensuring minimum hindrances to using their information so that the user never has to experience copyright disputes. BHL created their policies to be dynamic and support open access, open data, and open science (Biodiversity Heritage Library, n.d.-b). BHL policies reflect an organization that strives to engage users and provide relevant content and research tools. The preservation of content that BHL provides is only possible due to others sharing biodiversity information with BHL.

The technical architecture of BHL incorporates several technologies that both support and strengthen biodiversity research. One such technology worth mentioning is the *GNfinder* taxonomic intelligence tool created by *Global Names Architecture*. The GNfinder helps "to locate, verify, and record scientific names within the text of each digitized page"—but it does this with one small caveat, to which BHL acknowledges that the text within the documents is "uncorrected OCR" and "may not include all results expected or visible in the page" (Biodiversity Heritage Library, n.d.-e). The GNfinder is embedded in documents and resources in the BHL library and can be accessed by clicking the DNA strand icon for taxonomic names. Once the DNA link is clicked, a pop-up window appears with a list of data sources with taxonomic names, and then when the taxonomic name is clicked, it shows a taxonomic data source that is linked to over 200 data sources, including the *Catalogue of Life (COL)*, *Integrated Taxonomic Information System* (ITIS), and the *IUCN Red List* (Global Names Verifier, n.d.).

Additionally, the BHL digital library also arranges its data with Metadata Object Description Schema (MODS), BibTeX, and Research Information Systems (RIS) metadata, publishing its records via the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) (Biodiversity Heritage Library, n.d.-d). Through downloadable metadata and MODS-embedded XML, BHL supports interoperability and data that is accessible and machine-readable. Nevertheless, BHL's metadata framework relies heavily on general standards rather than specific biodiversity schema such as DwC.

American Museum of Natural History

The *American Museum of Natural History* (AMNH) is a historic institution that was founded in 1869, and ever since then, it has established a mission to "discover, interpret, and disseminate—through scientific research and education—knowledge about human cultures, the natural world, and the universe" (American Museum of Natural History, n.d.). AMNH is primarily a physical museum, although it includes numerous digital libraries and online resources that include subjects ranging from paleontology to vertebrate zoology, earth and planetary sciences, and astrophysics. Nevertheless, AMNH also has the *Research Library Digital Repository*, which will be the focus of this study.

Unlike the BHL, AMNH does not openly reveal any information about its digital preservation policies or technical infrastructure. However, by exploring the *Research Library Digital Repository,* one can partially infer technical methodologies by looking at the bottom of the webpage, where it mentions that DSpace powers the repository. The digital repository uses DSpace because it provides a free, open-source repository application that enables AMNH to "capture, store, index, preserve and distribute" their digital resources (Lyrasis, 2011). DSpace also utilizes Dublin Core metadata with support for METS, MODS, and supplementary custom Qualified Dublin Core (QDC) schemas (Morgan & Eichenlaub, 2017). Although DSpace does not come with DwC metadata, it is possible to add DwC to the DSpace registry since DwC is a QDC and XML-compatible metadata schema. By viewing the full item page of records, one can see that AMNH is utilizing the default DC metadata standards.

Like BHL, AMNH ensures its collections are highly accessible by supporting OAI-

PMH. A major advantage of AMNH utilizing the DSpace platform is its integration abilities with other sharing standards such as OAI-ORE, OAI-PMH, SWORD, LNI, SQL, and SOLR (Lyrasis, 2012). AMNH benefits significantly from fully customizable metadata and search functions. AMNH does include information about the copyright usage of their resources, so it is the case that all of the resources that AMNH has in their repository fall under their *End User Agreement*, which all third-party users or organizations have to agree to the terms of the license and use strictly for personal, non-commercial purposes (American Museum of Natural History, 2022).

U.S. Fish and Wildlife Digital Library System

The *U.S. Fish and Wildlife Service* (FWS) is a federal bureau within the *Department of the Interior of the United States* that has existed since 1871, and ever since then, it has helped enforce federal wildlife laws and conservation efforts, as well as provide open access to a digital library (U.S. Fish and Wildlife Service, n.d.-a). According to FWS, their digital library provides "central access to Service digital resources, including collections curated by USFWS staff, topical categories to browse, and resources to aid information discovery," and the resources that are not located in the public domain are intended for private use (U.S. Fish and Wildlife Service, n.d.-b). The FWS also includes the *USFWS Conservation Library*, which is a place where mostly physical content is stored, and according to the *Conservation Library* page, the digital component enriches the physical library by offering thousands of public domain images documenting species, natural habitats, and the agency's conservation activities (U.S. Fish and Wildlife Service, n.d.-c). All the content found on the digital library exists in the public domain; therefore, there are no copyright restraints on the content.

FWS does not openly include any information about its digital preservation policies or technical infrastructure, but the content management system (CMS) that FWS uses can be inferred by visiting *Drupal's* organization partnerships webpage, where the site lists FWS as a member and user of *Drupal* (n.d.). FWS recently switched and migrated all their digital legacy content from an older CONTENTdm platform to the new *Drupal* page, but FWS does not disclose any official announcements that mention the system side of their new digital library interface. FWS's current webpage is integrated with all other digital content into a centralized and searchable collection of public domain assets, which is why it is now referred to as the digital library portal—and since the technical details are hidden, it is unclear what metadata elements FWS is using in their database.

FWS provides access to a *Find a Species* and *Explore Taxonomic Tree* feature that allows the user to do detailed searches of Taxonomic Trees as well as use filters to narrow search results of species based on scientific and common names. Each results page presents basic data like the scientific name, common name, kingdom, and location in the taxonomic tree, with expanded filters to narrow down by genus or species within the taxonomic tree. Some results include a geographic map that shows the location where a species was spotted by FWS researchers, but the results do not include additional data like dates of entry or any other metadata; each data entry of a species includes a *Taxonomic Serial Number* (TSN) that is linked to the *Integrated Taxonomic Information System* (ITIS).

While the data provided by FWS's species search engine is limited to names, kingdoms, taxonomic tree, and geographical data that is not included on all records, it is searchable and links to ITIS, and through ITIS, that data becomes harvestable through many database formats, most importantly through DwC. ITIS can be linked by any digital library as long as it is tying taxonomic data with a TSN number, but it is important to differentiate that while ITIS is not a digital library that includes pictures, audio, or descriptive ecological or historical information, it does include raw data records of mapped taxonomic hierarchies, taxonomic status, data quality indicators, geographic information, and references that include links to points of entry from researchers around the world, not just in the US. The kind of data mapping that ITIS provides is not only accessible and easily downloadable into DwC but includes important data that is helpful to researchers across the world.

Results and Findings

My review of these three digital libraries suggests that ecological and biodiversity repositories, archives, and digital collections did not routinely utilize DwC metadata standards, even though DwC was created specifically for biodiversity exploration. Another finding showed a nuanced use of DwC implementation; on the one hand, it was clear that both AMNH and DWS utilized DC for their primary repositories, yet BHL and DWS showed an indirect pathway to DwC by incorporating ITIS into their expanded speciation search functions, which also allows the information that BHL and DWS provides in their digital collections to be globally harvested via DwC frameworks.

In contrast to a collective reliance on either standard DC or indirect DwC linkages, BHL assembles its data primarily using bibliographic formats such as MODS, BibTex, and

RIS metadata, and both BHL and AMNH publish their data via OAI-PMH. All three digital libraries provide information on their copyright policies to share and upload resources, and all three libraries also include a mission to offer ecological data for biodiversity research, preservation, and conservation of the United States wildlife. The type of resources provided by all three digital libraries includes both historic and new information that serve as publicly available resources for easy access and findability while on the site. However, due to the lack of linkages between systems, this information exists in silos of harvested data.

Implications

All three libraries would benefit from additional DwC metadata for their diverse collection of biodiversity resources, which is either excluded completely or only supported as a raw data download feature provided by ITIS; and the lack of DwC metadata in the three digital libraries creates a deficiency that impedes biodiversity information access—specifically, it prevents the widespread adoption of centralized standards and connectivity, which leads to vital ecological data that is isolated and disconnected, rather than centralized or integrated into an interconnected global network. At the same time, libraries like BHL have successfully relied on generalized metadata standards and taxonomic information embedded in generalized metadata elements, allowing taxonomic information to be searchable. General metadata standards like DC and MODS suffice for broad-spectrum ecological data sharing. This general metadata, however, only allows for a surface-level description of essential components of the digital resources (for example, resource type, copyright, title, and general description).

To move beyond surface-level descriptions and enhance interoperability, US digital libraries can look for two successful models of integration. The first model of integration involves direct assimilation of both DC and DwC, which is what the *Institute of Marine Sciences* (ISMAR-CNR) *of Venice* has created in their digital herbarium repository, the *Archivio di Studi Adriatici* (ASA). The second model of integration is revealed through external linkages, such as the supplementation of data in the FWS collection by linking to ITIS via TSN, and the use of GNfinder that connects the BHL collection to over 200 data sources, including ITIS. Digital libraries that utilize this second model demonstrate that it is possible to contribute to global data sharing by leveraging existing DC frameworks and linking taxonomic data to databases that are already harvestable via DwC.

Global data sharing has always been complicated due to all the moving and evolving components of the various metadata schemes, and some might see it tempting to solve this dilemma by choosing the easy way out by using Artificial Intelligence (AI) to automate curation and bridge global data sharing gaps by automatically piecing together unorganized and surface-level data. However, this easy way out would not suffice, since automated intelligence tools already struggle without structured frameworks; for instance, the GNfinder tool used by BHL relies on an OCR feature that can potentially create flawed text and present incorrect results. Data that is amorphous due to machine readability errors is going to introduce entropy into AI algorithms that are trying to make sense of the datasets. Current AI technology is unable to compose new knowledge out of unstructured data—and it also is unable to accurately interpret relationships between objects that do not already have reliable metadata. AI algorithms are blind to the original intentions of created data and information outside of its original programming, which means that true interoperability and accurate exchange of data between systems is inaccessible through AI.

Use of AI also has negative environmental implications and contributes to an immense carbon footprint by relying on a vast amount of energy produced by data centers that constantly compute and guess the relationships between millions of unorganized records. The use of AI is not sustainable, and if humans continue to rely on energy-intensive algorithms rather than actively transitioning to precise taxonomic frameworks like DwC or ITIS TSN linkages, we not only increase our computational pollution and add fuel to the fire of climate change, but we also cripple our ability to track the phenology of ecological data.

Conclusion

Although DwC metadata standards play a role in natural sciences, biodiversity research, and raw data keeping, it is uncertain whether DwC also serves a purpose for the typical use of ecological data in digital archives with amateur nature enthusiasts or non-scientists in mind. However, it is undoubtedly the case that general metadata like DC and MODS continue to thrive in most digital library contexts, even in libraries that include non-generalized topics such as ecology and biodiversity. As noted, the three biodiversity and ecology-focused digital libraries still lack the practical applications of DwC—but at the same time, it is promising to see that these same digital libraries are share a collective mission to preserve and conserve ecological data for future use and accessibility, which will only remain accessible as long as these digital libraries continue to garner support through both scientific endeavors as well as monetary funding to remain operable.

Establishing a true digital representation of the ecological web of life is not out of reach and could very well become a future reality if more libraries and biodiversity research institutions began to use DwC to link their biodiversity data across different institutions, especially those that are already using DC. Unifying metadata standards across multiple institutions has always been a challenge for libraries, since metadata is constantly evolving as libraries adapt to local contextual shifts that affect information storage and discoverability. Yet, with an increasing number of institutions either already using DC or migrating to its use, only a small evolutionary leap would be required to transition to DwC.

References

American Museum of Natural History. (2022, January 1). *End user agreement*. https://digitallibrary.amnh.org/info/end-user-agreement

American Museum of Natural History. (n.d.). *About the museum*. https://www.amnh.org/about/mission-statement

Bánki, O., Roskov, Y., Döring, M., Ower, G., Hernández Robles, D. R., Plata Corredor, C. A., Stjernegaard Jeppesen, T., Örn, A., Pape, T., Hobern, D., Garnett, S., Little, H., DeWalt, R. E., Miller, J., & Orrell, T. (2025). *Catalogue of Life (Annual Checklist 2025)*. Catalogue of Life Foundation. https://doi.org/10.48580/dgr6n

Biodiversity Heritage Library. (n.d.-a). *About the biodiversity heritage library*. https://about.biodiversitylibrary.org/

Biodiversity Heritage Library. (n.d.-b). *BHL strategic plan 2020-2026*. https://about.biodiversitylibrary.org/about/strategic-plan/#BHLstratplan

Biodiversity Heritage Library. (n.d.-c). *Copyright and reuse*. https://about.biodiversitylibrary.org/help/copyright-and-reuse/

Biodiversity Heritage Library. (n.d.-d). *Developer and data tools*. https://about.biodiversitylibrary.org/tools-and-services/developer-and-data-tools/

Biodiversity Heritage Library. (n.d.-e). *How can I view the taxonomic data sources for names found on a BHL page?* https://about.biodiversitylibrary.org/ufaqs/taxonomic-data-sources-for-names/

Burke, S. (2011). A survey of biodiversity metadata standards. *PNLA Quarterly*, *75*(2), 5-13.

Catalogue of Life. (2026n.d.). *Data sources*. https://www.catalogueoflife.org/data/sources

Choudhury, S. (2010). Data curation: An ecological perspective. *College & Research Libraries News*, *71*(4), 194–196. doi:https://doi.org/10.5860/crln.71.4.8354

Convention on Biological Diversity. (2010). *What is taxonomy?* https://www.cbd.int/gti/taxonomy.shtml

Cowie, R. H., Bouchet, P., & Fontaine, B. (2022). The sixth mass extinction: Fact, fiction or speculation? *Biological Reviews of the Cambridge Philosophical Society*, *97*(2), 640–663. https://doi.org/10.1111/brv.12816

Darwin Core Maintenance Group. (2026, May 26). *Darwin Core list of terms*. Biodiversity Information Standards (TDWG). https://dwc.tdwg.org/list/

DCMI Usage Board. (2012, June 14). *Dublin Core™ metadata element set, version 1.1: Reference description*. Dublin Core. https://www.dublincore.org/specifications/dublin-core/dces/

Drupal. (n.d.). *U.S. Fish and Wildlife Service*. Drupal. https://www.drupal.org/us-fish-and-wildlife-service

Global Names Verifier. (n.d.). *Data sources*. https://verifier.globalnames.org/data_sources

Hald-Mortensen, C. (2025). Applying the Rumsfeld matrix to biodiversity loss: A brief review. *Journal of Ecology & Natural Resources*, *9*(1), 1-13. https://doi.org/10.23880/jenr-16000411

International Union for Conservation of Nature. (2026). *The IUCN Red List of Threatened Species*. https://www.iucnredlist.org/

Larsen, B. B., Miller, E. C., Rhodes, M. K., & Wiens, J. J. (2017). Inordinate fondness multiplied and redistributed: The number of species on earth and the new pie of life. *The Quarterly Review of Biology*, *92*(3), 229–265. https://doi.org/10.1086/693564

Lyrasis. (2011, December 2). *What is DSpace? Lyrasis Wiki*. https://wiki.lyrasis.org/pages/viewpage.action?pageId=25467341

Lyrasis. (2012, August 13). *DSpace Mashups Lyrasis Wiki*. https://wiki.lyrasis.org/spaces/DSPACE/pages/32478498/DSpace+Mashups

Minicante, S. A., Birello, G., Sigovini, M., Minuzzo, T., Perin, A., & Ceregato, A. (2017). Building a natural and cultural heritage repository for the storage and dissemination of knowledge: the Algarium veneticum and the Archivio di Studi Adriatici case study. *Journal of Library Metadata*, *17*(2), 111-125. https://doi.org/10.1080/19386389.2017.1355165

Morgan, M., & Eichenlaub, N. (2017). Digital asset management systems: Open source or not open source? *Proceedings of the International Conference on Dublin Core and Metadata Applications*. https://doi.org/10.23106/dcmi.952137617

Ostermann, F., Willemen, L., Paspaldzhiev, I., Pavlova, D., & Georgiev, M. (2025). *Guide on best practices sharing biodiversity data for private companies* (Biodiversa+ Deliverable D2.22). Biodiversa+. https://www.biodiversa.eu/wp-content/uploads/2025/10/Biodiversa_D2.22_Business-guide-data-sharing_2.pdf

Pilsk, S., Person, M., Deveer, J., Furfey, J., & Kalfatovic, M. (2010). The Biodiversity Heritage Library: Advancing metadata practices in a collaborative digital library. *Journal of Library Metadata*, *10*(2/3), 136–155. https://doi.org/10.1080/19386389.2010.506400

U.S. Fish and Wildlife Service. (n.d.-a). *About us*. https://www.fws.gov/about-us

U.S. Fish and Wildlife Service. (n.d.-b). *FWS library*. https://www.fws.gov/library

U.S. Fish and Wildlife Service. (n.d.-c). *USFWS Conservation Library*. https://www.fws.gov/program/national-conservation-training-center/usfws-conservation-library

Wieczorek, J., Bloom, D., Guralnick, R., Blum, S., Döring, M., De Giovanni, R., Robertson, T., & Vieglais, D. (2012). Darwin Core: An evolving community-developed biodiversity data standard. *PLoS ONE*, *7*(1), e29715. https://doi.org/10.1371/journal.pone.0029715