DRAFT

IUCN SPECIES SURVIVAL COMMISION POSITION STATEMENT ON THE ROLE OF NATURAL HISTORY MUSEUMS, HERBARIA, AND SCIENTIFIC COLLECTIONS IN BIODIVERSITY CONSERVATION

1 The IUCN Species Survival Commission (SSC) recognises the crucial role of Natural History Museums (including Herbaria and Scientific Collections), hereafter referred to as the Natural History Museum Collections (NHMCs), in discovering, documenting, studying, and, with their action of documenting the history and knowledge of our planet, preserving its biodiversity. This aim is achieved mainly through the constitution, implementation, management and analysis of the collections that they care for, which include various kinds of voucher specimens (preserved organisms with data used as reference material), represented by dried, pressed, stuffed and preserved botanical, fungal and zoological materials, as well as human artefacts, photographs and digital media, acoustic recordings, tissue and genetic samples, among others, each of which helps to paint a detailed picture of our past and provides useful evidence for understanding the present and preparing for the future of biodiversity (Rocha et al., 2014; Poo et al., 2022; Nachman et al., 2023).

2 NHMCs are also critical in promoting and developing taxonomy, a scientific discipline that is crucial to recognizing and describing new species and assessing their relationships in the tree of life. By doing so, taxonomy provides not only other scientific disciplines but also society as a whole with a universal, sustainable, and unambiguous communication system about biodiversity. (Bradley Shaffer et al., 1998; Thompson et al., 2021; Johnson et al., 2023; Miralles et al., 2024; Gippoliti et al., 2024). To date, only about two million species have been described out of an estimated 8-9 million species of animals, fungi and plants living on the planet (Mora et al., 2011; Wiens, 2023), although there are studies that suggest the diversity is higher, from 563 million to 2.2 billion cryptic species (Li & Wiens, 2023). The description of new species is crucial to biodiversity conservation since formally named and described species are assessed for the “IUCN Red List of Threatened Species” or are entered into international or national conservation legislation, while those that are undescribed or unrecognized taxonomic concepts cannot be subject to targeted conservation action and may go extinct before acknowledged by science (Costello et al., 2013). Effective assessment and monitoring of ecosystems requires complete knowledge of their components, including their characteristic native biota (IUCN, 2016).

3 SSC also values the pivotal position of NHMC standing at the intersection between research, education, awareness and scientific documentation, recognising NHMCs as indispensable places where investigations are conducted, taxonomists are trained and reference specimens used for the description (type specimens) and revisions of species boundaries are housed (Hilton et al., 2021). SSC encourages its conservation partners, including government agencies, to collaborate and support NHMCs in a global collective endeavour of discovery, description, documentation, and preservation of species as well as their natural habitats. The work carried on in NHMCs should be integrated into regional, national, and global biodiversity conservation strategies to become a foundational part and partner in conservation planning. The scientific discovery of new elements of living organisms, not only their description, understanding, and dissemination of these elements, must be integrated into national and international policy tools for conservation.

RATIONALE

4 Natural History Museums - including Herbaria, Fungaria, and Scientific Collections (NHMCs) are institutions where global diversity and associated data are studied and valued, new species are constantly discovered and described with integrative methods, and knowledge of biodiversity and its inter-relationships is refined. Furthermore, NHMCs are also cherished as popular places of education where naturalists may meet and discuss, and where global diversity is shared with the public in a high-quality setting (Bakker et al., 2020). The study of voucher specimens (of animals, fungi, and plants) held in scientific collections also highlights the importance of these collections in the understanding of evolutionary and biogeographical phenomena, more so with the immense anthropogenic changes now taking place on Earth (Ball et al. 2025). Voucher specimens are essential in making taxonomy and biodiversity science in general reproducible, ensuring long-term scientific integrity. Indeed, the continuous surveying and documentation of biodiversity is one of the major tasks of NHMCs.

5 The increase, study, and long-term preservation of natural history collections play an important role in the documentation and conservation of natural diversity at a planetary scale. NHMCs are libraries of the natural world and must be made available to the public and cultural and scientific researchers. Furthermore, the research departments of NHMCs are usually studying the evolution, ecology, and conservation of species and maintain large digital biodiversity data collections (Ball et al., 2025). In particular, the IUCN Species Survival Commission (SSC) recognises that NHMCs, through their activities and initiatives, are strong partners in the conservation of species and ecosystems, particularly because they are repositories for the natural world. Through the preserved specimens and associated materials/information (biological, physical, and historical), they provide humanity's main verifiable record of past and present biodiversity, and thus the baselines against which current trends in biodiversity can be compared and inferred.

6 In alignment with IUCN's policy on the sustainable use of animals, fungi and plants, SSC supports the rational collection of specimen vouchers and the realisation of scientific collections as useful tools for documenting biodiversity change, paths to extinction, pathologies and pollution, and as a basis for taxonomic studies (Rocha et al., 2014). Unfortunately, in many countries, NHMCs, as biodiversity research in general, are today facing serious shortfalls in human and financial resources (Rodriguez et al., 2022). Some countries, including some of the richest biologically, lack local expertise and suitable infrastructure for repositories for voucher preservation or research (Andreone et al., 2022; Ball et al., 2025).

7 The taxonomic activity carried out through the analysis of natural history collections is also crucial for reducing the so-called discovery and description gap (Loebl et al., 2023), allowing us to describe species new to science. Furthermore, NHMCs provide support to SSC and others in assessing the status of the world's biodiversity for the "IUCN Red List of Threatened Species". Biodiversity knowledge is largely dependent on NHMC records, and with the possible exception of a limited number of taxa within well-known groups of vertebrates (e.g., birds, mammals, and reptiles), which have reasonably robust data sets, the majority of the estimated 8-9 million species on Earth do not. Many species (certainly for most invertebrates) now included in IUCN and related conservation portals are invariably listed as "data deficient".

8 The botanical, fungal and zoological series collected at various times in different geographical regions, are crucial tools in investigating the causes of biodiversity decline, including climate change, overexploitation, invasive species, pollution and other anthropogenic impacts, as well as in investigating the spread of emerging diseases, including zoonoses (Colella et al., 2021; Thompson et al., 2021). Thanks to their collections built up over the last three centuries, NHMCs are also places where extinction processes are often recorded and studied, in order to prevent a recurrence (Hung et al., 2014). It is also very important to stress that these investigations are over multiple timescales (historical and prehistoric).

9 The purpose of this document is to stress the significant role of NHMCs in helping achieve their potential in improving the knowledge and protection of animal, fungi, and plant diversity. SSC recognises the significant contributions that NHMCs have, and do, bring to conserving global biodiversity. SSC encourages all its partners, including government and philanthropic agencies, to collaborate with NHMCs in the collective work of classifying species and by recognising the significant contributions that NHMCs have to conserving and unveiling wild organisms and helping to protect against invasive species, amongst other things.

Natural history collections as important tools for discovering and preserving nature

10 NHMCs have access to large, diverse audiences and the ability to influence governments and policy makers on species- and conservation-related decisions (e.g., Butler et al., 1998; McCarter et al., 2001). Moreover, many of these institutions make use of varied funding sources and collectively contribute significant economic support to many aspects of species conservation. As with other sectors involved in nature conservation, many NHMCs work hard to prevent and reverse negative trends in species survival (Davis, 1996).

11 Many NHMCs have progressively expanded their scientific relevance (Huber, 2007; Rocha et al., 2014). In an era marked by dramatic environmental changes, increasing rates of extinction, and almost unstoppable anthropogenic impact on the World biota, many natural habitats are at serious risk, with an unknown number of species disappearing. According to Hochkirch et al. (2023), a quarter of species at the global level are at serious risk of extinction. At the same time, new species continue to be discovered. Just as an example, we may report that every year over 2000 species of plants and fungi are formally described (Antonelli et al., 2023).

12 This increase in species discovery is even greater in some zoological groups, such as insects. The number of described Orthoptera (grasshoppers, bush-crickets, and crickets) has increased by 20% between 2009 and 2025, from 24,380 to 29,299 (Cigliano et al., 2025). In other invertebrates, single publications can at times describe as much as 403 new species (Sharkey et al., 2021), and species of spiders for example have been growing year by year: 887 new species were described in 2017 alone, 814 in 2018 and 834 in 2019 (World Spider Catalog, 2020). In a well-known vertebrate class, the amphibians, it is impressive to compare the number of species known in 1985 according to the work "Amphibian Species of the World" (Frost, 1985), which were 4014, while in 2024, at the time of the online version 6.2 of the same database (Frost, 2024) there are more than 8870 species. Even in mammals, the number of species of African rodents has increased in the space of a few years by 13%, and that of bats by 18%; the number of primates has risen from 233 species in 1993 to 517 in 2024, and it is still growing. This is also in the light of our realisation that many crucial habitats remain poorly or unstudied, and that there are many cryptic species and tangled species-complexes, even for supposedly well-studied taxa. Other vertebrate groups, such as fishes, are described at a rate of about 200 new species a year (Lundberg et al., 2020).

13 This steep species-discovery trajectory is also due, among other things, not only to the application of cutting-edge methodological and survey techniques (DNA first and foremost), but also to new surveys in the field and the re-analysis of old and new collections held in NHMCs. Many of these studies would be impossible to do solely or mainly in the wild, especially for cryptic species and tangled species complexes.

NHMCs are libraries of a threatened nature

14 The accumulation, study, and appreciation of voucher specimens in NHMCs is fundamental within the museums themselves, as the scientific collections provide irreplaceable study material (English et al., 2018; Gippoliti, 2018). Biological series collected over almost three centuries and in many geographical areas have often proved crucial in investigating, among others, the effects of various contemporary issues, including climate change, overexploitation, habitat damage, the introduction of invasive exotic species, pollution and other impacts, not to mention the spread of zoonoses of human health concern (Colella et al., 2021). NHMCs are also very relevant as cultural deposits, either for historical or contemporary aspects, to be valorised in terms of long-term preservation.

15 The existing NHMCs may seem vast already, being increasingly accessible online (such as GBIF, the Global Biodiversity Infrastructure Facility: https://www.gbif.org/), but the expansion of specimen-based collections still remains an important necessity for assuring reproducible science and has an irreplaceable role. Detailed analysis often shows considerable gaps – both taxonomic and temporal – in the amount of vouchers available regionally (Santos & Ceríaco 2025). This is particularly valid in natural sites threatened by anthropogenic activity, with the presence of endangered species populations. In these cases, it is often necessary to preserve biological samples as a future historical record, since in the future those vouchers will allow conservationists to confirm the historical presence of a species in that area, to detect the impact of threats, or to conduct comparative and taxonomic analyses. In that way, NHMCs and the science of taxonomy that they support are especially and uniquely important. The original voucher specimens and associated material and information never become redundant as science progresses because they represent the physical source of the original material against which future research and conclusions must be compared and cross-checked, assuring scientific repeatability.

16 The analysis of historical reference collections has made it possible – for example – to ascertain whether mercury levels recorded in some fish in the Atlantic Ocean are due to human activity (Miller et al., 1972), or whether the virus that is decimating koalas in Australia recently arrived through the introduction of an alien species (Avila-Arcos et al., 2012). As further examples, some NHMCs are using bird specimens killed due to window strikes to examine what types of ectoparasites occur on the birds, and finally work together with molecular laboratories to isolate the blood parasites carried by migrating birds. Once the specimens are in the collection, they can be used for a large variety of projects, perhaps decades in the future, and for topics we cannot even predict at this point of time (Jaspers et al., 2011). Increasingly advanced molecular techniques now make it possible to extract historical DNA from voucher specimens, stemming from the very beginning of these collections, up to about 200 years old (Raxworthy & Smith, 2021) and to clarify the

phylogenetic relationships of related populations and species, in order to select the most suitable individuals for reintroductions. Such investigations can also reveal the history, origins, and spread of infections and pathogens associated with zoonoses and agricultural pests with direct relevance to human health and well-being.

17 One aspect that the museums will also have to expand in the future is the preservation of the genetic variability of populations with the establishment of a genetic bank of reproductive tissues for threatened faunal species, hopefully in collaboration with aquaria, botanical gardens, zoos and nature conservation organizations (Wandeler et al., 2007; Poo et al., 2022). Genetic information from museum specimens has also been used to develop DNA barcodes, which are facilitating the identification of morphologically cryptic species as well as non-invasive research, such as eDNA or meta-barcoding from environmental substrates.

18 NHMC voucher specimens are also an important component in ecological research, where understanding interspecific connectivity provides crucial information to measure or detect conservation concerns, such as co-extinction. Along with voucher specimens of different taxa being collected at the one place and/or time, each voucher specimen houses its own ecosystem. NHMCs often preserve valuable specimens for ecological research, such as diet, the host tree of a fungus, the plant species in which a caterpillar was found eating, or pollen preserved with the animal itself. Museum specimens are also used to look at stable isotopes and infer past environments, giving crucial information for conservation. This ecological ‘by-catch’ is increasingly becoming routinely accessible through the tremendous advances in DNA sequencing, making it affordable even for smaller NHMCs or partnering research institutions.

19 The preservation of valuable ecological material in museum collections, such as the preservation of gut content from road-killed animals, or sampled during the necropsy and preservation of marine mammals (like cetaceans) found deceased on shore, can provide unique records that could become crucial to protect species in the future, allowing not only for taxonomic activities, but a wide array of scientific comparisons (Rohwer et al. 2022; Charles & McKenna, 2024). This role has historically been mostly done by NHMC staff, and it provides data that is invaluable in supporting conservation. Furthermore, apart from ethical, scientifically grounded "purposeful" collection, NHMCs also preserve specimens that were found dead or were donated by partner organizations (such as road and window kills, beach strandings, material confiscated by customs and law enforcement agencies, etc.), where the specimens preserved are in themselves also a record of the threat/cause of dead, and hence provide valuable conservation information. Seized specimens at customs also alert wildlife biologists about what organisms are being trafficked illegally across borders (Wyler et al., 2008).

20 Moreover, it should not be forgotten that natural history museums are important because they are unique institutions that not only discover, describe, and study nature, but also disseminate and share scientific knowledge. They keep the history and science of a country and the world. Thanks to their awareness activities and their relationship with the public through lectures, encouragement of citizen-science initiatives, NHMCs have become irreplaceable laboratories and hubs for promoting and guiding the dissemination of scientific thinking. In close collaboration with universities and other research centers, NHMCs have their own unique appeal, as they combine moments of popularization and entertainment with scientific rigor. They enable, among other things, enthusiasts and associations to find a point of support and reference, and school-age children to approach the natural world, a very important role in a world that is more than ever oriented towards social media and virtual approaches. In several cases, NHMCs are also promoters of useful experiences of dialogues between science and art, facilitating the interchange between scientific and humanistic cultures.

21 In many natural history museums, there are expositive sections dedicated to global changes, with the mission to help create “advocates for the planet”. Furthermore, several NHMCs have living displays - even with touch tanks - that represent whole aquatic ecosystems, for example, thus engaging visitors in appreciating the wonder and interconnections of aquatic species and life forms (particularly invertebrates, plants, and fungi) they might not otherwise encounter, while herbaria are often linked or housed within their associated botanic garden.

22 By combining exploration, study, and documentation, NHMCs are undertaking a critical and valuable mission, namely explaining and promoting nature conservation and boosting people’s public education. Today, the most appreciated and efficient nature museums in the world have developed towards such a dimension that they are at the same time research stations of dissemination and active conservation. Among other things, this accounts for the uniqueness of natural history museums, i.e., their ability to operate as an interface between different activities. Museums, therefore, have a significant role in civil society.

23 Furthermore, conservation has harnessed growing support from NHMC researchers, beyond the known contribution towards conservation research as a data source of species occurrence, NHMCs have also supported international capacity building. Transferring knowledge from the Global North, where NHMCs are often based due to the history of Western science, to biodiversity hotspots in the Global South is rapidly becoming the new norm (Ball et al., 2025). This includes training taxonomic experts of species range countries, supporting the description of new species in the Global South as well as Red List training in those countries (Prathapan and Rajan 2020).

Scientific collections are necessary for conservation

24 As discussed, gathering scientific specimens, the creation, development, and everyday management, as well as the scientific analysis linked to the enhancement of modern NHMCs, operate from local to planetary scales. It is equally true that many NHMCs suffer from a concerning lack of support on the part of their responsible administrative authorities and policymakers, today facing a worrying crisis (Alberch et al., 1994; Andreone et al., 2014, 2022). Universities, and at times botanical gardens, often regard NHMCs as a small, outdated component of their current operations, neglecting their crucial role and historical responsibility to adequately fund those facilities and the necessary staff to maintain them. It should also be stressed that NHMCs are among the few institutions involved with filling gaps in our biased interest, both taxonomically and geographically, toward nature and biodiversity (Guénard et al., 2025). Therefore, the importance of NHMCs to maintain a serious focus on biodiversity research worldwide is today seriously overlooked.

25 Finally, it is also worth noting that NHMC bibliographic libraries have a special focus in storing taxonomic journals and archive historical material (such as field journals, correspondence, etc.) relating to the description of the specimens housed in the collections; more so than may be found in other academic institutions, and particularly for historic publications. This provides valuable information about the specimens, including qualitative assessments of historical density, the preservation conditions of the sampled habitats, or recorded threats.

26 As with the specimens themselves, these written accounts never become redundant as science advances, because of the need for scientists to recheck the original descriptions and illustrations of specimens. Archival documents from scientists, field biologists, and explorers may be critical in ascertaining the exact locations of collections and the physical state of those habitats decades or centuries previously. These bibliographic materials are part of the unique, essential value of NHMC for science and humanity. Museums are not just a scientific resource; they must also be seen as part of our cultural heritage.

27 We, as members of the IUCN Species Survival Commission, fully support the fundamental activities carried out by NHMCs and recognise their role as taxonomic centers and potential conservation hubs. SSC urges an integrated approach to species conservation that involves the active participation of diverse stakeholders and considers all potential conservation options in the development and implementation of species conservation and recovery plans.

28

EXAMPLES OF ROLES NATURAL HISTORY MUSEUMS AND HERBARIA CAN FULFILL IN THE CONSERVATION OF SPECIES

We here provide a non-exhaustive list of examples where natural history museums and herbaria currently contribute or can be further called upon to fulfil their conservation roles.

1) Discovery, study, and description of new species and definition of poorly known taxa

- Expertise in scientific research about the distribution, ecology, biology, human use, evolution, physiology, and behavior of many animals, fungi, and plants.
- Taxonomic and museomic knowledge to support new species, species identification, monitoring, and management.
- All specimens in NHMCs are vouchers, which are the backbone of scientific reproducibility in this research field, impacting all subsequent applications of taxonomic knowledge.
- By housing name-bearing type specimens, collections ensure nomenclatural stability and thus provide other scientific disciplines, as well as society as a whole, with a universal, unambiguous, and sustainable communication system about global biodiversity.
- Capacity to recognise little-known species belonging to a varied assemblage of taxonomic groups, including animals, fungi, and plants.
- Development of identification tools, such as field guides, identification keys, identification apps, AI identification tools, DNA barcodes, and other genetic technologies.
- Identification of wild relatives of crop species, and of the genetic resources to increase resilience of domesticated resources to ongoing climate change and the emergence of new diseases and pathogens.

29

2) Pathologies, pollution, and invasive species

- Ability to identify parasites within animal, fungi, and plant preserved samples.
- Capacity to identify and monitor invasive alien species.
- Developing expertise in detecting pollutant elements in voucher specimens and providing diachronic comparisons between samples collected at different times.
- Knowledge on comparative pathology, pathogen discovery, and pathogen ecology, including in relation to zoonosis and the related risks to humans and other animals, fungi, and plants.
- Identify viruses and other potential vectors of pandemics, such as Coronavirus in preserved fruit bats and Ebola in rodents.

30

3) Disentangling ecological and population issues

- Confirm the presence of historical samples in defined localities, thus aiding in mapping historical distribution areas and calculating the extent of range decline.
- Developing field methods for population surveys and monitoring
- Support key conservation assessment and planning processes (e.g., Red List assessments, Key Biodiversity Identification, species conservation planning).
- Evaluation of genetic information obtained from preserved species for the purposes of conservation translocations.
- Expertise and resources are important to conservation translocations based upon historical and ancient DNA extracted from preserved specimens.
- Phenology, climate change impact, and other valuable data on plants and fungi
- Gathering and recording of developmental, life history, phenological, morphometric, and demographic data.
- Development of metrics that are essential to quantifying biodiversity and biodiversity change. Metrics can also identify geographic areas that are underexplored, etc.

31

5) Biodiversity libraries and dissemination centers

- Acting as nature documentation centers, including books, papers, photographs and images, videos, acoustic libraries, tissue samples, voucher specimens, and digital biodiversity data, made available openly (FAIR principles).
- Availability and access to research materials, samples, biobanks, and biodiversity data as a resource for a wide variety of conservation-relevant research fields.
- Providing a lead to citizen-science initiatives, including nature surveys, urban nature, monitoring threatened and invasive species, and conservation projects.
- Provide expertise in educating people (in particular young generations) to learn and recognise natural science elements and their conservation requirements.
- Development and testing of new technology and monitoring techniques (e.g., eDNA protocols, testing, and samples).

32

6) **Crossroads between taxonomy, discovery, and education**

- Establish wide relationships with and engagement of local communities, governments, non-governmental organisations, universities, and civil society, with nature and conservation initiatives.
- Advocate for and implement conservation policy changes, laws, regulations, and standards, and treaties to conserve animals, fungi, and plants (e.g., CBD, CITES, Habitats Directive, Bern Convention, and Convention on Migratory Species).
- Expertise in informal and formal educational opportunities (e.g., classes, summer camps, school programs and field trips, undergraduate and postgraduate programming, lectures, intern programs, virtual programs), including in underserved communities.

- Social science expertise in design, delivery, evaluation, and impact monitoring of education, outreach, citizen science, and behavior change programmes.
- Conservation hubs to cross the gap between knowledge and conservation action.

33

7) Capacity building and resources for developing countries

- Employ, train, and motivate staff and volunteers to work for an efficient, caring, and effective management of collections of animals, fungi, and plants.
- Without collections personnel, a good amount of the collections would not exist, have been preserved, or kept in the good condition we find them in today.
- Funding, preferably long-term, for conservation work, including through engagement with wider conservation donors (e.g., individuals, foundations, government agencies, local business partners, docents, volunteers).
- Working as catalysts for strategic species assessments, conservation planning, or mobilizing action, including in partnership with the volunteer expert SSC network, such as through hosting an SSC Center for Species Survival or an SSC Specialist Group.
- Expanding programs for digital repatriation of key type material from the country of origin to enable research in Global South countries.
- Building capacity in developing countries to study biodiversity and engage in biodiversity conservation.

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