Natural Science Collections Facility
SOUTH AFRICA

Collection Management & Conservation Manual

2021

SANBI
Biodiversity for Life
South African National Biodiversity Institute

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Chapter 1

Photographs

Examples of material newly acquired by an institution - images provided by ARC.

Example of a handwritten acquisition register for newly acquired collection objects - image provided by ARC.

Newly accessioned material prior to full processing and allocation of catalogue numbers - image provided by ARC.

The data entry form for new acquisitions in a Specify database - image provided by SAIAB.

Chapter 3

Photographs

Specify menu showing the different functions (interactions) available for electronic management of collections activities - image provided by SAIAB.

Specify database opening page showing tabs with options along the top of the page and drop-down menu for selecting the category for new acquisition in the database - image provided by SAIAB.

Example of a fluid preserved object showing the locality information on the collection object label - image provided by ARC.

Example of a visitor register which is signed by all collection visitors on arrival - image provided by ARC.

Example of paperwork required for reporting an accident -image provided by ARC.

Chapter 4

Specify logo and image: https://www.specifysoftware.org/;

https://www.specifysoftware.org/products/specify-6/

The OAIS data management model describing the seven 'functions' associated with long term, archival data management. Illustration by Jørgen Stamp digitalbevaring.dk CC BY 2.5 Denmark.

Georeference for suburb Rondebosch in Cape Town in Google Maps.

Georeference for 'Mpathe hill, near Dundee' in Google Maps, with the radius capturing the entire hill.

Chapter 5

Photographs

Collection storage area with metal shelves and white fibre tanks - image provided by SAIAB.

Air-conditioning condenser units outside a building housing collections. This is useful in case of a leak as the potential flood will be outside the collection storage area - image from Ildar Sagdejev (Specious), Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=4370335

A fireproof cabinet holding type material housed in the same storage area as the rest of the non-type collection objects - image provided by ARC.

Entrance to the National Arachnida Collection storage area, and metal cabinets with drawers holding vials - images provided by ARC.

Verdigris, where metal reacts with insect fats or lipids, spreading on a clearwing moth. Image: © - Oxford University Museum of Natural History (with permission) (https://morethanadodo.com/2018/08/09/from-pin-to-paper/).

Archival box with plant collection objects that cannot be mounted on herbarium sheets - image from Conserve O Gram 11/12, Preparing and Storing Herbarium Specimens. https://www.nps.gov/museum/publications/conserveogram/11-12.pdf

Collection object labels printed on an acid free goatskin paper - image provided by ARC.

Shelf covers used on steel shelves to create a barrier between agents of deterioration and the collection objects. (https://stashc.com/the-publication/covers/shelving-covers/ - image provided by Museum of Culture and Environment at Central Washington University.

Closed metal slide cabinet (left) and with one door opened to show storage capacity and arrangement - image provided by Chris Grinter, California Academy of Sciences.

Arrangement and positioning of microscope slides for storage - image provided by Chris Grinter, California Academy of Sciences.

A digital density metre for checking the ethanol concentration - image from the Anton Paar website (https://www.anton-paar.com/za-en/products/group/density-meter/).

The Alcomon tablet system for monitoring ethanol concentration. The first bottle shows ethanol of concentration greater than 60%, the second bottle between 50 and 60%, and the third bottle, less than 50% - image from the Alcomon website (http://alcomon.com/info/).

Example of a jar volume template. Braker, Emily M. 2017. University of Colorado Museum of Natural History - with permission.

Example of an oxygen scavenger (left) and an Anoxibug bag (right) used in anoxic treatment of larger sized collection objects - image from Hanwell Solutions website (https://hanwell.com/s).

Other images

The 10 agents of deterioration in a museum. With permission. © Copyright is owned by ICCROM and the Government of Canada, Canadian Conservation Institute, 2016, as published originally in https://www.iccrom.org/wp-content/uploads/Guide-to-Risk-Managment_English.pdf.

Multi-layered protection of a collection object. With permission. Image from Museum Handbook, Part I, published by the National Park Service. (2012). https://www.nps.gov/museum/publications/mhi/chap7.pdf.

Chapter 6

Photographs

Collection object being wrapped in moistened tissue for packing - image provided by SAIAB.

Individually packed collection object in a plastic bag in preparation for heat sealing (left), and heat sealing of a collection object in a plastic bag (right) - images provided by SAIAB.

Heat sealed collection objects - image provided by SAIAB.

Chapter 7

Staining and corrosion of an archival document affected by a water - image by José Luiz Pedersoli Jr., CCI-ICCROM, 2016. With permission.

An example of mould damage to old documents - Image by Pemba. mpimaji - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=18543283).

Conservation staff drying mould-damaged materials- image from Benjamincarpenter - Own work, CC BY-SA 4.0 (https://commons.wikimedia.org/w/index.php?curid=63198099).

Preventing mould from developing on wet bird specimens by placing a paper towel cut into a small strip under a feather to avoid more feathers getting wet. Image by Mariana Di Giacomo, Natural History Conservator. With permission.

Other images

Summary of the main steps (inner circle), concepts and tools (outer circle) involved in risk management for heritage resources, starting with Context in the inner circle, and moving clockwise. With permission. © Copyright is owned by ICCROM and the Government of Canada, Canadian Conservation Institute, 2016, as published originally in https://www.iccrom.org/wp-content/uploads/Guide-to-Risk-Managment_English.pdf.

The 10 agents that can cause deterioration and loss to collection objects. With permission. © Copyright is owned by ICCROM and the Government of Canada, Canadian Conservation Institute, 2016, as published originally in https://www.iccrom.org/wp-content/uploads/Guide-to-Risk-Managment_English.pdf.

Foundation for Advancement in Conservation (FAIC) Emergency Response and Salvage Wheel. With permission.

Example of a Pocket Response Plan, based on the original design by the Council of State Archivists (USA) and accessed through the WESTPAS (Western States and Territories Preservation Assistance Service) website (http://www.connectingtocollections.org/wp-content/uploads/2019/09/PReP-Samples.zip).

Chapter 8

The Occupational Health and Safety Act (OHSA) of 1993 and its Regulations, visibly displayed in an institution as required by the Act - image provided by ARC.

Health and safety devices for working with formalin preserved collections. The green and orange devices worn by the technician and shown separately are for monitoring chemical vapours in the collections at SAIAB, while the exhaust unit extracts odours and fumes - images provided by SAIAB.

Example of an institution floor plan, marking evacuation route and exits in the building - image provided by ARC.

Example of a smoke detection system - image provided by ARC.

Fire extinguisher and water hose for use during a fire emergency - image provided by ARC.

Image showing air monitoring devices - image provided by SAIAB.

Example of PPEs worn while carrying out activities in natural science collections. The cloth face masks are worn as a precaution during the Covid-19 pandemic - *Image provided by SAIAB.*

Chapter 9

Ethics image: https://www.homeappliancesworld.com/2019/07/18/the-importance-of-ethics-in-the-fourth-industrial-revolution/.

Chapter 10

CITES logo: https://logodix.com/cites.

Nagoya Protocol logo: http://antonantonio.blogspot.

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PREFACE

The assessment of natural science collections in South Africa commissioned by the National Research Foundation (NRF) in 2009-2011 highlighted the lack of policies, procedures and standards documents as one of the main shortcomings of the institutions. Institutions were found to have some documents, but in most cases, these were hidden on some dusty shelf. The staff did not know what they contained. The documents were outdated and generally not implemented. There was no common approach to collection management and curation in the country, and in most cases, this was the case even within an institution, where different collections were managed according to very different, undocumented, practices.

This was not considered as a problem amongst most of the staff at institutions, who believed that they had a sound knowledge of what needs to be done to care for the collection, and how to do it, and they had gained this knowledge from previous curators or collection managers. This is a historically global phenomenon, with institutional knowledge and practice being passed from one generation of staff to another, and staff remaining at an institution for very long periods of time, or even for their entire career, developing an extensive knowledge of a particular collection, to which they became passionately dedicated.

But times have changed … in just so many ways. We can't operate in the same way as we did 200 years ago.

People seldom stay in one post for their entire career. There are usually gaps between the appointment of old and new staff and so no transmission of knowledge happens. New staff can't be left to just figure things out themselves or come up with their own system of doing things. Collections are considered as assets (which they certainly are), that were collected with public funds and that continue to require investment for care and maintenance, and so the way they are managed is now audited just as any traditional asset would be. Everything has to be documented.

There is a whole new set of requirements relating to biodiversity conservation and sustainable use legislation and ethics, that cover the principle that the people of a country should benefit from its biodiversity, including benefits resulting from use in research and capacity development. The law requires accurate documentation, permits and careful tracking of use and benefits when materials are used. There are also far more complex governance and reporting demands, especially in terms of authorisations and financial management when government funds are used.

Technologies that were not available in the past are integral to modern collections, including specialised software, climate control and monitoring devices, storage systems and collections that are used for DNA analyses. All of this requires new

ways of working. There is also a far greater awareness of the risks posed by some materials in collections to the health of staff, and field work presents a new set of hazards that were not prevalent even 50 years ago. The law says that institutions are responsible for providing a safe working environment for their staff.

We know that staff are key to securing the collections and ensuring that there is compliance with legal and audit requirements. The NRF report also highlighted that there is no formal training in curation available for natural science collections staff. Collection management was not promoted as a profession and was often considered as a stepping-stone to being a scientist or an academic or to just about anything else. Many of the staff were demoralised and unmotivated, mostly because of the lack of opportunities in collections. If we all make up our own procedures and standards, how do we professionalise collection management and curation and address the need for the training of staff, who may move between collections or institutions?

There has long been a call to government from the natural science collections and the broader research community, to recognise the collections as being critical for scientific research, capacity development and biodiversity conservation. After many years, government responded, and the Natural Science Collections Facility was established and funded through the Department of Science & Innovation's South African Research Infrastructure Roadmap (SARIR). The collections are recognised as global research infrastructure that needs to serve society not only in the present but also far into the future; and so, we have a duty and a responsibility far beyond ourselves and own institutions to safeguard, but to also make the collections and associated data accessible. The collection objects or specimens and their associated data must be scientifically credible and useful for a range of applications; ad hoc approaches to managing collections will not achieve this.

The only way of moving from the old way of managing collections to the new way, and to ensure that the collections survive into the future, and that they are valued as critical research infrastructure, is to make sure that we do things in a systematic, defensible, globally accepted way. This means having good, carefully thought through policies, standards and procedures. That is the purpose of this manual.

Developing the manual was an ideal opportunity for the staff from 16 institutions participating in the NSCF to pool their knowledge and experience and to work collaboratively. It has been a mammoth task – so many different aspects, so much detail and so many debates and discussion and issues to resolve! but I am convinced that it has all been worthwhile. The manual is not the end point, but the first step towards achieving individual, institutional and national goals for the collections. We look forward to the next steps in our journey together.

Thank-you and congratulations to everyone who contributed to this manual.

Michelle Hamer, NSCF Lead

Reflections on Implementation

In her preface to this manual, Michelle Hamer creates a picture for us of the 'old way', of the way things have been done for the past 200 years, knowledge and practices being passed from one generation to another, and then she wakes us up to how times have changed and convincingly advocates for a 'new way', to meet the shape of the future that has come to meet us.

But what would make it possible for us to release and let go of the 'old ways' that have become so entrenched in our institutions over such a long time, and to embrace and enact the 'new ways' we are being called upon to do, as stewards of our natural sciences collections? What will make it possible for us to transform from the various versions of the old which currently still live within and shape our work practices, into something that is qualitatively different, and far more aligned to the standards, processes and practices contained in this manual?

As Michelle says in her preface, the creation of the manual is not the end point of this journey, but the first step in achieving a new era for Collection and Data Management. So how then do we take the next steps on this journey? What will make it possible to practically 'implement' this manual in all our institutions?

Consider for a moment the myriad of micro-actions, of different decisions and new behaviours, of re-calibrated relationships and re-designed processes it will take to give effect to this new vision? How do we create the conditions in which these

things can happen? How do we help usher in, or be the midwives of this new era? How do we do this in each of our participating institutions? How do we do this as a collective, as a network of institutions, each with our own unique conditions and constraints? How do we do this as an entire community of practitioners, curators, researchers and managers?

We want to offer some thoughts for you to consider as you reflect on your own unique implementation journey.

Organisations are complex living systems, similar in some ways to the living ecologies the various collections come from and form a part of. As Michelle says in the Preface **... 'times have changed ...'** and so has our best thinking about how to create the most optimum conditions for transformative change. Let's be real. Implementing this manual will require a process of transformative change in institutions. It will not be possible to merely 'comply' with the provisions in this manual and for everything, on a day-to-day basis, to remain mostly unaffected in your institutional and collection and data management processes.

The old ways of the so-called 'scientific management era' based on old paradigms of organisations as machines and a misunderstanding of how we can 'manage' change, as if we are replacing a widget in a machine, are over. What we know now is that transformative change happens primarily through the quality of our relationships in our institutions. It happens through the art and the courage of convening the difficult conversations about what matters to us and connects us to our purpose. It requires the empowered agency of everyone's leadership in the organisation being liberated, regardless of your official role and position. It assumes that we all come to our tasks as leaders. It requires institutional cultures and spaces that are psychologically safe and working in a deliberate and intentional way to heal the wounds of the past and to co-create and actively promote equality and prevent ongoing unfair discrimination in our organisations.

Transformative change requires a diversity of voices and experiences to give effect to the new ways advocated for in this manual. It is likely that staff most affected by the changes will be best positioned to wrestle with and enact new processes and behaviours, aligned to the new standards set in this manual, based on their extensive experience and expertise.

While we are proposing that the implementation of this manual constitutes a process of transformative change, we are also suggesting that all transformative change is fundamentally organisational learning; and so we also ask ourselves what enables learning in our institutions? What conditions make it possible for us to learn, grow, adapt, change and ultimately transform?

Learning is both a personal and a social process. Change at an individual level and changes in organisational practices are entangled. They are inextricably interwoven with one another, as well as with a myriad other contexts and relationships; and so the one thing we can all do to contribute to creating the conditions for the transformative change contained in this manual, is to reflect on what change might be asked of us personally? What might you have to let go of? What might you have to embrace that might be difficult for you? How will it be for you to move out of your comfort zone, the way you have always done things and to experiment

with doing things differently? Do you have the courage to be an initiator of change in your institution? Are you willing to speak your truth? Are you ready to step into your own leadership, wherever you find yourself in the community of people who are the stewards of our natural sciences collections?

Some research indicates that it takes a 'critical mass' of people for a system or organisation to shift. Often that magical number is considered to be about one third of the group of people that make up an institution or a community. Another bit of research suggests that we actually only require about 13% of members of a community to innovate and adopt new ways of being and in so doing, to midwife a new concept, product or approach into the world. What complexity theory tells us is that even the smallest interference or disturbance in a complex adaptive system, the proverbial flutter of a butterfly's wing, can result in magnificent and entirely unforeseen changes over a vast terrain. Wangari Maathai, one of our NSCF heroes and the embodiment of a life dedicated to transformative change affirms this approach with her story of the hummingbird who drops a single drop of water on a blazing fire, over and over again or the creation of an entirely new forest with the cultivation of one single seed at a time.

What follows are a few Transformation and 'Change Management' principles and guidelines readers of this manual can take into their implementation journey.

- **Always start with the Purpose –** The Vision, Mission, Values of both the NSCF and your institution will need to be revisited/highlighted/renewed and collectively engaged with. Use this as your starting point for any process involving learning, renewal and change. Why are we doing this? What is our purpose? What is our reason for being and what are the values that will guide us and hold us accountable? Such a vision and values- led approach will strengthen and align the values of each institution with the values and principles of the NSCF, and if worked with consciously and intentionally throughout the process, can assist with aligning the goals and strategies of the NSCF with the goals and strategies of the various institutions.

- **Contextual understanding and engagement –** Reflect on the larger context and environment within which you are working. What is happening around us? Which other stakeholder groupings or external forces might form part of your context? What do we need to do to create greater readiness and fertility for change within our own context?

- **Relationality –** How are people relating and interacting and engaging with each other and with any renewal process? This might need several rounds of conversations and meetings to become familiar with what needs to be done. How are we together? How are our relationships? Do they need strengthening? Do we need to build more trust? Do we need to listen to each other's stories? What do we need to do to renew and deepen our relationships?

- **Personal to collective –** As mentioned above, transformation and change happens at an individual, inter-personal as well as at organisational level. Therefore, start with yourself. Work on your own processes of learning and development. Learn how to be more self-aware and mindful of your effect

and impact on others. How open are you to learning and coming to these processes with a 'beginners mind', to allow yourself to be challenged and in turn challenge and confront others? In which ways are you resistant to change? What will it take for you to initiate or lead some of these change processes in your institution? What do you personally need to do differently? What will we do differently together? How do we then ultimately ensure coherence and consistency of practices within our institution as a whole? Working consciously with a self-reflective process of learning and transformation both individually and collectively, ensures that we are able to harvest and unearth the wisdom that we already have within individuals and organisational systems that can help us to reflect, learn and improve, adapt and evolve into new versions of ourselves and organisations that will be better equipped and more effective in bringing about the changes we want to see.

- **Conceptual thinking and working with new paradigms towards transformation and change –** How do we believe change happens? How do we think about our institutions? Do we see them as living organisms of diverse, complex, striving human beings or do we still think of hierarchies and bureaucracies, silos and cogs in a machine? What might the implications be of our conceptual understanding of the institutions we form a part of?

- **Frame as a Learning Journey –** Can we create a culture of conscious learning and reflection in our organizations, and in particular learning together, to allow for sharing of experiences to liberate the collective wisdom that lives within our organizations to come to the fore? This requires, amongst other factors, mutual vulnerability. In times of uncertainty, Brenda Zimmerman says, there is a greater spirit of experimentation – people are more willing to try new things, as it becomes clear that the old ways of dealing with issues are not working. At the same time, we have to be more attentive to detail, and take the time to reflect more carefully as we act.

- The process of learning and reflection needs to be built into regular organisational rhythms and spaces, so that it becomes part of institutional functioning and a dynamic and lively process that brings together cross disciplinary teams, as well as similar streams of work, always being mindful towards contextualising new learnings in the space where they land. Do we feel psychologically safe enough in our organisations to learn? To reflect critically on our practices? Can we admit to mistakes and failures without it attracting negative consequences? Are we practising giving and receiving constructive feedback? Have we created a culture of appreciation, where colleagues feel sufficiently valued and appreciated to be able to receive feedback without high levels of anxiety or using damaging defensive strategies? What might we need to change in our work culture and practices to create this kind of environment?

- **Facilitating new forms of engagement –** Have we acquainted ourselves with the social process skills, the methodologies and the social technologies that enable meaningful participation, dialogue and quality conversations for relationship building towards an authentic community where all voices are heard and listened to equally? Do we realise that for any transformative change and learning

processes to take place, we need to make use of these participative processes that mimic complex systems? We require a more facilitative approach where the role of the person leading the process is to bring out the best thinking and engagement of the group and to ensure that everyone's voice is heard at all levels of the organization. This approach includes circle conversations, using 'rounds' based on the Time to Think methods, World Café Conversations, Courageous Conversations, Liberating Structures, conversations that create community amongst many others. Through these processes we cultivate leadership at all levels and allow new forms of leadership to emerge. Using such a participatory approach involves ongoing consultation and collaboration - encouraging, valuing and validating the views, perspectives and questions of all involved and working with the diversity of views, to build a collective understanding of the processes required for the implementation of the manual to live into our future desired collective vision.

- **Bring the whole system into the room –** Enable teams to connect across traditional organizational boundaries and levels, thus allowing for more integration and collective learning and problem-solving. Increase connectivity and communication in all your meeting, strategic, reflective and learning spaces within institutions and across institutions. These vital feedback and communication loops are a critical aspect of learning and transformative self-organization and change, in complex adaptive living systems.

- **Critical diversity –** Create an environment where diversity is engaged within all its many facets and worked with in a manner that unleashes the fullest potential of all, within a culture of respect and appreciation, placing a high value on issues of equity, equality, social and organizational justice and healing. Recognize that this will challenge many traditional organizational practices and be prepared to be surprised at the vitality this unleashes in your organizations.

- **Decolonisation approach –** Consider whether you have sufficiently committed yourself to the journey to understand how our organisations, our work and our relationships have been shaped by the complex forces of colonialism and Apartheid? In what ways are we actively engaging with radically transforming these colonial practices that are very much alive within our organisational systems? Are we able to challenge the status quo and 'the way things have always been done' and re-imagine more humanising and life-affirming ways of honouring ourselves, our colleagues, our work processes and practices, our ancestors as well as every living thing that makes up our world?

- **Catalysts of change –** Do we nurture those who see themselves as active champions of change and are willing to drive transformation processes in your institutions? They will need encouragement as well as the space to grow. They will need to learn how to work with resistors and influence those who may not see the benefit of doing things differently. Connecting these change champions to each other within an organization, and across institutions may also help to develop social solidarities, as well as a 'critical mass' to help all institutions and the network as a whole, to move more swiftly along the transformation and implementation journey.

- **Skilled facilitation –** In some instances, where a difficult and challenging institutional culture has developed over time, for whatever reasons, it may be the correct course of action to make use of skilled facilitation to provide containment and safety for the team to get to a place of greater capacity and resilience to do their own ongoing internal organisational work and continue on their implementation journey.

- **COVID –** times – During these extraordinary times, are we holding sufficient awareness of the impact of the pandemic on every aspect of our personal and professional lives? Are we allowing for the expression of how it has affected our personal and workspaces and how these have become merged with working from home in virtual spaces? Are we practicing sufficient self-care and care of each other during these challenging times with significant mental health and wellbeing implications for us all?

In conclusion, the entire project of the NSCF is an experiment in working collaboratively across multiple institutions for the greater good, as the network members did on this manual. Throughout this process we have been deepening our recognition and understanding of the historical context of our organisations, our collections and their management; a context of colonialism and Apartheid, of systemic and legalised race and gender discrimination in the institutions responsible for safeguarding those collections, of the disregard of indigenous knowledge systems, of the appropriation of land, a history of violence and oppression, as is referred to in Chapter 9 of the manual. In addition, the NSCF have been engaged in an ongoing conversation about the 'ownership' of the collections and data, wrestling with the idea of private institutional ownership of certain collections and the belief that all collections are our national heritage and form part of 'the commons' for all to share and protect.

In the end, it is the collection of human beings who have dedicated themselves to the protection and understanding of the natural record of life here on the southern tip of Africa that is our most critical and precious collection. Without you, all our other natural science collections, and with them the secrets that could help support sustainable, enriched, on-going life on earth, is in peril. We bless you on your journey to give life to what is contained in the pages and chapters of this manual.

Desiree Paulsen & Ilze Olckers

Facilitation Team - Africa Spirals of Change

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CHAPTER 1: ACQUISITION OF COLLECTION OBJECTS

1.1 Background

Collections may be expanded through institutional collecting programmes, donations from scientists or other institutions, and from the public, including private collections. Long term loans from one institution to another are also a form of acquiring a collection. There are both legal and ethical requirements related to accepting or acquiring collection objects.

The terms "accession" or "acquisition" are often used to refer to newly obtained collection objects in natural science collections, and there has been some debate about what these terms mean, and which one should be used. "Acquisition" is defined as the act of getting something, or as something obtained, and "accession" is defined in this context as a new item added to an existing collection of books, paintings, or artefacts, and the verb refers to the act of recording the new item. This means that either term is correct, and in this chapter the two terms have equal meaning.

1.2 Principles

- Collection objects should only be deposited in institutions with the resources to provide appropriate care, conservation, storage and security for the collection objects.
- Collection objects should only be deposited in institutions that have a focus on the particular collection type.
- All collection objects accessioned and catalogued must have been obtained legally and ethically. The legality of any collection should be considered in the timeframe of that collection, as permitting requirements have changed over time.
- Collection objects accepted by an institution must have a minimum amount of documented information associated with them, and the collection objects must be in a condition that will allow use for research purposes.
- An acquisition form, signed by the donor and recipient must be completed for each collection object/lot, and the collection object/lot must be entered into a hand-written accession register.

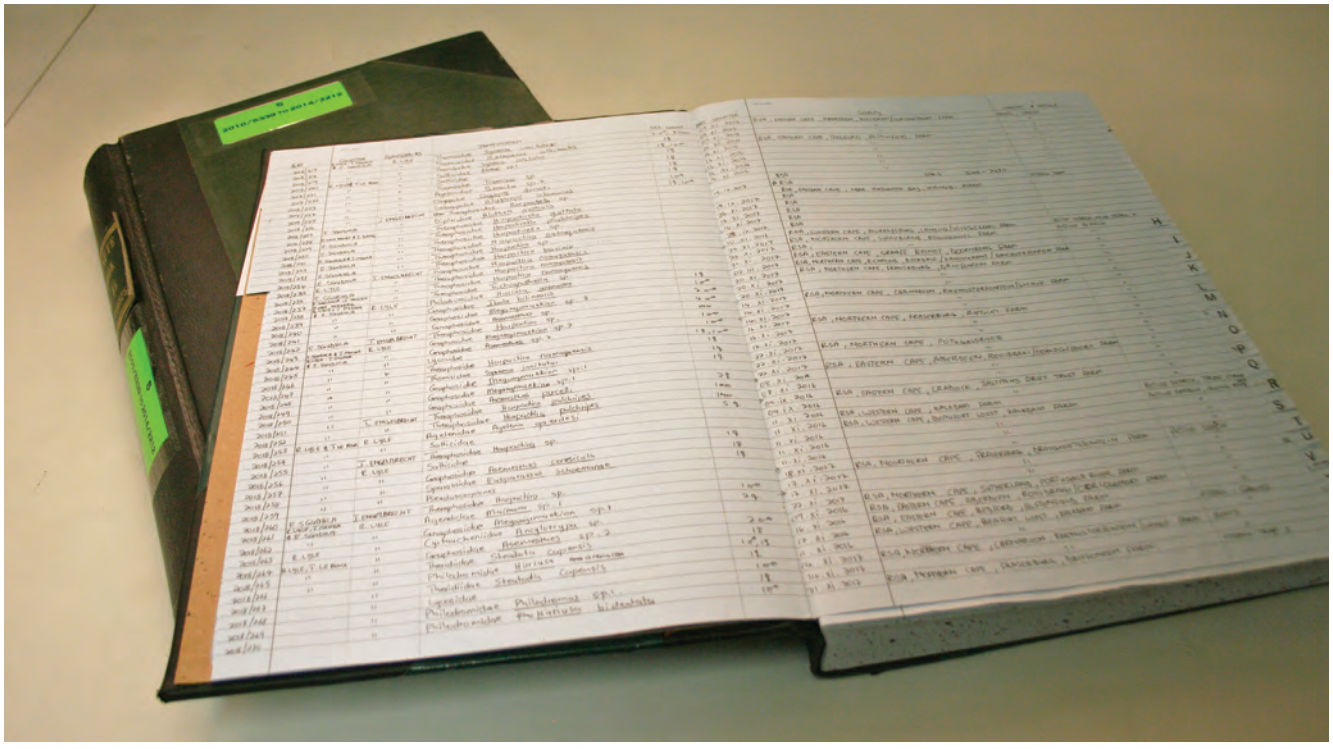
Examples of material newly acquired by an institution - *Images provided by ARC*

- Institutions must have a policy and strategy that details the collections focus, in line with available resources, and collections must not be built or accepted outside of this policy.

1.3 Guideline Statements

1.3.1 Legal and ethical requirements for accepting collection objects

- All collection objects acquired must comply with legislation at provincial, national and international levels. Relevant international conventions and national legislation include the Convention on International Trade in Endangered Species (CITES); the Nagoya Protocol on Access and Benefit Sharing (ABS); the Animal Disease Control Act (1984); National Environmental Management: Biodiversity Act (NEMBA) and associated Regulations including Threatened or Protected Species (ToPS) Regulations (2007), Threatened or Protected Marine Species Regulations (2017), and the Biodiversity Access & Benefit Sharing Regulations (BABS) (2015); the National Forests Act (1998) and the National Heritage Resources Act (1999). All provinces have ordinances that regulate the collection, donation and receipt of biological materials.



Example of a handwritten acquisition register for newly acquired collection objects
- Images provided by ARC

- The receiving institution must be able to provide proper care, conservation, storage, and security of the collection objects under conditions ensuring access and meet professionally accepted standards for collection preservation.
- All collection objects collected by staff employed in the institution belong to the institution. In other words, no private collections may be established by staff at an institution. Collection objects collected that do not align with the focus of the institution must be sent to an appropriate institution and may not be kept by the member of staff as a private collection.

- Only collection objects collected under a legal collecting permit or with a landowner's consent can be accepted by the institution, whether these are acquired as gifts or donations or through exchange or collected by staff or the public. The permit/landowner's consent must be provided to the institution by the donor. In cases of historical collections, or other situations where there is no collecting permit, the relevant authority (provincial or national department) must be consulted regarding permission to receive the collection objects. Private and corporate landowners may donate and deposit collection objects in institutions, provided that legitimate ownership of the land on which the collection objects have been collected can be verified.
- In the case of collection objects originating from other countries, the relevant export and import permits as well as any Material Transfer and/or Benefit Sharing Agreements between the donor country and the recipient of the collection objects must be submitted with the collection objects. The latter documents are required in terms of the Nagoya Protocol and serve to protect the rights of the country of origin to any benefits, including scientific outputs, resulting from the collection objects.
- For donation of collection objects, an individual or institution shall demonstrate, in writing (completion of the intention to donate form), that they are in possession of full title to the collection objects, and that acquisition of the collection objects by them was in full compliance with all legislation.
- Collection objects collected by the institution staff and from donors must have been collected according to global ethical standards. This would include consideration of the impact of collecting on the population/species' conservation, on other species (bycatch), unintentional spread of disease or associated organisms, animal ethics, methods of killing and preservation, as well as landowner permission.

Newly accessioned material prior to full processing and allocation of catalogue numbers
- Images provided by ARC

- The Collection Manager (relevant delegated staff member) and the Director (relevant institution authority, as per institution protocol) shall review the ethical and legal aspects of the donation or exchange.
- All collection objects acquired must be in line with the collection focus of the institution (i.e., there must be existing collections that focus on the same taxa or themes and preservation methods as the donated collection objects). Should the collection objects/lot offered not be in line with the focus of the institution, the donor must be referred to an appropriate institution. Donated items for which the institution anticipates no foreseeable use for research, exhibition, education, or exchange should not be accepted. Collection objects collected by institution staff as bycatch or that are not within the focus of the institution should be sent to the most appropriate institution.

1.3.2 Minimum requirements for collection object/s being accepted by an institution

- Each collection object / lot must bear a **minimum amount of data**, specifically locality (preferably with co-ordinates), date of collection and name of the collector, but other relevant information such as host plant/animal, habitat, collection method, and other biological associations are also important because this increases the value of the collection object/lot. Copies of any data collection forms and/or field notes should be submitted with collection objects for long term archiving. This includes copies of the data sheets and field notes from the institution's own staff.
- Material that does not have the minimum required set of data should not be accepted by the institution. If the incoming collection object / lot has abbreviated information, it must be accompanied by explanatory field notes and/or data collection forms.
- A collection object that is accessioned must meet a **minimum standard in terms of its condition**. Collection objects that will not be useful for research should not be accepted. In some cases, collection objects may have potential for use in displays or education programmes but not research, and this must be specified on the acquisition form and accession register.
- All newly acquired collection objects must be treated in an appropriate way (e.g., frozen / decontaminated, visually checked for pests, transferred to the standard container, labelled, allocated a unique number) before being incorporated into the main collection.

1.3.3 Documentation and conditions for acquisition

- An appropriate **donation form** such as that in Appendix A1.3 must be completed, which specifies the condition of the acquisition. This must be signed by both the donor and the recipient and one copy must be provided to the donor and one copy retained by the recipient institution.
- An **acquisition register** (hard cover book) must be kept, where all collection objects / lots coming into the institution through staff collecting or donations are recorded. This may be the same register as that used for collection object received temporarily, but the source must be clearly stated (staff collected vs donated by external donor and name of donor vs incoming loan vs objects

received for identification purposes). This must be completed as soon as the collection objects are received, and not later than two weeks after receipt of the collection objects. While some institutions may prefer to use an electronic database for acquisitions, this does not serve as a permanent, un-editable record, which is required according to the CITES standards for collection institutions.

- It must be possible to **trace all acquired collection objects back to the entry in the acquisition register** even once the collection objects have been formally accessioned and integrated into the collection. This is important so that the collection objects remain linked to the original donation form and any associated permits or other documents.
- Once the collection objects have been assigned **new catalogue numbers**, these should be recorded in the acquisitions register with the entry for those collection objects.
- In cases where the donated collection object has an **existing institutional acronym and catalogue number** associated with it, this should always be traceable as an alternate catalogue number in the database records of the institution receiving the donation.
- The **original labels and number that were assigned to a collection object by the donor should be retained** with the collection object, but if it is not feasible, then at least the number should be retained and the label archived, with the documentation received, with the collection object. All original labels should be retained. However, over time, some may get damaged and so photographing labels and attaching such photos to the collection object record in the database would be desirable.
- **Hard copy documentation** (e.g., data sheets, field notes, etc.) **and electronic resources** (e.g., images) that accompany collection objects must be accessioned according to the appropriate procedures (i.e., they must be linked to collecting events on Specify or Brahms as well as recorded in the catalogue book).
- Donated collection objects **must be accessible to other researchers**, (i.e., no special conditions should be required by the donor about what can or cannot be done with the collection objects).
- Donated collection objects that are part of an ongoing research study may be accessioned into the collection with an **embargo**, but the end date for the embargo must be specified on the donation form. The embargo period must not exceed that agreed upon for the NSCF Access Policy.

1.4 Institutional Policies and Strategies for Collection Focus and Expansion

- Institutions must have a **policy that states their area/s of focus and specialisation** for collections. This must include taxonomic focus, types of collections for each taxon (fluid preserved collection object/s, skins – whether mounted or as study skins only, skeletal collection object/s, and geographic scope (global, Africa, southern Africa, South Africa or provincial). This policy must be in line with resource allocation (i.e., staffing, space and curation budget), and collections should not be established or retained or expanded if there is no staffing or curation budget available for the care of these collections, or if the storage facilities for the collections pose a risk to their security or preservation.
- The institutional policy should include a section on collections expansion that

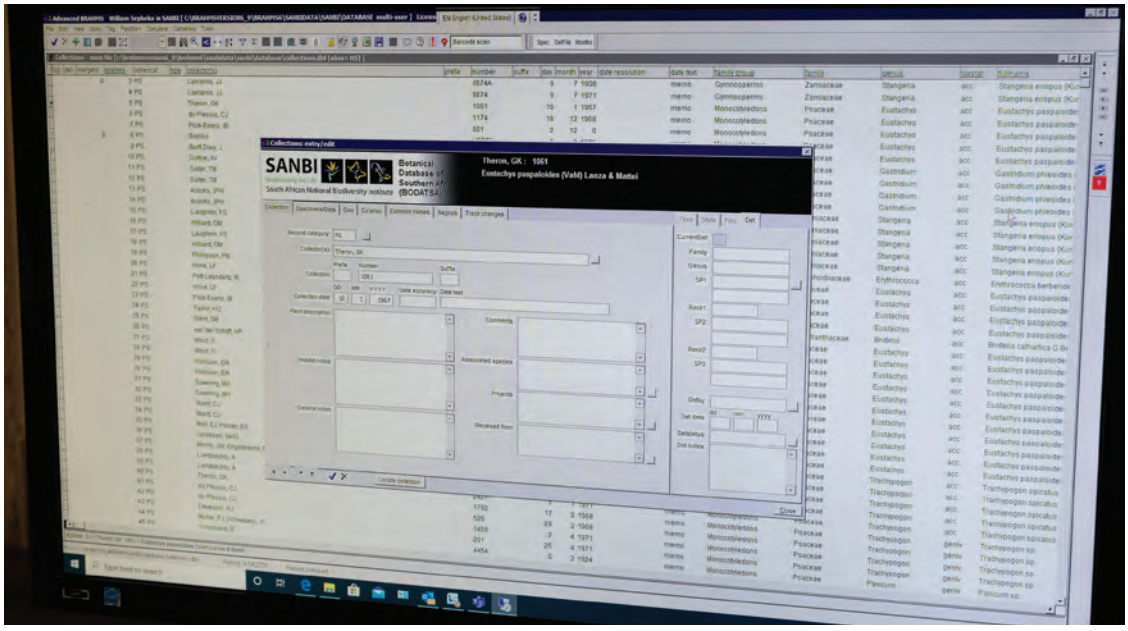
informs decisions about staff collecting trips and collection object/s that will be accepted through donations or exchanges. Institutions must not change focus according to the interests of individual staff members because this leads to fragmentation and duplication at a national level and the burden of orphan collections when staff retire or leave the institution. It also leads to dilution of resources and neglect of existing collections.

1.5 Procedures for Collection Object/s Coming into Collections

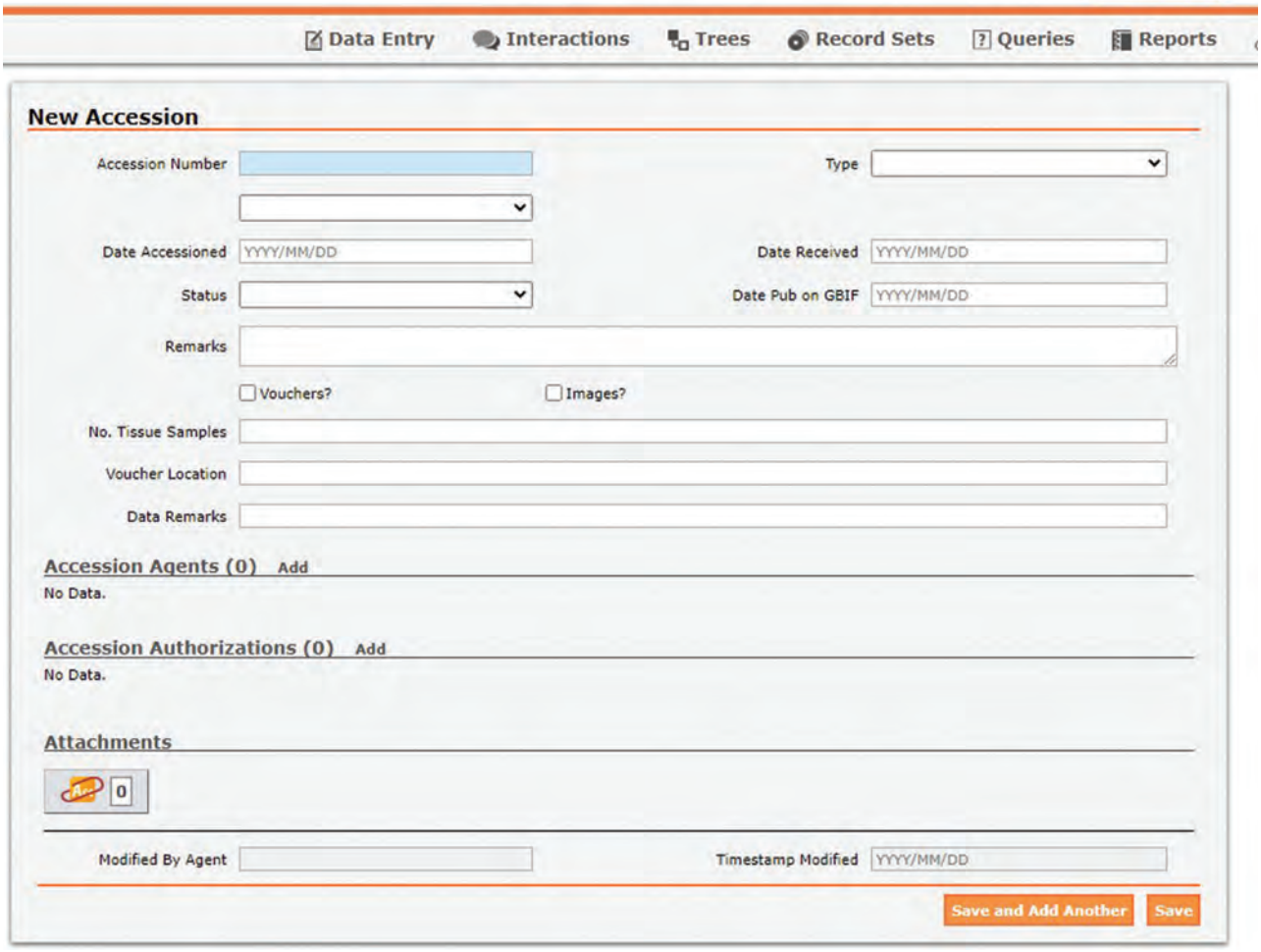
A **documented workflow (SOP) for incoming collection object/s**, that details each step in the process and roles and responsibilities and timeframes, is required for institutions / collections. The sequence of actions and the details of each action will depend on the type of collection object, the type of collection and the size and scope of the institution (i.e., whether it includes a single or multiple collections, and the number and responsibilities of staff), and the nature of the incoming collection objects (whether a gift, collected by staff, or loaned from another institution or collection objects received for identification). For institutions that have collections of taxa considered to be **high risk in terms of the spread of disease** (e.g., mammals), an SOP that details how this material will be handled in order to prevent contamination or infection is a legal requirement in terms of the Animal Disease Control Act. This SOP must also document the waste management processes for materials such as tissue, packaging and discarded parts of the collection object.

1.5.1 Registration of all collection objects entering the institution

- All collection objects / lots coming into an institution must be recorded in the acquisitions register, as described above. This includes objects from staff collecting trips, donations, exchanges or collection objects received temporarily on loan or for identification purposes. Ideally, this should be done through a central point or person at an institution, rather than by the staff in separate



Data entry form for new botanical collection objects in the Brahms database



The data entry form for new acquisitions in a Specify database
- image provided by SAIAB

collections. At this stage it may be acceptable to record a summary of the consignment that has been received (e.g., 35 prepared study skins of Rhabdomys, 34 skulls of Rhabdomys in vials), rather than details of each object.

- Each incoming consignment should be assigned a unique registration / acquisition / accession number which is recorded with details of the consignment. The registration number will accompany the collection object/s at all times while held by the institution. A single number can apply to all individual objects in the consignment, if there are a large number of objects.
- Details of each collection object or lot (a container holding many individuals of the same species, from the same collecting event) can be recorded in the electronic database, once documented in the register. The accession or acquisition number assigned to an object or a lot must be recorded in the electronic database, as a link between the register and the database.
- For each acquisition, all documents received with the consignment must be recorded, and the documents must be filed in hard copy and / or electronically, with the unique registration and acquisition / accession number for the consignment. This includes permits, the donation form, field notes, images and publications relating to the consignment.
- The final fate of each consignment must be recorded in the acquisitions register (e.g., accessioned into collection, returned to loaning institution, identification completed and collection object/s or lot/s returned to their owner, and the date of completion).

1.5.2 Accessioning collection object/s into the collection

- A tracking (acquisition) form (see example in Appendix A1.4) should accompany each collection object / consignment along each step of the workflow and must be signed and dated by the recipient at each step. This is especially important when there are multiple steps (e.g., treatment / decontamination, identification, preparation, digitisation, labelling and incorporation into the collection), and different staff are involved at each step.
- Collection objects must be decontaminated in the case of pinned insects, skins, skeletal collection object/s and herbarium collection objects, before being processed beyond the reception room.
- Fluid preserved collection objects should be rebottled if necessary (e.g., if they are received in sealed plastic bags), and the lids checked, to ensure that there is no leakage, and they should be topped up with the correct preservative before being processed through the different steps of accessioning and cataloguing.
- Existing collection object numbers or labels (those that were with the collection objects when they were received) should be checked to ensure that these are well secured before being processed through the different steps of the workflow. This is especially important for herbarium sheets or labels tied onto collection objects as there is a possibility that the collection object and its label may become separated.
- Collection objects should be identified as far as possible before being incorporated into the collection.
- Collection objects must be recorded in the collection database before being incorporated into the collection.
- Collection objects must be allocated a unique number (e.g., institutional catalogue number or barcode) and this must be recorded with the collection object record in the database.
- Collection objects must be appropriately labelled, and the new catalogue number marked on the collection object or label, as appropriate, before being incorporated into the collection.

APPENDICES

A1.1. Summary of documents required for acquisitions

POLICIES

- **Collection focus and expansion policy.**
- **Policy on acquisitions** (this could be included in the collections expansions policy, and it should state what materials will be accepted, and what will not be accepted into the institution. This should include not only taxa / type of collection objects, but also statements about proof of legal collection, requirements for donations in terms of documentation, minimum requirements for associated information, requirement that all objects coming into the institution must follow the documented processes for acquisitions, and the requirements / delegations for authorising acquisitions.

SOPS / WORKFLOW

- **Workflow document for the acquisition of collection objects,** which should document the steps, roles and responsibilities for each step, and the expected

timeframes for each step in the process. The workflow should include all steps involved in the processing of incoming objects, from the point at which they are received, to the point where they are incorporated into the collection. There may be separate process documents for detailing how each step or selected steps should be carried out.

STANDARDS

- Minimum standards for **data sheets for field collection of objects** for use by staff should be developed. This should ensure that the data collected meets the requirements for the collections data.

BOOKS & FORMS

- **An accession / acquisitions register book.**
- **Donation forms.**
- **Object tracking slips** are required for all objects / object lots coming into the institution and these must accompany objects / object lots from entry into the institution to final incorporation into the collection.

EXAMPLES OF FORMS

A1.2 Intention to donate forms

DONATION FORM

Donor Details

Name: _____

ID number / Passport number (non-South African citizens / residents): _____

Address: _____ Postal code: _____

Email address: _____ Telephone No.: _____ Cell No.: _____

No. of items: _____ (for large donations, complete after collection objects have been inventoried). Class of items (list all that are known): Insect, Bird, Mammal, Reptile, Plant, Fossil, etc. _____

Date/s Found / Collected: _____ Cause of death: _____

Location where found / Collected: _____ Province: _____

Coordinates if known: _____

Date Received by Institution: _____ (day/month/year)

Donor catalogue number/s (if applicable): _____

Known publications associated with collection object/s: _____

I/we _____ herewith present to the **XY institution**, irrevocably and for the use and purposes of the institution, all rights, title, and interest in the following collection object/s received by the **institution name** on (date) _____: (a detailed list of objects and a list of associated documents, images, data sets may be appended)

Signature of donor: _____ Date: _____

The **XY institution** hereby acknowledges receipt of this donation/gift in accordance with the conditions specified above.

Signature of receiver: _____ Date: _____

To be completed by receiving institution

Accession Number/s: _____ Field Notes/Data submitted: _____

Attached Permits: _____

A1.3 Donation form

Details of the donated collection object/s to be submitted by the donor (may be a separate electronic file (spreadsheet or database).

Donor Catalogue No. (if applicable)	Species / common name	Locality (with coordinates if known)	Name of collector	Date collected / found	Condition of object (good, rotten, etc.)	Data quality (no data, some data, good, etc.)

Provide details of all resources including documents such as permits, data sheets, data sets, images and other materials that are being donated with the objects.

Signed: Donor: _____	Date: _____
Signed: Recipient: _____	Date: _____

A1.4 Basic collection object receipt for tracking collection object/s

This slip / form serves to allow tracing of any consignment or collection objects coming into the institution, from the point that it enters the institution, to the point that it is incorporated into the main collection (in the case of donated or inhouse collected objects) or returned to its owner (in the case of incoming loans or objects submitted for identification. This form must be used for consignments including:

- material on loan from another institution by an internal researcher for study.
- material that is brought to the institution for identification purposes and will be returned to the rightful owner in due course.
- material that is being donated to the institution and will be accessioned, looked at and, catalogued if it is fit to be part of the collection.
- material brought by a visitor, to simultaneously study with material from the visited institution.
- samples from a field trip.

Essentially any collection objects that comes in through the door, whether on a temporary or permanent basis.

The form below will need to be modified according to the workflow of the institution. If a particular section is not relevant to a particular purpose, a line can be drawn through that section (e.g., objects for identification will not be labelled, or mounted).

INSTITUTION LOGO

BASIC COLLECTION OBJECT RECEIPT FORM
COLLECTION OBJECT RECEIVED BY THE INSTITUTION

Purpose (donation / incoming loan / identification / staff collecting trip): _____

_____

_____

Date received: _____ Received by (name and signature): _____

Method of shipment: _____

Received from (individual or institution name): _____

_____

Physical address: _____

_____

Email: _____ Cell No.: _____

Telephone No.: _____ Loan No.: _____

_____

Assign accession No.: _____

Collection group: _____

Consignment description: _____

_____

_____

Number of samples / objects: _____

_____

_____

Decontamination required: Yes/No _____

Decontamination process to be followed: _____

Received for decontamination by (name and signature): _____

Date received: _____

Date decontamination completed:_____

Identification required: Yes / No _____

Details of identification required (level, purpose):_____

Date sent for identification: _____

Received for identification by (name and signature: _____

Date identification completed: _____

Data capture required: Yes / No _____

Date sent for data capture: _____

Received for data capture by (name and signature): _____

Date data capture completed: _____

Labelling required: Yes / No_____

Date sent for labelling: _____

Received for labelling by (name and signature): _____

Incoming loan: Date taken to requesting researcher: _____

Received by (name and signature): _____

Date returned for packing for return to loaning institution: _____

Date sent to loaning institution: _____

Sent by (name and signature): _____

Mounting / rebottling / sorting / pinning - depending on the nature of the collections these steps should be included, and include the date received by the relevant person, and the name and signature of the receiving person, the date of completion of that step.

Date sent: _____

Actions required: _____

Received by (name and signature): _____

Date incorporated into the main collection: _____

Name and signature of person responsible: _____

Data updated in database (catalogue number, identification, location in collection):

Date: _____

Responsible (name and signature): _____

Notes: (include any damage noted, rebottling or topping up of preservative fluid, whether existing labels were removed and where these are now housed etc):

_____

NOTES:

CHAPTER 2: DE-ACCESSIONING COLLECTION OBJECTS

2.1 Background

This chapter deals specifically with de-accessioning, which is defined as the formal, permanent removal of a collection object from the institution's collection, normally as a result of disposal or theft or permanent exchange, after following the stipulated procedures; and the formal process of updating the collection object records, following removal of a collection object from the permanent collection.

De-accessioning of collection objects from a collection or an institution may involve:

- permanent transfer of the collection objects to another institution;
- destruction of collection objects when these have deteriorated or are damaged to such an extent that they are of no value or if they pose a significant risk to the health and safety of staff; or
- amending or updating documentation to reflect permanent loss or accidental destruction of collection objects, or when collection objects have been erroneously catalogued, such as when material on loan from another institution is catalogued.

2.2 General Principles

- All acquisition and de-accessioning decisions should be based on the institution's strategy and policy for collections focus and expansion.
- Old collecting policies, collection management policies, and institution collection scope must be saved as permanent records that will provide information for subsequent generations of staff members about how the institution's acquisition policies have evolved.
- De-accessioning of any collection objects must follow the de-accessioning procedures.
- A significant part of responsible and ethical de-accessioning is making actions transparent and known to collection staff, and the council / board of the institution. There is no need to de-accession secretively because these are responsible practices for better managing collections, although the process may at times call for discretion.
- In acquisition / donation forms it should be stated that the institution has a right to make decisions regarding de-accessioning in the future.
- The legal requirements for donating, exchanging or destroying any collection objects must be determined and complied with. For example, in most cases the collecting permit conditions state that permission must be obtained from the permit issuing authority before the collection objects are transferred to a third party, and in the case of CITES and Threatened or Protected Species it is a legal requirement to maintain thorough records of all such actions.
- It is critical to maintain a full record of the decision-making process, all correspondence and documents relating to legal requirements, and to ensure that the accession and catalogue records are updated to reflect de-accessioning.

2.3 Possible Reasons for De-accessioning of Collection Objects

- The institution collecting strategy (focus) has been refined or altered, and the collection objects fall outside of this strategy.
- The collection objects were accessioned historically and have never been within the focus of the institution.
- The collection object is a duplicate with no added value as part of a series and will be donated to another institution or exchanged for collection objects that will add value to the collection.
- The collection objects can no longer be suitably stored by the institution. The institution can no longer provide appropriate storage space, adequate care, or provide access to the collection objects.
- The convention for a particular discipline is to deposit a paratype or isotype at another institution for the purpose of security.
- The collection objects have been damaged or have slowly deteriorated over time and can no longer be used for research purposes.
- The collection objects pose a significant risk to the health or safety of staff.
- Data associated with the collection objects is poor or non-existent and there are other, better collection objects accompanied with good data that represent the same research value as the collection objects to be de-accessioned.
- Another country or one of its institutions may request repatriation of collection objects collected in their country but held in a South African collection.
- The institution's possession of the collection object is noncompliant with applicable legal or ethical principle (e.g., the collection object was, or may have been stolen or illegally exported or imported, or the collection object may be subject to other legal claims for return or restitution).
- The authenticity of the collection object, or that of the label data, is determined to be false or fraudulent, and the fraudulent collection object lacks sufficient historical and/or scientific value to warrant retention.
- A collection object has been accidentally lost or destroyed.
- Collection objects were erroneously catalogued into the collection such as when material on loan is catalogued.

2.4 Options for Fate of De-accessioned Collection Objects

- De-accessioned collection objects may not be sold.
- A de-accessioned research collection object may be designated as a non-collection item held for interpretive / educational purposes for use within the institution. It may be assigned a non-collection object registration number.
- Collection objects may be exchanged between institutions where there are sufficient duplicates (>10 specimens of the same species from the same collecting event), and where the material gained is in line with the collection focus of the recipient institution.
- De-accessioned collection objects may be donated to other research collection institutions, but not to individuals.
- Collection objects may be destroyed if these have been damaged or deteriorated to such an extent that they cannot serve any research or educational purpose or if they pose a health risk.

2.5 Decision-making Process to be Followed for De-accessioning

- Written recommendations and motivations to dispose of collection objects should go from the collection manager / curator of the collection to the institution's Director, for support, and then to the governing body (e.g., Board or Council) for approval. The decision may be referred to the Minister, in accordance with the Cultural Institutions Act (1998, amended in 2001) for those institutions that fall under this Act.
- For other institutions, the responsible authority for approving the disposal of collection objects must be documented and followed, and there should be a recommender and an approver in the process, so that decisions are not made by individuals acting independently.
- Before an institution removes a collection object from the collection, it must ensure that all required processes have been followed, and that there is full compliance with the relevant legislation.
- If the intention is to donate the collection objects to another institution, their willingness to accept the donation must be obtained in writing from the relevant authority before the proposed de-accessioning is approved.
- Depending on the scale of the project, de-accessioning can cost a significant amount of money through such expenses as personnel time and shipping costs. It's important to calculate the costs and benefits before implementing such a project, to decide if de-accessioning is the correct route for the institution.

2.6 The Process of De-accessioning

Some of these operational guidelines will need to be modified, depending on the nature of the de-accessioning and the type of collection object/s.

2.6.1 Thorough documentation

- Each step of the de-accessioning process requires methodical documentation, and all documents should be retained as a permanent administrative record. An order for the deaccession by the relevant collection manager or curator should be made using a form such as that in Appendix A2.1. Documenting of the process and decisions taken are essential for the upkeep of responsible and ethical practice. Proper documentation regarding what happened to collection objects and the reasons for de-accessioning is crucial for auditors, institutional staff who create and transfer records, researchers who may have published on the de-accessioned material, for past donors and for providing recipients with information.
- The motivation / recommendation for de-accessioning, with support from the relevant collection manager / curator, support or approval from the Director, and where required, support and approval by the board or council, and in some cases, approval by the Minister must be kept on file.
- All de-accessioning must be recorded in the collection inventory in Specify or Brahms, noting the destination of the collection objects, the date of de-accessioning and reference to any documents relating to the de-accessioning and, where relevant, the donation to another institution.
- De-accessioning should also be updated in the acquisitions and catalogue registers.
- Copies of correspondence of the recipient institution (where applicable) relating to the donation, permits, and agreements must be retained on file.

2.6.2 Legal considerations

- Legal issues of ownership of collection objects must be resolved before de-accessioning can occur. Restrictions or commitments in written donor agreements must be taken into account (e.g., embargo periods).
- Export permits out of the province or country are required, and additional permits may also be required for ensuring legal compliance.

2.6.3 The steps of the de-accessioning process

- Identify and list the collection objects that are proposed for de-accessioning.
- The written motivation / recommendation from the collection manager or curator should include the following:
  - Accession and catalogue numbers (whichever exist) and the description of the collection objects.
  - Provenance of the collection objects (where did they come from, and how did they get into the institution?).
  - Check institution records for donor forms and date of acquisition, and if necessary, get advice on the legal status of ownership of the collection objects (e.g., are there any donation forms relating to them? If there are, do they say anything about transferring the collection objects to another institution or destroying them?).
  - Check if there are permits under which the collection objects were collected and any restrictions in these on transfer to a third party. Include this information in the motivation.
  - Reason for de-accessioning (refer to the institution's strategy or policies or resource constraints).
  - Any additional information regarding the collection objects (e.g., condition).
  - Recommended method of disposal, including the proposed recipient institution in the case of a donation, or the mechanism of destruction if that is proposed.
  - In the case of collection objects that will be donated to another institution, obtain a letter stating that they are willing to accept the donation.
  - Estimate of resource requirements for de-accessioning (staff time, materials, and budget).
- If the institution has a committee that assesses acquisitions and de-accessioning, then submit the motivation for input and support, and submit this to the institutional Director, and if necessary, the board / council and Minister.
- Once approval to de-accession of the collection object is obtained, if it will be donated to another institution, an agreement with the recipient institution needs to be finalised before the collection object is moved. This agreement must cover aspects such as responsibility for packing and unpacking, transport, who is responsible for costs, who is responsible for obtaining permits, whether data, documents, storage cabinets or other containers will be donated, at what point is ownership and liability transferred, and any conditions applicable to the collection objects, and the rights of the donor and recipient institutions relating to decision-making for the collection objects, including future use and further transfer / donation.

- Obtain all relevant permits and permissions for donating and, where applicable, export, of the collection objects.
- Indicate the de-accessioning in all institution records such as the card catalogue, accession register and catalogue book, collection object files or electronic database, that the collection objects have been de-accessioned.
- Remember to record in the accession register and catalogue book the fate of the collection objects, so that this is recorded for future workers or to answer queries relating to the collection objects.
- If the collection objects are being donated to another institution, they will need to be appropriately packaged and transported to the new institution. An inventory of the collection objects, and all relevant paperwork (collecting permits, field collection datasheet, donation form, etc.) should be provided with the donation. Once the affected objects have been removed from the collection, a collection object movement record slip (see Appendix A2.2) should accompany the objects until they leave the institution, at which point the form should be filed with other relevant documents.
- If the collection object is to be destroyed, an investigation into the appropriate method must be carried out and followed. Destruction of collection objects should have minimal impact on the environment and/or on the health and safety of staff.
- If the objects are to be destroyed, any labels associated with the collection objects must be retained, and the collection objects should be imaged prior to destruction. These records must be retained on file.
- In the case of de-accessioning based on a lost collection object; it may be necessary to test certainty that the collection objects are actually lost before formally de-accessioning them.
- When there is certainty, or if the collection objects have been destroyed, or if they were erroneously catalogued, records of the de-accessioning and the reason must be recorded in all collection records.
- Never reuse a de-accessioned collection object's number and permanently retain all records relating to the collection objects.

APPENDICES

A2.1 Summary of documents required

POLICIES
- Collection focus and expansion policy.
- De-accessioning policy.

PROCEDURES
- Procedures document for identifying, approving and implementing deaccessioning.

FORMS
- Form for de-accessioning.
- Collection object movement slip.

A2.2 Collection object de-accession order

Collection object de-accession motivation and authorisation			Institution Logo
Document prepared by: Name:		Date: Form completed:	
Collection object/s description			
Catalogue No. / UID	Accession No. / Alternate No.	Collecting event / Series title	Date/s of Collection
List details for each collection object / lot to be deaccessioned.			
Number of collection object / lots (specify whether individual or whether lots / samples, and in the case of lots / samples, provide number (or estimate) of individuals in the sample / lot.			
Location in institution / collection			
Provenance of the collection objects (how did the institution obtain the collection object/s?)			
Proof of institution's ownership			
Reason for de-accessioning			
Recommendation for collection object/s (what should happen to them, and what options were considered?)			
What external opinions have been solicited, and what were they?			
Donor restrictions on the collection objects (e.g., embargos or further donation?)			
Permit restrictions of donation to third party or destruction of collection objects? (if yes detail these)			
Documents or data or images associated with the collection objects? (If yes list these)			
Resources required to dispose of the collection object/s (e.g., staffing time, packing, transport, or destruction costs)			
Deaccessioning Recommended by: Name: _____ Position: _____ Date: _____			
Supported by: Name: _____ Position: _____ Date: _____			
Approved by: Name: _____ Position: _____ Date: _____			
Deaccessioning Recommended by: Name: _____ Position: _____ Date: _____			
Removed from collection by: Name: _____ Position: _____ Date: _____			
Disposal or destruction by: Name: _____ Position: _____ Date: _____			
Records updated by: Name: _____ Position: _____ Date: _____			
Additional notes / comments: _____ _____			

A2.3 Collection object movement record / slip

Collection object movement record / slip	Institution Logo
Slip completed by:	Date:
Accession No.:	Catalogue No.:
Is the CO part of a series?	
Removed from cabinet No.	Removed from shelf/ drawer No.:
Removed by:	
Removed to:	
Reason for removal: _____ _____	
Notes: In the case of de-accessioning, record the date that the objects were dispatched to another institution, or that they were destroyed, and include the name and signature of the responsible person. _____ _____	

NOTES:

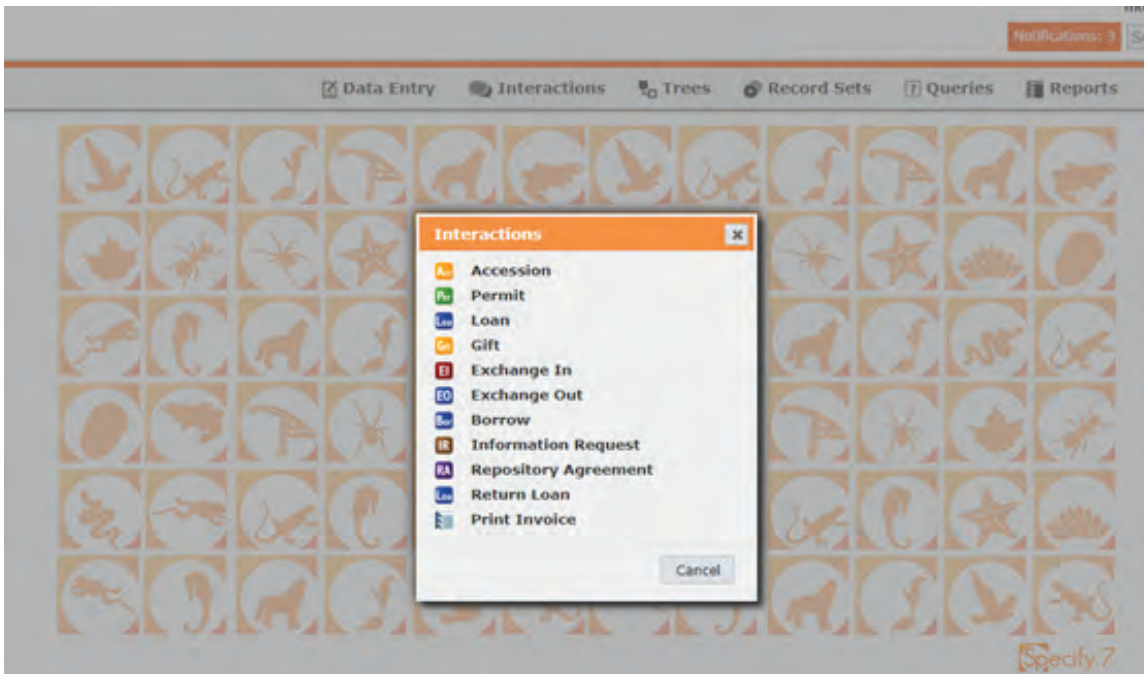
CHAPTER 3 : DOCUMENTATION OF COLLECTION ACTIVITIES

3.1 Background

The need for maintaining documentation relating to the collections has become increasingly important in terms of compliance with various pieces of legislation (e.g., Threatened or Protected Species Regulations and CITES registration and Animal Disease Control Act) and to comply with audit requirements. In addition, maintenance of full records detailing the source of collection objects and preservation and conservation interventions is critical for performing different types of analyses for research purposes, and for ensuring the integrity of the collections for future generations. Documentation of collections is recognised globally as being a critical aspect of curation practice, and the ICOM International Committee for Documentation (CIDOC) provides various fact sheets, procedures and standards, which have been used to inform some of the guidelines and standards presented below.

While in the past hard copies of documents were standard, and this practice is still recommended by ICOM, many institutions have moved to electronic documentation systems. This may be acceptable, but in some cases (e.g., CITES), a "permanent" record is required, which means that hard copy documentation of accessioned objects should be maintained, in order to register as a scientific institution. In the case of electronic databases and documents, professional levels of electronic document management and security systems are essential to avoid the loss, the corruption or the misuse of information and to ensure accessibility into the distant future. Maintenance of information on an individual's desktop computer is not an acceptable document management system. Important collection-related documents should be printed and filed as a permanent record to make sure that the information is still accessible for future generations responsible for a collection.

Example of hard copy catalogue registers, including two archival volumes on the right



Specify menu showing the different functions (interactions) available for electronic management of collections activities - *image provided by SAIAB.*

The following documentation categories are covered here as the minimum requirements:

1. Institutional policies, standards and procedures.
2. Acquisitions: acquisitions form, accession record, intention to donate forms, donation forms, permits, other documents accompanying incoming collection objects (e.g., field notes, images, literature).
3. Collection object inventory.
4. Collection preservation and conservation on two levels:
   i. collection object level; and
   ii. collection level.
5. Access to collections: access requests, visitors, loans, other materials supply registers, and permits and agreements associated with access.
6. Disaster assessments and records.
7. Health and safety documents.
8. Backup copies and storage of documents.

3.2 Standards for Documentation

3.2.1 Institutional policies, standards and procedures

All institutional strategies, policies and guidelines should form part of the document management system, either as a separate electronic folder or integrated with the relevant sets of documents. These must be readily accessible to all staff as well as to the public. Ideally, these should be accessible on the institutional website.

3.2.2 Acquisitions

- All items accepted temporarily or permanently by a collection institution must be properly, fully and permanently documented to ensure that their origins, identity, requirements and location are traceable. Entry records must be maintained for

collection objects resulting from staff field trips, or donated by an external person or institution, or collection objects on loan, or those deposited temporarily for expert identification.

- Every collection object or collection object lot must be recorded in the acquisition register as soon as it is received.
- Separate registers for different types of acquisitions (e.g., incoming loans, identifications, accessions) or a single register for all types of incoming materials can be maintained. These registers must form a permanent record.
- The record for each collection object / lot must reflect the following information:
  - The nature of the acquisition (whether it is an incoming loan, collection objects for identification, donation or collection objects from a staff collecting trip).
  - A brief description of the collection object / lot (e.g., parcel containing 120 herbarium sheets of Fabaceae as an incoming loan for Dr Smith / 28 vials containing mixed freshwater invertebrates from Berg River survey, May 2020, W. Bright).
  - The source person or institution.
  - The mode of delivery (hand delivered, post or courier)
  - The date of receipt
  - Person responsible for documenting receipt (name and signature).
  - Temporary location of the material (where it has been placed immediately after receipt).
  - A list of documents that were received with the collection object / lot (permits, donation form, images, field notes etc.).
  - Any relevant notes (these may be about the donor or the collector or the purpose for which the collection objects were collected, or if the collection objects are linked to a publication, specific survey or study, or if there are any restrictions or embargos on the collection objects).
- A temporary number should be assigned to the collection object / lot to allow it to be tracked, and this should be recorded in the register, and on a temporary label attached to the object / lot, which also includes details of the collection object / lot. This is sometimes referred to as the "accession number".
- For items received on a temporary basis, once returned to the owner, the date on which this was done must be recorded in the register, with the name and signature of the person recording this.
- For collection objects that are likely to be catalogued into the collection permanently, in addition to the details recorded in the accession record, the following documents need to be filed and numbered, so that they can be linked to the entry in the register and the collection objects:
  - completed donation form.
  - collecting permit/s.
  - field notes.
  - data sheets.
  - Image.
  - any literature or other documents relevant to the collection object/s.
- Once catalogue numbers / barcodes have been assigned to individual collection objects, these numbers or in the case of a large number of collection objects in a lot, the start and end number of the series, must be recorded in the acquisition / accession register, together with the location of the collection objects in the collection and the date of formal cataloguing and incorporation into the collection.

Specify database opening page showing tabs with options along the top of the page and drop-down menu for selecting the category for new acquisition in the database *- images provided by SAIAB.*

- If incoming collection objects are not accessioned into the collection for some reason (e.g., poor condition), this must be recorded in the register, together with the fate of the collection objects and date. This is also applicable to individual collection objects received as part of a lot, if they are discarded, returned to the donor or donated to another institution.

3.2.3 Collection object inventory (database)

- All collection objects permanently accessioned into the collection must be included in an inventory, which is in the form of an electronic, searchable database. This must ensure that the links between individual collection objects and all associated data are maintained.
- As a minimum, the following should be recorded in the inventory:
  - The catalogue number / barcode.
  - Any old catalogue numbers or collector numbers.
  - The scientific identification (species name).
  - Who identified the collection object/s (determined by)?
  - The locality where the collection object was collected.
  - The collector.
  - Date of collection.
  - Type status (where applicable).

Example of a fluid preserved object showing the locality information on the collection object label *- image provided by ARC.*

- Additional information such as re-determinations, date of determination, date of accession, locality co-ordinates, habitat description, collecting method, link to any scientific publication where the collection object is referenced, are valuable, but not always available, especially for historical collection objects. Further details for database fields and standards are provided in the data management chapter (Chapter 4).
- Each collection object / lot must be assigned a unique number (sometimes referred to as the "catalogue number") or barcode, which is recorded in the inventory / database, and marked on the collection object and / or on an attached or inserted label. Such marking must not damage the collection object or obscure features of taxonomic importance. Any previous markings must be preserved (if possible) and recorded.
- Ideally, a hard copy of the inventory should be maintained. Registering an institution for CITES permit exemption for the exchange of materials requires that a permanent catalogue book be maintained. This may be in the form of a handwritten catalogue book, or a printout of the database, with a new version printed every one to five years and appropriately labelled with the printout date. If an institution chooses not to maintain a hard copy inventory, then the database must be archived on an annual basis, with appropriate metadata which includes the date of archiving.

3.2.4 Conservation and management of individual collection objects and samples

- The inventory / database must be used to record the following information for individual collection objects or lots relevant to curation / collection management:
- Information on the preparation method, (e.g., the composition of preservative substances, or the type of mounting board and adhesive, the labelling material and method).
- Location of the collection object / lot in the collection (can be a coded system for room, cabinet and shelf).
- Any embargo or restrictions on access and expiry date for this.
- Condition of collection object/s and any change in this (linked to images if possible).
- Any conservation or restoration action applied specifically to the collection object or lot.
- Any movement of the collection object / lot in the collection (collection object movement slip).
- If a collection object is subsampled or a sample is split, the date and reason for this.
- If the collection object or lot is sent on loan (can be in the form of a link to the loan number).
- Any change in the unique number for the collection object / lot and the reason and date for this.
- Link to the permit/s under which the collection object / lot was collected or state that there is no collecting permit for the collection object / lot.
- Link to any permits under which the collection object / lot was exported on loan or subsampled / DNA extracted for export.

NOTE: Much of this information will be absent for older collection objects but efforts should be made to find and add to the information from accession registers and catalogue books, publications, illustrations, as well as the undocumented knowledge of the curator and/or collection manager of that particular collection. Collection object collectors are also sources of information.

3.2.5 Curation and management at the collection level

A file should be maintained that includes the following information:

- **Collection overview / summary**

A summary of each collection, including the following may be kept as a hard copy or digitally:

- Name and scope of the collection: higher taxon / taxa, or collection theme (e.g., Malaise trap samples collected as part of ongoing monitoring programme in the Western Cape, or vouchers from a medicinal plant study by Rev. Smithers in the 1920s), and the nature of the collection object / lot (e.g., herbarium sheets or mixed fluid preserved samples, or small mammal skins).
- Number of collection objects / lots of each broad type.
- Description of approach to organisation of the collection (e.g., based on a particular phylogeny (APG III or APG IV) and reference for the particular phylogeny used, and/ or alphabetically arranged and at what taxonomic level).
- Overview of location (name of building, location within a building (e.g., in collection storeroom on first floor of Herbarium Building or distributed in three storerooms, one in basement, one on ground floor and one adjacent to staff offices on second floor)
- Storage conditions for each collection / storeroom including:
  - Intended temperature and humidity (at what temperature and humidity is the collection maintained?).
  - Light exposure (e.g., room kept dark unless in use; collection objects kept dark in cabinets).
  - Climate control mechanisms / equipment.
  - Fire detection and suppression system in each storeroom (present absent and if present, type).
  - Any structural faults in the storeroom (e.g., large crack in ceiling or water leaks after heavy rain etc.).
  - Storage equipment (e.g., compactor shelving, open shelving, wooden herbarium cabinets).
  - Storage consumables (e.g., herbarium collection objects mounted on board or varying quality and thickness; or Consol jars with Consol manufactured plastic lids).
  - Type and concentration of preservative fluids used in fluid preserved collections
- General assessment of the condition of the collection, with a brief explanation for the assessment.

- Date on which the summary was compiled.
- Name and signature of compiler.
- Authorisation of the summary (designated manager responsible for collections).

This summary information should be updated at least annually, but previous records must be maintained on file.

- **Collection-level monitoring, results and interventions**

Records should be kept of results of climate control and pest monitoring that include:

- the date/s of monitoring period (start and end).
- method used.
- where monitoring equipment was placed (preferably, images where possible).
- results and outcome (i.e., were any adjustments made to settings, or was equipment serviced or upgraded or was pest control implemented as a result?).

- **Records of any pest outbreaks or fungal or bacterial infections should be maintained, including:**
  - dates, location, photos of damage caused.
  - remedial actions taken (e.g., fumigation including type of fumigant used and method of application, isolation of incoming material).

- **A record should be kept of any large-scale collection management / conservation actions carried out, including:**
  - scheduled checking of preservative levels and concentrations.
  - pest checks.
  - relabelling.
  - cleaning or other activities.
  - the dates.
  - staff involved
  - extent of work and any points of interest.

If institutions have recording sheets for inspections or checks these should be kept on file with other relevant collection level information.

- Any **historical records that are relevant to conservation and collection management / storage** should be kept on file.

3.2.6 Documentation process of de-accessioned collection objects

- Record all decision-making processes such as minutes where a formal meeting was held to decide on de-accessioning.
- On a de-accession form, record at least:
  - quantity, group or name of collection objects de-accessioned.
  - date of authorisation of de-accessioning.
  - method of disposal and date of disposal.

3.2.7 Documentation standards for access to collections and data

- **Access requests and queries**

A standard access request form is recommended (see Chapter 6 on access to collections and their data), and these requests, as well as any other records of communication pertaining to collection visits, loan or data requests should be kept on file and be linked to Specify or Brahms records.

- **Visitor register**

A visitor register should be maintained that records name, identity number (passport or student card), contact details and institution address of collection visitors, as well as date/s of visit.

Example of a visitor register which is signed by all collection visitors on arrival - *image provided by ARC*

- **Loan register and documents**
  - A loan register must be maintained that lists summary information for all loans, including:
    - researcher name and institution to which loan was sent.
    - number and nature of collection objects and description of taxa.
    - shipping method.
    - loan period including date sent and return date.
    - whether the collection objects were imaged before sending.
    - any special conditions.
    - extensions granted.
    - person responsible for packing the loan.
    - person who authorised the loan.
    - links to the loan invoice.
    - export permit, Material Transfer Agreement.

- Where the information is captured in Specify or Brahms, it must be printed and filed.
- When the loan is returned the following information must be recorded in the loan register:
  - date received.
  - shipping method.
  - person who checked the loan.
  - person who signed off on the returned material.
  - condition of collection object/s on return (with images where necessary).
  - any other relevant information.
  - date that loan return acknowledgement receipt form sent, and the method used to send the loan acknowledgement receipt.
- Loan invoices, which include a list of all collection objects included in the loan, export permits and Materia Transfer Agreements, and loan return acknowledgement receipts must be kept on file and linked to the loan - register (manually and electronically). These can be printed from the database and backed up.

- **Register of DNA samples or material for DNA extraction**
  - A register of all samples provided for destructive sampling / DNA extraction or DNA extracts must be maintained. This should include the following information:
    - name, contact details and institution of the requester.
    - purpose of the request (e.g., research project, PhD study).
    - a summary of the material supplied (number of samples, what these include – taxon and type of material) and any conditions applied to the supply of data.
  - The register must link to the access request form, and to the export permit, Material Transfer Agreement and Benefit Sharing Agreement.
  - The results of any DNA analysis must be provided, with repository accession number for the sequence data. This must be recorded with the entry in the register, together with the reference to any publication resulting from the analysis of the material.
  - All relevant documents relating to the provision of materials for DNA analysis should be maintained on file and linked to the register.

- **Data and image request register**
  - A register of all data and image requests and a summary of the data and images sent in response must be maintained. This should include:
    - name, contact details and institution of the requester.
    - purpose of the request (e.g., research project, PhD study, EIA assessment, Red List assessment etc.)
    - a summary of the data or images sent (number of records / images, what these cover).
    - any conditions applied to the supply of data.
  - The register must link to the access request form.

3.2.8 Documentation for recording disasters in the collections disaster report

A disaster report should be compiled for any event where collection objects are damaged, destroyed or lost. This may be through flooding, fire, structural collapse, or theft. This report should document:

- The nature of the disaster.
- The date/s on which it occurred.
- A preliminary assessment of the cause.
- Details of the location where the disaster occurred.
- A general account of damage done.
- Photographs of the damage to infrastructure and to the collection objects.
- Reference to records / documentation of damage assessments carried out.
- Details of salvage efforts and methods.
- Photographs of the response and recovery operations.

- **Damage assessment forms**
  - Damage Assessment Forms, suited to the specific collection and prepared in advance must be used to record the following information for any collection objects damaged or destroyed:
  - Accession, catalogue, group or series number (If number is missing or unreadable, assign a supplemental number for tracking purposes. The system used to assign the supplemental number should be clear and easy to follow).

Example of paperwork required for reporting an accident - image provided by ARC

- Type of collection object/s.
- Location in the collection storeroom.
- Condition of the collection object/s – note type of damage to it.
- The emergency event circumstances.
- Visual records of damaged area/s must be captured with a still or a video camera. Both typical examples of damage and specific collection objects by themselves in situ should be captured. Electronic images must be stored as part of the electronic collection records and referenced in the hard copy documents. For digital photos, printouts can be filed with the damage assessment forms.
- A record of collection object/s moved and the location to where they have been moved must be kept, and any subsequent movement recorded, including when the collection object/s are returned to the original storeroom.

• Documenting restoration efforts

All restoration efforts applied to damaged collection objects must be recorded, including details of which collection objects have been treated (this may be done in the collection object inventory / database, but reference should be made to this in the general document for the disaster).

3.2.9 Documentation process for health and safety

While institutions should deal with health and safety documentation as a whole, some records relating specifically to the collections and associated staff should be managed and maintained by collections staff, so that they have a solid understanding of the current health and safety issues and risks. All of these documents must be submitted to the relevant health and safety manager or unit or human resources department, but a copy should be retained with the other collection documentation. The following records should be documented and retained in a risk register or file:

- Standard incident report forms for all health and safety incidents.
- Results of all health and safety inspections and reports done for the collections areas.
- All health and safety related training given to staff.
- A list of all required staff medical tests/surveys and their scheduled test intervals as per suggestion of medical practitioner. Records of when tests were done, and which staff were tested. The results of tests are likely to be confidential and should be managed by the Human Resources or Health and Safety Officer or Manager.
- Records of all air monitoring tests conducted and the results of these.
- Records of all engineering control maintenance and servicing that has been carried out (e.g., extraction unit air leakage test, flow rate, etc.).
- Records of all fire drills, emergency event simulations, and any preparedness exercises related to the collections.
- Records of any testing conducted on collection objects for residues of toxic substances previously used on them.

3.2.10 Documentation back-ups and storage

- Back-up copies of critical documents including the acquisition form, register of incoming collection objects / accession register and catalogue books should be made and kept in a secure location.
- Originals of valuable documents that are not used on a regular basis such as old catalogue books or accession registers should be kept in a secure location such as in the reference section or safe in the library.
- All original records relating to collections, including field notebooks and data sheets, should be scanned and put into the accession records in the Specify or Brahms database, and the actual documents must be preserved (kept in the library or in an environmentally controlled area).
- Databases need to be backed up offsite on a regular basis, following a documented procedure.

APPENDIX

A3.1 Summary of requirements relating to collection document management

POLICIES

- Documentation / archive policy. This should state that all documents relating to the collection must be retained by the institution, including field data sheets; whether these are kept in the original or copy form, where they are stored, the use of a dating and versioning system, for what purpose archival documents can be used and who controls access to these, which documents can be disposed of and when, and whether there is an authorisation process for disposal, whether there are any limitations or requirements for use of archival documents (external users, commercial use, acknowledgements). Printed images (photographs) and artwork associated with the collections (line drawings, paintings) should be included in this policy.

STANDARDS

- Standards for storage, access and handling of archival documents.
- Standards document for labelling and versioning of documents, including policies, workflows, standards and process documents.

PROCEDURES

- Process document for lodging / filing of current documents, including how documents should be stored (hard copy vs digital, central repository), where they are stored (institutional server, library, admin office cabinet), and in what form they should be stored (ring file, ring bound, permanently bound, filing cabinet, digital repository), and steps from draft, to final version and sign off, recording in register.

REGISTERS (hardcopy or digital)

- A register for all documents, including the date of sign off / update and person responsible for the document.

CHAPTER 4: COLLECTION DATA MANAGEMENT

4.1 Summary of Requirements for Data Policy, Databases and Shared Datasets

- The points below are a summary of the NSCF data standards and requirements presented in this chapter. These are intended for quick reference. The details are in the main body of the chapter.
- Institutions should have a data management and sharing policy that is consistent with the NSCF Access Policy for collections and their data. Guidelines for such policies are provided in Appendix A4.1.
- An institution should aim to have all specimen records digitized, within capacity constraints.
- Data management workflows and processes should be documented and followed. Some guidelines for these workflows are provided in Appendix A4.1.
- Data cleaning and upgrading processes must be efficient while conforming to standards.
- Data that are shared and published should be correct, complete, consistent, and comprehensive (see the text for what this means).
- When publishing data to public platform records for sensitive species (see the National Sensitive Species List, nssl.sanbi.org.za) must be removed prior to publication. When serving individual data requests, sensitive species records should only be provided to bona fide researchers and conservation agencies.
- New specimen records for extant taxa can be embargoed for a maximum of five years from the date of collection. For fossils, the maximum embargo period is eight years.
- Metadata for published datasets should indicate appropriate citation of the institution, and when serving individual data requests users should be requested in writing to provide appropriate acknowledgement.
- Shared data should have Darwin Core column headings. Required and recommended Darwin Core terms are provided in the tables of this chapter.
- Data values must be in the correct fields/columns of databases and shared or published datasets.
- Shared and published data must follow formatting standards of the Darwin Core and NSCF standards. Dates must be in ISO8601 format (e.g., `2012-02-16`, or `2012-02-16/03-15` for a date range) and agent names as [surname], [initials with full stops and spaces], e.g., `Smith, J. L. B.` Text must be trimmed of white space and have any double spaces, tabs, new lines, and invisible characters removed. Special characters in text must be preserved. Decimal coordinates should be to a maximum of six decimal places. Standard vocabularies following the recommendations of TDWG should be followed.
- Fields in shared datasets should be ordered to be logical and facilitate ease of use. A recommendation is provided in this chapter.
- Field names in shared and published datasets should be preceded by the relevant namespace abbreviation of the standard they belong to (e.g., `dwc:catalogNumber` and `dc:licence`).
- Institution and collection codes must follow the international standard at www.gbif.org/grscicoll.

- Taxon and geographic boundary (e.g., country or province) names must match an authority such as a taxon backbone or the Getty Thesaurus of Geographic Names.
- Metadata for published datasets should include measures of data quality to facilitate assessment of fitness for use. Potential measures of data quality are suggested.
- Digitization projects should include a data quality assurance step where newly captured records are checked for correctness.
- During digitization, data should be recorded verbatim from labels or the catalogue book, and these verbatim values should not be changed or removed during data cleaning or upgrading processes.
- Data cleaning workflows should be efficient and manual work, minimised by the use of automated tools as far as possible. When doing data cleaning or upgrading, changes must always be recorded back to the original database.
- Workflows for georeferencing localities and specimen identification should ensure that high quality metadata are associated with those georeferences and identifications.
- Georeferencing should follow a modified point-radius method, where a measure of coordinate uncertainty is recorded. Categories for radial coordinate uncertainty are provided. In some rare cases it is more sensible to provide an alternative measure of uncertainty, defined by a spatial polygon instead of a radius (see dwc:footprintWKT).
- New identifications should include supporting data such as the name of the identifier, the date of identification, the identification method, and an indicator of certainty.
- For born-digital data (specimen records that are originally provided in digital format), the original datasets should be preserved, and workflows must ensure that the data are appropriately mapped and imported into the institutional database.
- Institutional data should always be appropriately backed up and stored safely, to prevent data loss in the event of database corruption or failure.

4.2 Background and Purpose of this Chapter

The specimen data held by museums and herbaria is one of their most valuable assets. Most natural science collections traditionally recorded the data for their specimens in catalogue books or catalogue cards. The information held in these books or cards is called primary biodiversity data – the foundational information base representing where and when species were recorded in geographic space and time. Over the last few decades these data have largely been moved to electronic databases of various types.

Specimen data are used in a wide range of research and practical applications, from modelling species distribution ranges and developing a better understanding of biodiversity patterns to IUCN Red List assessments and environmental impact studies. There has been a global drive to mobilize these data online, openly and freely through the Global Biodiversity Information Facility (GBIF) and other platforms; to facilitate research and applied uses and to ultimately address the global environmental crisis currently faced by humanity. Specimen data are important, and they should be treated and managed as an asset in their own right, at the institutional level.

One of the significant challenges to managing specimen data in natural science institutions has been the lack of standards that can guide the development of policy and processes for data management. The purpose of this document is to propose such standards, as well as policy and process guidelines for NSCF partner institutions in South Africa. Specimen data management is tightly integrated with broader collection management processes in natural science institutions, and proper data management can support better collections management overall. More broadly, a goal of having these standards is to facilitate data use by the wider user community, primarily scientists and conservationists. The standards presented here provide a basis against which data management practices within institutions can be developed and evaluated, as well as for identifying capacity development needs for data management within institutions and across the NSCF network.

This chapter begins with an overview of principles of data quality, which lay the foundations for policy, process and standards development. A standard for required data fields for datasets is then presented, based on the internationally accepted Darwin Core standard, with specific guidelines on how the Darwin Core should be implemented within the NSCF network. Appendices to this chapter are provided which indicate the mappings of Darwin Core fields to fields in Specify and Brahms. The topics of namespaces, codes for institutions and collections, formatting standards for particular data types like dates and collector names, and standard vocabularies are also introduced. Following these concepts are the kinds of tests that might be applied to datasets to identify errors or data quality issues, based on the work of the TDWG Biodiversity Data Quality working group. Protocols for georeferencing are also provided (Appendix A4.3). The NSCF will provide tools to automate data quality testing and upgrading processes. Guidelines for data management processes within institutions are provided, and some standards for imaging of specimens are presented.

This chapter aims to provide the information needed by data managers in institutions, to undertake their work according to accepted standards, to provide a resource for readers interested in improving their knowledge of data management practice, and to provide the foundations needed to guide improvement, upgrading and standardization of datasets and databases in institutions.

4.3 Principles of Data Quality

Given that specimen datasets are a valuable asset under the care of natural science institutions, it is important that institutions strive to ensure the best possible levels of data quality. The topic of data quality is covered in detail in Chapman (2005) and much of what is presented here is based on that document.

4.3.1 Data quality means fitness for use

When assessing data quality, it is important to understand what the data will be used for, termed “fitness for use”. Specimen data are used for a wide range of purposes within natural science institutions and by the broader external community. An important use within institutions is for collection management purposes such as providing a register of institutional holdings, assessing the size and growth of collections, associating collecting permits and collector notebooks

to specimens, and recording loans and loan histories of specimens. Uses by the wider scientific community are very broad, including taxonomic research, climate change research, conservation biology, invasive species research, biogeography and macroecology. Powney & Isaac (2015) provide an insightful overview.

An assessment of data quality means assessing whether the data are of sufficient quality to support these uses. For specimen data this can be challenging because many potential uses are not known when the data are generated or curated. Therefore, data should be generated and maintained at the highest possible levels of quality so that they may support the broadest range of uses possible.

The key components of specimen data can be summarised as "what, where, and when". This refers to what type of organism was recorded, where on the planet it was recorded, and when it was recorded. Additional important components for collection management are the catalogue or accession number for the specimen as well as its storage location in the collection.

The core concepts of data quality are that specimen data should be Complete, Correct, Comprehensive, and Consistent. These can be remembered as the four 'C's of data quality.

- **Complete**

Being complete means that there aren't data missing. All relevant fields have values if those values exist for the record of that specimen. While it is an ideal that all data should be recorded in specimen databases, capacity constraints often require that particular fields be prioritized for data capture, while others are excluded. The required and recommended fields below from the Darwin Core standard should be used as a guideline for such prioritization.

- **Correct**

Specimen data must be correct. Correctness means that there are no errors in the data. Errors might be spelling mistakes in taxonomic names, or locality data having been recorded incorrectly. The source of truth for data correctness should be the original data recorded for the specimen, as represented on the specimen label or the catalogue book entry for that specimen. An important principle is to retain the specimen data as they were originally recorded as far as possible in specimen databases, and not to modify the original data arbitrarily.

- **Comprehensive**

Comprehensiveness means that data should be as rich and meaningful as possible for the range of potential uses to which they may be applied. A good example of comprehensiveness is when an identification has additional data such as who the identifier was, when the specimen was identified, and the level of confidence of the identification. This helps users assess fitness for use for their particular applications and can be assessed much more easily than the case where only a taxon name is available for the identification. Another important example is for georeferences, where supporting information on the source of coordinates and their uncertainty is important for a range of different uses.

Another important dimension of comprehensiveness is that when data are shared or published, as many fields as possible should be provided to maximise benefits and potential for use by users. The tables of required and recommended fields below provide a guideline in this regard, but the principle should be that if a field is present and contains values it should be included in shared and published datasets.

- **Consistent**

Consistency means that data should be standardized as far as possible. Examples are that dates and agent names should be consistently formatted, a standard taxonomy should be used, and that standard vocabularies are used so that the same concepts are represented by the same terms. Guidelines for data formats and standard vocabularies are provided in the data standards section below.

4.3.2 Data cleaning

Data cleaning is the process of identifying errors in datasets and correcting those errors. Errors may arise when data are captured from labels or catalogue books and errors are not detected before the data are incorporated into the specimen database. Errors also arise when data are incorrectly modified in the specimen database. Data cleaning ensures that data are Correct and Complete. Data cleaning might involve extracting the data from the database and then running it through a number of data cleaning processes or using different data cleaning tools. Very often more than one process or tool is required to identify different kinds of errors. A commonly applied example of a data cleaning process is mapping specimen records in a GIS and looking for outliers to identify incorrect georeferences or identifications. Open Refine (openrefine.org) is a valuable data cleaning software tool that is worth learning for anyone involved with data management. A tool designed specifically for biological specimen collections data is Kurator (wiki.datakurator.org). The NSCF will also be developing tools to facilitate data cleaning. An important principle with data cleaning for specimen data is that any errors that are identified or changes made should be made in the main specimen database, and not only on extracts from that database. This improves the quality of the database overall and removes the need for different users to correct the same errors repeatedly in their own analyses.

4.3.3 Data upgrading

Data upgrading refers to the process of making improvements to data that already exist. The main types of data upgrading are georeferencing locality records that don't have coordinates, updating taxonomy and checking specimen identifications. Data upgrading can also include standardizing particular fields like dates and collector names. Data upgrading makes specimen records more consistent and comprehensive. It is important for georeferencing and identification that appropriate protocols are in place to ensure that the results are correct, comprehensive, complete and consistent. For example, a georeferencing process must, as a standard, record any uncertainty, who the georeferencer was, when the record was georeferenced, and what the source of the coordinates was (see Guidelines for Data Management Processes below). Upgrading specimen identifications is usually done by a taxonomic expert who works through a collection, makes sure that the most recent, accepted taxon names are applied, and corrects incorrect identifications. Supporting fields for georeferences and identifications are referred to as record

level metadata and are important for facilitating fitness for use. Data cleaning and upgrading processes are interrelated. For example, checking for geographic outliers first requires georeferencing. It is important that institutions have well defined processes for data cleaning and upgrading, so that they are done efficiently and produce maximum value.

4.4 Institutional Policy and Standard Operating Procedures for Data Management

Institutions should have a policy on data management in place, as well as documents that describe their various data management processes, such as processes for data cleaning, georeferencing, and serving data requests from external users (see section on processes below for guidelines). The policy should have a broad focus and should include a statement on the institutional policy on data access, which should be aligned with the NSCF Access Policy. It should not include standard operating procedures (a common mistake in data related policy documents) as these are likely to need revision more frequently than the institutional policy itself. A template for policy statements that can be used by institutions to guide policy development is provided in Appendix A4.1.

4.5 Sensitive Data, Embargoes and Redaction

An important consideration for managing biodiversity datasets, particularly when sharing datasets or servicing data requests, is that certain data might need to be withheld. These could be data for sensitive species or data embargoed to protect researchers' or originators' interests. Data might also need to be withheld if they are of economic significance. Each of these cases is addressed below.

4.5.1 Sensitive species data

An important concern with primary biodiversity data is that data for sensitive species, namely those that might be harmed through unsustainable collection, exploitation or harvesting from the wild, should be protected appropriately. This issue of sensitive species data has been workshopped extensively by SANBI and its partners, and SANBI currently hosts a National Sensitive Species List (http://nssl.sanbi.org.za), which indicates species that should have their data protected. These have been identified through expert consultation, using a well-defined set of criteria. The intention is to have a nationally agreed list of species for which data are protected, rather than leaving this decision to individual scientists, taxon experts, or collection management staff.

The criteria relate to potential trade in these species, where individuals might potentially be harvested from the wild to such a degree that such harvesting might impact negatively on the extinction risk of the species. Species that are widespread and grow or reproduce quickly might be able to sustain relatively high levels of harvesting. Localized, specialised, slow reproducing species are more likely to be at risk of unsustainable harvesting. The primary drivers of unsustainable harvesting in South Africa are collection for the exotic pet trade, the muthi (traditional medicine) trade, and the ornamental plant trade.

The NSCF standard for sensitive species data is that ALL sensitive species records should be excluded from public datasets, such as those published through GBIF. When servicing data requests, collection managers must carefully consider who they are providing data to and only provide sensitive species records to bona fide, recognized researchers or conservation agencies. The alternative strategy is to generalize or remove or decrease the resolution of locality data, and the Darwin Core provides dwc: dwc:dataGeneralizations and dwc:informationWithheld terms to indicate this. However, field-level data redaction or generalization carries the risk that by indicating the existence of a record, potential users might work out its details by comparing it with other records collected nearby or by the same collector on a particular collecting expedition or obtaining the record directly from its source if staff are not aware of the sensitivity.

Where sensitive species records are excluded from datasets this MUST be indicated in the metadata for the dataset as the removal of those records can impact certain types of analysis using the data, such as species richness estimates and other biodiversity and ecological studies.

4.5.2 Data embargoes for protecting researcher interests

Another important consideration in determining which data should be embargoed is protecting researchers' or originators' interests. Very often there is a lag of several years between collecting a new species in the field and having that species formally described. Providing data for such specimens publicly might jeopardize the opportunity for a researcher to describe their discovery by enabling unscrupulous competitors to scoop them. Conversely, it is also important that newly discovered species, and particularly those that are rare or of conservation concern, are described within a reasonable period of time. This topic has received much deliberation during NSCF meetings and workshops. A more complex scenario is the case where a researcher is revising a larger taxonomic group. Taxonomic revisions can take a long time, and new discoveries made during revision also need to be protected.

- The NSCF standard for embargoing newly discovered species (excluding fossils) is five years from the collection date.
- For fossils, the maximum embargo period is eight years, but this is also linked to the validity period of the permits under which specimens are collected, and the time period is governed by the South African Heritage Resources Act.
- For undescribed species discovered amongst historical material during the course of a taxonomic revision, the maximum embargo period is five years.
- New material collected for the purposes of a revision can be embargoed for the duration of the revision, provided this does not exceed five years.
- Records for specimens collected before commencement of a revision cannot be embargoed.

4.5.3 Data embargoes for species of economic importance

Some institutions hold collections of economically or agriculturally important species. Public release of data for such species might have negative impacts on the agricultural sector or the economy of the country as a whole. In such cases these records are permanently embargoed from public release.

4.6 Data Attribution and Ethical Conduct when using Data

Collections data should be provided by institutions to the user community openly and freely, without restriction. Open data sharing provides prestige, encourages data re-use and so increases the return on investment in generating and maintaining those data, it facilitates new avenues of scientific enquiry, but most importantly, it better capacitates society as a whole, to respond to, adapt to, and mitigate the impacts of climate change and the biodiversity crisis. However, open data sharing is a relatively new practice in science, and much has been written about it. Many scientists are still reluctant to share data as there are risks involved. A body of research on practices and barriers to data sharing exists, and readers are directed to Enke et al. (2012), Poiset et al. (2013), and Fecher et al. (2015).

It is important that the scientific community in natural science collection institutions foster a culture of data sharing and ethical use of shared data. To this end, the NSCF recommends the following practices:

- use open data wherever possible.
- when using open data in scientific publications or other published products, the originating institution for the data must be acknowledged. If data are obtained from a source such as GBIF, the originating institutions should be acknowledged and not only the data platform.
- when using open data, consider collaboration and co-authorship with the data originators if this will add value to your work, or if their contribution through collecting data warrants it.
- scientists should not use open data to scoop other scientists of their discoveries. When reviewing publications, reviewers should be aware of this risk and alert journal editors if they suspect scooping. Institutions, professional networks and societies, and informal networks should also strongly discourage scooping.

4.7 Data Aggregation

Mobilizing specimen datasets is a globally recognized priority for natural science institutions. GBIF (www.gbif.org) is the primary provider of specimen and observation records on the internet, and at the time of writing includes over 1.3 billion records from more than 1500 institutions. GBIF serves the role of a data aggregator, taking data from several different sources and combining those data into a single data portal, where data can be searched and downloaded. The existing datasets for South African institutions receive several downloads a day, indicating the extent to which GBIF data are accessed as well as the value of publishing data online. Other data aggregation tools and platforms exist as well. The Atlas of Living Australia (ALA, www.ala.org.au) is a well-known example that provides data for Australian natural science institutions online. Symbiota is a taxon focused data aggregation tool that allows communities of users to set up dedicated taxon specific portals. At the time of writing, Symbiota is used for 38 data portals covering taxa from lichens to invertebrates.

Data standards are essential for data aggregation as they allow for datasets with standard field names to be integrated easily with each other. Darwin Core is the most widely used data standard, and is the standard that GBIF, ALA and Symbiota are built on. An alternative standard is the Access to Biological Collections Data

(ABCD, abcd.biowikifarm.net), which is used by the network of institutions in the BioCase project (biocase.org).

Data aggregation for scientists

Individual scientists, particularly taxonomists, often have the need to integrate specimen records they receive from several different institutions. The typical workflow for a taxonomist involves obtaining loans of their taxon of interest from a number of institutions, together with the data for those specimens. The time that it can take to then standardize those records from different institutions and aggregate them into a single dataset that can be used for mapping or other analyses can be substantial. One of the goals that the NSCF has in promoting data standards is to minimise the time required by scientists to process data received from a number of different institutions.

Most scientists simply use spreadsheets to manage the datasets they use for their research. OpenRefine (openrefine.org) is also a valuable tool that researchers can use to clean data. For data aggregation, researchers can use R (www.r-project.org) and the bind_rows() function of the dplyr package, or Python with the concat() or append() functions of the pandas package, which automatically merges columns with the same column headings. Again, the use of standards for column names is important to facilitate aggregation in this way.

4.8 The NSCF Data Standard

The NSCF data standard is derived from the Darwin Core (dwc.tdwg.org/terms). The Darwin Core is an international standard for data sharing developed by the TDWG (www.tdwg.org). The NSCF standard is a subset of Darwin Core fields that have been selected and identified as either required or recommended fields for datasets. Required fields must be included in datasets provided, to serve data requests from individuals, or when providing data to SANBI or the NSCF, or publication to platforms such as GBIF.

While the required fields indicate the minimum data that should be provided to serve data requests, the aim should always be to provide as much data as possible to service requests and when publishing data (thus applying the data quality principle of comprehensiveness). There have been cases in the past where minimal data were provided to data users, such as taxonomists, and those users have had to re-digitize data from labels themselves when those data already existed in the institutional database. The intention in providing a standard based on the Darwin Core is that these standards can be mapped to the relevant fields in specimen databases for individual collections, where mappings of the fields in those databases to the Darwin Core terms may vary. Standard mappings of the Darwin Core terms to fields in Specify and Brahms are provided in Appendix 2. These standards should also be considered in new data collection initiatives as well as digitization, data cleaning and data upgrading projects within institutions.

The Darwin Core term definitions and comments are taken here from the Darwin Core website (dwc.tdwg.org/terms). Some of the examples from the website have been modified to give them a southern African context. Additional comments and guidelines for how these fields should be used are provided.

NSCF specimen data terms based on the TDWG Darwin Core standard. Definitions are as per the Darwin Core standard available at https://dwc.tdwg.org/terms. Terms should prepended with the 'dwc:' namespace in datasets so it is clear what they mean. See Appendix for mappings of these terms to Specify and Brahms fields. Required terms are indicated with **.

Darwin Core Class	Darwin Core term	Darwin Core definition	Darwin Core comments	Darwin Core Examples	NSCF comments
Record-level	institutionID**	An identifier for the institution having custody of the object(s) or information referred to in the record.	For physical specimens, the recommended best practice is to use an identifier from a collections registry such as the Global Registry of Biodiversity Repositories (http://grbio.org/).	For SAIAB: 'http://biocol.org/urn:lsid:biocol.org:col:34984'	Note that the new URL for GRSciColl is https://www.gbif.org/grscicoll. Codes for institutions and collections can be located on this site. For dwc:institutionID the full URL for the institution should be used, as per the example for SAIAB.
Record-level	collectionID**	An identifier for the collection or dataset from which the record was derived.	For physical specimens, the recommended best practice is to use an identifier from a collections registry such as the Global Registry of Biodiversity Repositories (http://grbio.org/).		See notes regarding GRSciColl above. At the time of writing collection IDs are not available on the website.
Record-level	basisOfRecord**	The specific nature of the data record.	Recommended best practice is to use the standard label of one of the Darwin Core classes.	`PreservedSpecimen`, `FossilSpecimen`, `LivingSpecimen`, `MaterialSample`, `Event`, `HumanObservation`, `MachineObservation`, `Taxon`, `Occurrence`	For records from natural history collections this value is always going to be PreservedSpecimen, but this is important for integration with other datasets so that users can differentiate different sources of records.
Record-level	accessRights**	Information about who can access the resource or an indication of its security status.	Access Rights may include information regarding access or restrictions based on privacy, security, or other policies.	`CC BY-SA`	For NSCF purposes the relevant licence title can be indicated. The preferred licence class for open sharing of data is CC BY-SA. Note that this is a Dublin Core term, so the namespace identifier is 'dcterms:'.
Record-level	ownerInstitutionCode**	The name (or acronym) in use by the institution having ownership of the object(s) or information referred to in the record.		`SAIAB`, `TMSA`	It is important to include this field so that there is no confusion as to which organization must be accredited for the specimen record in any use of that record. It should not be left to the assumption that users will refer to dwc:institutionCode.
Record-level	modified**	The most recent date-time on which the resource was changed.	Recommended best practice is to use a date that conforms to ISO 8601-1:2019 and ISO 8601-2:2019.	See examples under dwc:eventDate	Note that this is a Dublin Core term, and should be appended with the 'dcterms:' namespace identifier.

Darwin Core Class	Darwin Core term	Darwin Core definition	Darwin Core comments	Darwin Core Examples	NSCF comments
Record-level	institutionCode	The name (or acronym) in use by the institution having custody of the object(s) or information referred to in the record.		MVZ, FMNH, CLO, UCMP	This should be the standard, internationally recognized code for the institution, as indicated on GRSciColl (www.gbif.org/grscicoll).
Record-level	collectionCode	The name, acronym, coden, or initials identifying the collection or data set from which the record was derived.		Mammals, Hildebrandt, EBIRD, VP	This should be the standard, internationally recognized code for the collection, as indicated on GRSciColl (www.gbif.org/grscicoll).
Occurrence	occurrenceID**	An identifier for the Occurrence (as opposed to a particular digital record of the occurrence). In the absence of a persistent global unique identifier, construct one from a combination of identifiers in the record that will most closely make the occurrenceID globally unique.	Recommended best practice is to use a persistent, globally unique identifier (GUID) such as a UUID* or a permanent URL. *A UUID is a computer generated, long code broken into sections separated by dashes that is guaranteed to be globally unique, e.g. 000866d2-c177-4648-a200-ead4007051b9	`http://arctos.database.museum/guid/MSB:Mamm:233627`, `000866d2-c177-4648-a200-ead4007051b9`, `urn:catalog:UWBM:Bird:89776`	The GUID must be minted by the holding institution of the record. It cannot be generated by third party data sharing or aggregating platform, and should not be removed or replaced in such platforms. dwc:catalogNumber cannot be used as a unique identifier as some collections do not allocate catalogue numbers to their specimens, and where they do, they are not guaranteed to be unique within the collection (catalogue numbers are often duplicated in collections) even though they are intended to be, and uniqueness across institutions also cannot be guaranteed. Note that permanent, resolvable URLs for individual specimens will be available as 'https://purl.org/[NSCF path]/[dwc:institutionCode]/[dwc:collectionCode]/[dwc:occurrenceID]', e.g. https://purl.org/nscf/saiab/ac/000866d2-c177-4648-a200-ead4007051b9. The NSCF recommendation is to use UUIDs as the GUID, without resolving details.

Darwin Core Class	Darwin Core term	Darwin Core definition	Darwin Core comments	Darwin Core Examples	NSCF comments
Occurrence	catalogNumber	An identifier (preferably unique) for the record within the data set or collection.		`PRE0023421`, `SAMC-ENW-B1234`	This should be the number used within the collection to identify the record and the specimen/s it belongs to, as it is used in that institution. The catalogue number is also often called the accession number. For plant specimens it will usually be the barcode number for the specimen, unless no barcode is allocated in which case a traditional catalogue/accession number is used (which will be deprecated when a barcode is added). The NSCF standard is that dwc:catalogNumber should include institution or collection codes if these are included in this field in the specimen database. This departs from the Darwin Core standard which intends to separate these codes into other fields as the catalogue number cannot be automatically reconstructed from atomized fields without the rules for doing so. Ideally, data users, such as taxonomists, should cite catalogue numbers as they are indicated in the museum specimen database, i.e. including the institution/ collection codes, to maintain consistency and discoverability by electronic means.
Occurrence	otherCatalogNumbers	A list (concatenated and separated) of previous or alternate fully qualified catalogue numbers or other human-used identifiers for the same Occurrence, whether in the current or any other data set or collection.	Recommended best practice is to separate the values in a list with a vertical bar (|).	`FMNH:Mammal:1234`, `NPS YELLO6778 | MBG 33424`	This should include catalogue numbers from other collections where the specimen was previous housed if it is donated to a new institution or moved to another collection. Importantly, for cases where a collection changes its catalogue number format, but the number stays the same, the old format should also be recorded in this field. For example, the South African Museum added institution and collection codes to their catalogue numbers several years ago. So `SAMC-ENW-B1234` should be stored in dwc:catalogNumber and `B1234` should be stored in dwc:otherCatalogNumbers.

Darwin Core Class	Darwin Core term	Darwin Core definition	Darwin Core comments	Darwin Core Examples	NSCF comments
Occurrence	recordedBy	A list (concatenated and separated) of names of people, groups, or organizations responsible for recording the original Occurrence. The primary collector or observer, especially one who applies a personal identifier (recordNumber), should be listed first.	Recommended best practice is to separate the values in a list with space vertical bar space (|).	`José E. Crespo`, `Oliver P. Pearson | Anita K. Pearson` (where the value in recordNumber OPP 7101 corresponds to the collector number for the specimen in the field catalogue of Oliver P. Pearson).	This is normally referred to as the collectors for preserved specimens. The NSCF standard is that names should always be represented as [surname], [initials with full stops and spaces], e.g. `Engelbrecht, I. A. | du Preez, A. | Labuschagne, C.`
Occurrence	recordNumber	An identifier given to the Occurrence at the time it was recorded. Often serves as a link between field notes and an Occurrence record, such as a specimen collector's number.		`OPP 7101`	Please note that this term might be confusing as it is ambiguous, but it refers to a number that the collector allocates to the specimens of one species (or thought to be one species) in the field. It is commonly called a collector number. It must not be confused with the Darwin Core term 'fieldNumber', which is a code given to all material arising from a field collecting event (sometimes called a station number). The collector number should be captured verbatim from specimen labels or field notes.
Occurrence	occurrenceRemarks	Comments or notes about the Occurrence.		`gravid when collected`, `found dead on road`, `more abundant lower down the hill`.	Note that this should be remarks typically recorded in the field by the collector, e.g. behaviour, ecological notes, etc. It should not be used to record curatorial notes such as preservation media, storage locations, or a history of edits made to the record.
Occurrence	organismQuantity and organismQuantityType	organismQuantity: A number or enumeration value for the quantity of organisms. organismQuantityType: The type of quantification system used for the quantity of organisms.		organismQuantity 27 organismQuantityType individuals or organismQuantity 12.5% organismQuantityType % biomass	These two terms are complimentary and both are required if either one is used. They are intended to represent the abundance of the organism in the wild at the time of observation or collection. However for museum collections the NSCF standard is to represent the count of specimens in the sample held by the museum, and to use `preserved specimens` in dwc:organismQuantityType

Darwin Core Class	Darwin Core term	Darwin Core definition	Darwin Core comments	Darwin Core Examples	NSCF comments
Occurrence	sex and lifeStage	The sex, age class or life stage of the biological individual(s) represented in the Occurrence.	Recommended best practice is to use a controlled vocabulary.	sex: `female`, `male`, `hermaphrodite` lifeStage: `egg`, `eft`, `juvenile`, `adult`	The definitions of dwc:sex and dwc:lifeStage include data that are often recorded in a single field in a database (e.g. 2M2F2imm for 2 males, 2 females, and 2 immatures) or spread across multiple fields where counts are recorded per sex or per life stage. These need to be processed appropriately to conform to the requirements of these fields. Please note that these fields do not include counts. To represent counts (which can only include totals for the series represented by the catalogue number), see dwc:organismQuantity and dwc:organismQuantityType above.
Occurrence	preparations	A list (concatenated and separated) of preparations and preservation methods for field sample.	Recommended best practice is to separate the values in a list with space vertical bar space (|).	fossil, cast, photograph, DNA extract, skin | skull | skeleton, whole animal (ETOH) | tissue (EDTA)	
Occurrence	associatedMedia	A list (concatenated and separated) of identifiers (publication, global unique identifier, URI) of media associated with the Occurrence.		http://arctos.database.museum/SpecimenImages/UAMObs/Mamm/2/P7291179.JPG, http://204.140.246.24/Fish/Collection%20Pictures/10118-00.jpg | http://204.140.246.24/Fish/Collection%20Pictures/10118-00a.jpg	These should point to a resolvable URL for the media item provided by the institution, or if that is not available, a URL for an online repository such as JSTOR, Flickr, etc.
Taxon	scientificName AND the appropriate combination of taxon fields (family, genus, specificEpithet, etc)**	dwc:scientificName: the full scientific name, with authorship and date information if known. When forming part of an Identification, this should be the name in lowest level taxonomic rank that can be determined. This term should not contain identification qualifications, which should instead be supplied in the IdentificationQualifier term. For family, genus, specificEpithet, etc., it is the full, atomic name of that taxon.		`Coleoptera` (order). `Vespertilionidae` (family). `Manis` (genus). `Ctenomys sociabilis` (genus + specificEpithet). `Ambystoma tigrinum diaboli` (genus + specificEpithet + infraspecificEpithet). `Roptrocerus typographi (Györfi, 1952)` (genus + specificEpithet + scientificNameAuthorship), `Quercus agrifolia var. oxyadenia (Torr.) J.T. Howell` (genus + specificEpithet + taxonRank + infraspecificEpithet + scientificNameAuthorship).	Minimum requirement for the NSCF is a Family for vertebrates or plants, Order for invertebrates, and Phylum or Class for fossils. Please note that for species or infraspecific taxa, dwc:scientificName should have the taxon authority included. Also note that the names and their combinations must match the agreed national reference taxonomy for the taxon as names will be verified against that during data quality testing.

Darwin Core Class	Darwin Core term	Darwin Core definition	Darwin Core comments	Darwin Core Examples	NSCF comments
Taxon	scientificNameAuthorship	The authorship information for the scientificName formatted according to the conventions of the applicable nomenclatural code.		`(Pocock, 1897)`, `Wright et al., 2019`, `Smith & Smith, 1956`.	This is important for resolving scientific names if the dwc:scientificName field is provided as the specification for that field indicates that it should include the authority, and programmatically separating the name from the authority for verification against nomenclators is difficult without knowing precisely what the taxon authority part of dwc:scientificName is (although see parser.globalnames.org). The NSCF standard for this field is that 'and' should be represented with the ampersand (&) character for two-author authorities, and that authority name and year should be separated by a comma.
Taxon	verbatimScientific Name	Not currently a Darwin Core Term, but the scientific name of the taxon the specimen is identified as, as it is recorded on the specimen label or in the catalogue book.			This is useful for recording identifications exactly as written by the identifier, including unusual qualifiers such as question marks, or abbreviated names. Having a verbatim record of original label can assist with interpretation of other fields during assessments of fitness for use.
Taxon	verbatimScientificNameAuthorship	Not currently a Darwin Core Term, but the taxon authority for the scientific name of the taxon the specimen is identified as, as it is recorded on the specimen label or in the catalogue book if it is recorded.			
Taxon	taxonRank	The taxonomic rank of the most specific name in dwc:scientificName.	Recommended best practice is to use a controlled vocabulary	subspecies, varietas, forma, species, genus	

Darwin Core Class	Darwin Core term	Darwin Core definition	Darwin Core comments	Darwin Core Examples	NSCF comments
Taxon	taxonomicStatus	The status of the use of the scientificName as a label for a taxon. Requires taxonomic opinion to define the scope of a taxon. Rules of priority then are used to define the taxonomic status of the nomenclature contained in that scope, combined with the expert's opinion. It must be linked to a specific taxonomic reference that defines the concept	Recommended best practice is to use a controlled vocabulary.	invalid, misapplied, homotypic synonym, accepted	
Identification	acceptedNameUsage	The full name, with authorship and date information if known, of the currently valid (zoological) or accepted (botanical) taxon.		`Boaedon capensis` (the currently valid name) where the record is identified as `Lamprophis fuliginosus`.	This is important where taxonomicStatus is 'synonym' to indicate the current valid name. Including it as a separate field means that synonymy doesn't have to be updated in identifications but only in the taxon backbone of a database.
Identification	nameAccordingTo	The Darwin Core definition is as follows, but see notes for clarification of how we would like it used:The reference to the source in which the specific taxon concept circumscription is defined or implied - traditionally signified by the Latin "sensu" or "sec." (from secundum, meaning "according to"). For taxa that result from identifications, a reference to the keys, monographs, experts and other sources should be given.		If dwc:scientificName is `Pterinochilus murinus`, then dwc:nameAccordingTo could be any of `Pocock, 1897`, `Smith, 1990`, or `Gallon, 2002` (or others).	Taxon concepts clarify the meaning of scientific names, which can become ambiguous in identifications as taxonomy changes. Despite being proposed more than 15 years ago, and being demonstrated to improve the value of specimen data, taxon concepts are still not widely used. The NSCF advocates that taxon concepts should be included when specimens are identified to improve the value of specimen records. The suggested format is `[authorName], [ [year]`.
Identification	identificationQualifier	A brief phrase or a standard term ("cf.", "aff.") to express the determiner's doubts about the Identification, followed by the parts of the taxonomic name that follow that identifier. See the examples.		`cf. pictus` if a specimen label indicates `Opistophthalmus cf. pictus`; `aff. natalitia var. procumbens` for `Crotalaria aff. natalitia var. procumbens` with accompanying values `Crotalaria` in genus, `natalitia` in specificEpithet, `procumbens` in infraspecificEpithet, and `var.` in taxonRank; `pumilio s.l.` indicated a sensu lato identification for `Rhabdomys pumilio s.l.`	Possible values are `cf.`, `nr`, `aff.` and `s.l.` (there may be others). This is usually used to specify uncertainty about an identification, but see Sigovani et al. 2016 Met. Ecol. Evol. 7(10): 1217-1225 who propose stricter use of qualifiers and clarification of the relationship between qualifiers and identification certainty. See also proposed property identificationCertainty below.

Darwin Core Class	Darwin Core term	Darwin Core definition	Darwin Core comments	Darwin Core Examples	NSCF comments
Identification	identifiedBy	A list (concatenated and separated) of names of people, groups, or organizations who assigned the Taxon to the subject.	Recommended best practice is to separate the values in a list with space vertical bar spa space (|).	`Patton, J. L.`, `Pappenfuss, T. | Macey, R.`	The NSCF standard is that names should always be represented as [surname], [initials with full stops and spaces], e.g. `Engelbrecht, I. A. | du Preez, A. | Labuschagne, C.`. This differs from the examples which are provided in the Darwin Core specification, which are modified to conform to the NSCF standard here.
Identification	dateIdentified	The date on which the subject was identified as representing the Taxon.	See dwc:eventDate above	See dwc:eventDate above	
Identification	identificationMethod	The method used for identifying the specimen.	Recommended best practice is to use a controlled vocabulary.	`tacit expertise, `, `field guide`, `taxonomic literature`, `key`, `DNA`, `compared with type material`, `compared with non-type material`, `taxonomic update`, `based on distribution, no examination`, `based on distribution, with examination`	This is not a Darwin Core term but is intended to improve the semantic richness of the identification overall. Recording the method by which a specimen is identified might facilitate better evaluation of fitness for use of records by users not familiar with the taxonomy or expert community for the taxon of interest. For cases where the specimen forms part of a taxonomic description (i.e. it is not specifically identified using existing resources but is the basis of a new resource) the method can be recorded as `material examined` with an in prep. reference recorded in identificationReferences, such as `Engelbrecht in prep. Review of baboon spiders`. Alternatively identifications for such specimens can be updated following publication and the formal citation provided.

Darwin Core Class	Darwin Core term	Darwin Core definition	Darwin Core comments	Darwin Core Examples	NSCF comments
Identification	identificationCertainty	An indicator of whether the identification as provided by the identifier is certain or not.	This should be a binomial value, i.e. yes it is certain or no it is not certain. Existing standards with additional certainty categories are difficult to interpret and implement consistently. Using a binary value also corresponds with traditional taxonomic practice of using a question mark (?) to indicate uncertainty on determination labels.		This is not a Darwin Core term, although it has been proposed. However the NSCF advocates for use of such a field, which is available in many specimen collection databases, to indicate identification certainty. Given the pervasive problem of incorrect identifications in museum collections, this field, together with dwc:identification VerificationStatus should be given priority in specimen data improvement initiatives. Taxonomists are encouraged to include these two fields in their standard workflows when identifying specimens.
Identification	identificationReferences	A list (concatenated and separated) of references (publication, global unique identifier, URI) used in the Identification.	Recommended best practice is to separate the values in a list with space vertical bar space (|).	For a southern African mammal identification an example might be `Smithers, 1986`, or for a thick tail scorpion identified from a published key `Prendini, 2004`.	When doing identifications and indicated the references used, it may be useful also to include page numbers, e.g. `Smithers 1986, p244`.
Identification	typeStatus**	A list (concatenated and separated) of nomenclatural types (type status, typified scientific name, publication) applied to the subject.	Recommended best practice is to separate the values in a list with space vertical bar space (` | `). If the specimen is not a type the value should be null/empty.	`holotype`, `lectotype`	For NSCF purposes, this property can simply indicate the type of type, e.g. holotype. Note that this property is part of an identification, i.e. in combination with the taxon name it typifies the specimen for that taxon name. Therefore, for datasets that do not include identification histories, and the taxon name has subsequently been synonymised, type specimens for those names will not be indicated as types. This is important to avoid confusion.
Identification	identificationRemarks	Comments or notes about the Identification		'Unusual markings on gular area for this species, needs further investigation'	It is important that these are remarks about the identification (i.e. application of a particular name to a particular specimen) and not remarks about the taxon. Remarks about taxa should be recorded in dwc:taxonRemarks.

Darwin Core Class	Darwin Core term	Darwin Core definition	Darwin Core comments	Darwin Core Examples	NSCF comments
Identification	identificationVerificationStatus	A categorical indicator of the extent to which the taxonomic identification has been verified to be correct.	Recommended best practice is to use a controlled vocabulary such as that used in HISPID or ABCD.	0 (“unverified” in HISPID/ABCD)	The NSCF recommendation is that this should be binary, i.e. verified or unverified. Ideally, if an identification is verified the name of the verifier and date verified should be recorded too.
Identification	identificationVerificationBy	The name of the person who verified the identification.			This is not a Darwin Core property, but is intended to add to the semantic richness of the identification record in the case where the record is verified by the third party. Facility to implement verifications is not available in most museum collection management databases.
Identification	identificationVerificationDate	The date that the identification is verified			This is not a Darwin Core property, but is intended to add to the semantic richness of the identification record in the case where the record is verified by the third party. Facility to implement verifications is not available in most museum collection management databases.
Location	country**	The name of the country or major administrative unit in which the Location occurs.	The TDWG recommended best practice is to use a controlled vocabulary such as the Getty Thesaurus of Geographic Names.	`South Africa`, `Colombia`, `España`	The NSCF standard is that geographic boundary names should always be in English.

Darwin Core Class	Darwin Core term	Darwin Core definition	Darwin Core comments	Darwin Core Examples	NSCF comments
Location	**stateProvince**	The name of the next smaller administrative region than country (state, province, canton, department, region, etc.) in which the Location occurs.	Recommended best practice is to use a controlled vocabulary such as the Getty Thesaurus of Geographic Names.	`Gauteng`, `Western Cape`, ` Bié` (Angola).	This must be the current level two administrative division that the locality falls into. It should not have old province names, such as 'Cape' or 'Transvaal'. It should also not have an indication of the type of administrative division, such as 'Prov.', 'Distr.', etc (this should be recorded in a separate field if needed). These values will be verified against an authority during data quality checking. Importantly, for cases where a locality footprint falls into more than one province (e.g. a locality '5km from Rust de Winter' covers three provinces), the province field must be left blank.
Location	**locality OR decimalLatitude and decimalLongitude****	dwc:locality: the specific description of the place. Less specific geographic information can be provided in other geographic terms (higherGeography, continent, country, stateProvince, county, municipality, waterBody, island, islandGroup). This term may contain information modified from the original to correct perceived errors or standardize the description. dwc:decimalLatitude and dwc:decimalLongitude are decimal coordinates, in number format (i.e. no directional or unit symbols like `N`, `SW`, or `°`)		`Jansenville, 12km NW`, `Farm Uitzak, 186km NW Upington`, `Pietersburg (Polokwane)`, `Fairie Glen Nature Reserve, Pretoria` .	For the NSCF, if a locality value is not available, coordinates must be provided as dwc:decimalLatitude and dwc:decimalLongitude. For example, specimens collected at sea might not have a specific locality name provided. If locality is supplementary to verbatimLocality then it should not include abbreviations like 'NP' or 'Nat Res'. These should be spelled in full. Note that locality names can be generated a posteriori from coordinates using tools such as GIS or the GeoNames service.
Location	**verbatimLocality**	The original textual description of the place.		`Percy Fife NR, Potgietersrus`	This must be the locality exactly as it is written on the specimen label. Strictly speaking it should be a property of the Occurrence, or even MaterialSample, as the locality may be written differently on every specimen label for a series of specimens from one collection event. In practice localities are often changed when they are recorded off labels or from catalogue books without a record of the original text.

Darwin Core Class	Darwin Core term	Darwin Core definition	Darwin Core comments	Darwin Core Examples	NSCF comments
Location	verbatimCoordinates	The verbatim original spatial coordinates of the Location. The coordinate ellipsoid, geodeticDatum, or full Spatial Reference System (SRS) for these coordinates, if indicated, should be stored in verbatimSRS and the coordinate system, if indicated, should be stored in verbatimCoordinate System.		`224532.3S 185344.2E`	This is preferred to dwc:verbatimLatitude and dwc:verbatimLongitude for the sake of simplicity.
Location	verbatimSRS	The ellipsoid, geodetic datum, or spatial reference system (SRS) upon which coordinates given in verbatimLatitude and verbatimLongitude, or verbatimCoordinates are based.	Recommended best practice is to use the EPSG code of the SRS, if known. Otherwise use a controlled vocabulary for the name or code of the geodetic datum, if known. Otherwise use a controlled vocabulary for the name or code of the ellipsoid, if known. If none of these is known, use the value unknown.	`unknown`, `EPSG:4326`, `WGS84`, `NAD27`, `Campo Inchauspe`, `European 1950`, `Clarke 1866`.	
Location	verbatimElevation OR verbatimDepth	The original description of the elevation (altitude, usually above sea level) or depth below the local surface (usually for marine sampling) of the Location.		`100-200 m`	Where available, dwc:minimumElevationIn Meters and dwc:maximum ElevationInMeters (or their depth equivalents) can be provided as an alternative.
Location	decimalLatitude and decimalLongitude	The geographic latitude and longitude (in decimal degrees, using the spatial reference system given in geodeticDatum) of the geographic center of a Location.		`-27.098342`, `32.443256`	These should always result from a georeference. If coordinates are provided with the specimen, even if they are decimal degrees, they must be recorded in dwc:verbatimCoordinates and copied here. Also note that these should only be precise to a maximum of six decimal places, and four decimal places is often sufficient to capture the precision of a georeferenced locality. More decimal places imply precision beyond what is sensible for organisms recorded in the field.

Darwin Core Class	Darwin Core term	Darwin Core definition	Darwin Core comments	Darwin Core Examples	NSCF comments
Location	geodeticDatum	The ellipsoid, geodetic datum, or spatial reference system (SRS) upon which the geographic coordinates given in decimalLatitude and decimalLongitude as based.	Recommended best practice is to use the EPSG code of the SRS, if known. Otherwise use a controlled vocabulary for the name or code of the geodetic datum, if known. Otherwise use a controlled vocabulary for the name or code of the ellipsoid, if known. If none of these is known, use the value unknown.	`EPSG:4326`, `WGS84`, `NAD27`, `Campo Inchauspe`, `European 1950`, `Clarke 1866`, `unknown`.	This is almost always going to be WGS84 for southern African collections.
Location	coordinateUncertaintyInMeters	The horizontal distance (in meters) from the given decimalLatitude and decimalLongitude describing the smallest circle containing the whole of the Location. Leave the value empty if the uncertainty is unknown, cannot be estimated, or is not applicable (because there are no coordinates). Zero is not a valid value for this term.		30 (reasonable lower limit of a GPS reading under good conditions if the actual precision was not recorded at the time). 71 (uncertainty for a UTM coordinate having 100 meter precision and a known spatial reference system).	In practice georeferenced accuracy should be recorded in two fields in collections databases, one of the value and one for the unit. This allows for different units, e.g. m or km to be used when georeferencing, and dwc:coordinateUncertaintyIn Meters can be calculated easily. The NSCF standard is to use categorical uncertainties, as developed by SANBI. These are `10m`, `50m`, `100m`, `250m`, 500m`, `1k`, `2k`, `5k`, `10k`, `50k`. Anything that can't be georeferenced more accurately than 50km should not be georeferenced, or indicated as 'indet.'.
Location	georeferencedBy	A list (concatenated and separated) of names of people, groups, or organizations who determined the georeference (spatial representation) for the Location.	Recommended best practice is to separate the values in a list with space vertical bar space (|).	`Papenfus, G.`	These georeferenced metadata fields are important for inferring fitness for use of specimen records, in a similar way to which we use metadata fields for identifications. The NSCF standard is that names should always be represented as [surname], [initials with full stops and spaces], e.g. `Engelbrecht, I. A. | du Preez, A. | Labuschagne, C.`.
Location	georeferenced- Date	The date on which the Location was georeferenced.			See dwc:eventDate for required format for dates and examples.

Darwin Core Class	Darwin Core term	Darwin Core definition	Darwin Core comments	Darwin Core Examples	NSCF comments
Location	georeferenceProtocol	A description or reference to the methods used to determine the spatial footprint, coordinates, and uncertainties.			The required protocol for NSCF institutions is point-radius, as described in Weiczorek et al. 2006 Int. J. Geog. Inf. Sci. 18(8):745-767, modified with a standard vocabulary for accuracy measures. See dwc:coordinateUncertaintyIn Meters above.
Location	georeferenceSources	A list (concatenated and separated) of maps, gazetteers, or other resources used to georeference the Location, described specifically enough to allow anyone in the future to use the same resources.		`https://www.geonames.org`, `USGS 1:24000 Florence Montana Quad | Terrametrics 2008 on Google Earth`, `GeoLocate`	Georeferencing should ideally be done using a combination of tools. A good toolset for gereferencing in Southern Africa is Google Maps, the SANBI gazetteer, the Fuzzy Gazetteer (isodp.hof-university.de/ fuzzyg), and a GIS with layers for 1:250k topocadastral maps, farm names, and district names loaded. If Google Maps is used to locate a place name it should always be verified against one of the other sources before being used as a source for coordinates.
Location	georeferenceRemarks	Notes or comments about determining the georeference, explaining assumptions made or potential uncertainties.		`Assumed distance by road (R365)`, See other farm by same name 2km NE - assumed this farm based on availability of rocky habitat`.	This may include referrals to the collector, notes about uncertainty, etc. It is another important georeference metadata field that should be used liberally.
Location	georeference-VerificationStatus	A categorical description of the extent to which the georeference has been verified to represent the best possible spatial description.		`verified`, `unverified`	This should simply be binary, as with dwc:identificationVerification Status, for simplicity.
Location	georeference-VerificationBy	The name of the person who verified the georeferenced.		`Steyn, H.`	This is not a Darwin Core field, but important to tracking incorrect georeferences.

Darwin Core Class	Darwin Core term	Darwin Core definition	Darwin Core comments	Darwin Core Examples	NSCF comments
Location	georeference-VerificationDate	The date that the georeferenced is verified.			This is also not a Darwin Core field. See dwc:eventDate for standard format and examples.
GeologicalContext	earliestEonOrLowestEonothem and latesEonOrHighestEonothem	The full name of the earliest latest possible geochronologic eon or lowest or highest chrono-stratigraphic eonothem or the informal name ("Precambrian") attributable to the stratigraphic horizon from which the catalogued item was collected.		`Phanerozoic`, `Proterozoic`	For palaeontological collections.
GeologicalContext	earliestEraOrLowestErathem and latestEraOrHighestErathem	The full name of the earliest/latest possible geochronologic era or lowest/highest chronostratigraphic erathem attributable to the stratigraphic horizon from which the catalogued item was collected.		`Cenozoic`, `Mesozoic`	For palaeontological collections.
GeologicalContext	earliestPeriodOrLowestSystem and latestPeriodOrHighestSystem	The full name of the earliest possible geochronologic period or lowest chronostratigraphic system attributable to the stratigraphic horizon from which the catalogued item was collected.		`Neogene`, `Tertiary`, `Quaternary`	For palaeontological collections.

Darwin Core Class	Darwin Core term	Darwin Core definition	Darwin Core comments	Darwin Core Examples	NSCF comments
GeologicalContext	earliestEpochOrLowestSeries and latestEpochOrHighestSeries	The full name of the earliest possible geochronologic epoch or lowest chronostratigraphic series attributable to the stratigraphic horizon from which the catalogued item was collected.		`Holocene`, `Pleistocene`, `Ibexian Series`	For palaeontological collections.
GeologicalContext	earliestAgeOrLowestStage and latestAgeOrHighestStage	The full name of the earliest possible geochronologic age or lowest chronostratigraphic stage attributable to the stratigraphic horizon from which the catalogued item was collected.		`Atlantic`, `Boreal`, `Skullrockian`	For palaeontological collections.
GeologicalContext	lowestBiostratigraphicZone and highestBiostratigraphicZone	The full name of the lowest possible geological biostratigraphic zone of the stratigraphic horizon from which the catalogued item was collected.		`Maastrichtian`	For palaeontological collections.
GeologicalContext	group	The full name of the lithostratigraphic group from which the catalogued item was collected.		`Bathurst`, `Lower Wealden`	For palaeontological collections. Note that Darwin Core does include a term for supergroup

Darwin Core Class	Darwin Core term	Darwin Core definition	Darwin Core comments	Darwin Core Examples	NSCF comments
GeologicalContext	formation	The full name of the lithostratigraphic formation from which the catalogued item was collected.		`Notch Peak Formation`, `House Limestone`, `Fillmore Formation`	For palaeontological collections.
GeologicalContext	member	The full name of the lithostratigraphic member from which the catalogued item was collected.		`Lava Dam Member`, `Hellnmaria Member`	For palaeontological collections.
GeologicalContext	bed	The full name of the lithostratigraphic bed from which the catalogued item was collected.		`Harlem coal`	For palaeontological collections.
Event	eventDate	The date-time or interval during which an Event occurred. For occurrences, this is the date-time when the event was recorded. Not suitable for a time in a geological context.	Recommended best practice is to use a date that conforms to ISO 8601-1:2019 and ISO 8601-2:2019.	`1963-03-08T14:07-0600` (8 Mar 1963 at 2:07pm in the time zone six hours earlier than UTC). `2009-02-20T08:40Z` (20 February 2009 8:40am UTC). `2018-08-29T15:19` (3:19pm local time on 29 August 2018). `1809-02-12` (some time during 12 February 1809). `1906-06` (some time in June 1906). `1971` (some time in the year 1971). `2007-03-01T13:00:00Z/2008-05-11T15:30:00Z` (some time during the interval between 1 March 2007 1pm UTC and 11 May 2008 3:30pm UTC). `1900/1909` (some time during the interval between the beginning of the year 1900 and the end of the year 1909). `2007-11-13/15` (some time in the interval between 13 November 2007 and 15 November 2007).	This is the equivalent of a collection date. Note that dwc:year, dwc:month and dwc:day cannot be used to present date ranges, hence the standard requires eventDate and not these three fields.

Darwin Core Class	Darwin Core term	Darwin Core definition	Darwin Core comments	Darwin Core Examples	NSCF comments
Event	fieldNumber	An identifier given to the event in the field. Often serves as a link between field notes and the Event.		`RV Sol 87-03-08`, `Kara01`	Note that this is easily confused with dwc:recordNumber. The difference is that dwc:recordNumber is a collector number specific to a specimen or batch of specimens of the same species, from a single collection event. Hence it is a property of dwc:Occurrence and not dwc:Event. dwc:fieldNumber is a code applied to all specimens collected from a field collecting event, i.e. a single number that refers to the total batch of samples collected during one event, such as all the specimens from a set of terrestrial pitfall traps or suction sample from a marine habitat.
Event	verbatimEvent-Date	The verbatim original representation of the date and time information for an Event.		`spring 1910`, `Marzo 2002`, `1999-03-XX`, `17IV1934`, `2018-v-2`	This is important to record as dates may be interpreted incorrectly when captured into dwc:day, dwc:month, dwc:year, and dwc:eventDate fields.
Event	samplingProtocol	The name of, reference to, or description of the method or protocol used during an Event.		`UV light trap`, `mist net`, `bottom trawl`, `ad hoc observation`,` point count`, Penguins from space: faecal stains reveal the location of emperor penguin colonies, https://doi.org/10.1111/j.1466-8238.2009.00467.x`, `Takats et al. 2001. Guidelines for Nocturnal Owl Monitoring in North America. Beaverhill Bird Observatory and Bird Studies Canada, Edmonton. Alberta. 32 pp.`, `http://www.bsc-eoc.org/download/Owl.pdf`	This corresponds to what is commonly referred to as the collecting method. The standard for museum collections is typically to record the name of the method and not a publication or reference.

Darwin Core Class	Darwin Core term	Darwin Core definition	Darwin Core comments	Darwin Core Examples	NSCF comments
Event	habitat	A category or description of the habitat in which the Event occurred.		`tall Acacia woodland on deep sandy soils`,`valley bottom with vertic clays and norite rock outcrops`, `riffle pool sequence channel`, `kelp beds`.	Habitats change over time, hence the association of habitat with dwc:Event. A repeat visit to site several years or decades apart might find important habitat variables have changed. While it is possible to record detailed habitat information at a site (for example, splitting soil properties into hardness, texture, colour, and structure), and to atomise these values into different fields in a database, it is often simpler easier to record habitat information as text. Habitat data are seldom standardised. Properties of the habitat than can be recorded include terrain unit (`bottom slope` or `stream bed`), slope and aspect, vegetation type, rock type and rock cover, and soil properties. Please note that it should not be assumed that accurate values for vegetation type, rock type, or soil type can be obtained from GIS layers or maps and don't need to be recorded in the field. Maps of environmental variables are often made at much courser scales than what sampling takes place and important habitat variables might be missing on those maps, or habitat derived from maps might be entirely wrong.
Event	eventRemarks	Comments or notes about the Event.		`Cool, windy, recent rain`, `dry, recently burned`	This will most often be used to record the conditions under which sampling took place, including weather and disturbance. As with habitat the simplest is often to record conditions as text rather than in detailed, atomised fields. Variables that can be included are disturbance, temperature, humidity, barometric pressure, wind speed and direction, cloud cover, precipitation (at the time of sampling or recently before), and moon phase or an estimate of percentage illumination when sampling at night. Factors that affect the activity or motility of the organisms being sampled should be given preference.

4.8.1 Summarised list of required and recommended terms for specimen datasets

The following list of 78 Darwin Core terms is summarised from the table above. It is provided to enable an easy means of creating spreadsheets for specimen records by scientists and other workers, with minimal effort. While most natural science collection institutions use databases that have built-in fields that map to these terms, we recognise that there is often the need for individual workers to quickly create spreadsheets for specimen data capture, and this list is intended to facilitate data consistency and ease of integration with other data.

To create a spreadsheet from this list, copy and paste the list from the electronic version of this document (available on the NSCF website) into an empty text file. Do not add spaces and make sure there are no new line or carriage returns in the list. Save the file in .csv format. Then open that text file in Excel or another spreadsheet programme, selecting the comma delimited format when requested. The fields included can then be reordered or removed at will, depending on the needs of the specific project.

The required and recommended terms, excluding geological terms are:
occurrenceID,institutionID,collectionID,institutionCode,collectionCode,
basisOfRecord,accessRights,ownerInstitutionCode,modified,catalogNumber,
otherCatalogNumbers,kingdom,phylum,class,order,family,genus,subgenus,
specificEpithet,infraspecificEpithet,taxonRank,scientificName,
scientificNameAuthorship,typeStatus,taxonomicStatus,identificationQualifier,
identifiedBy,dateIdentified,identifierExpertise,identificationCertainty,
identificationReferences,identificationRemarks,identificationVerificationStatus,
identificationVerificationBy,identificationVerificationDate,
identificationVerificationExpertise,country,stateProvince,locality,verbatimLocality,
verbatimCoordinates,verbatimSRS,verbatimElevation,verbatimDepth,
decimalLatitude,decimalLongitude,geodeticDatum,coordinateUncertaintyInMeters,
georeferencedBy,georeferencedDate,georeferenceProtocol,georeferenceSources,
georeferenceRemarks,georeferenceVerificationStatus,georeferenceVerificationBy,
georeferenceVerificationDate,eventDate,verbatimEventDate,recordedBy,
recordNumber,fieldNumber,samplingProtocol,habitat,eventRemarks,
organismQuantity,organismQuantityType,sex,lifeStage,preparations,
occurrenceRemarks,associatedMedia

The geological terms, which can be added for palaeontological datasets are:
earliestEonOrLowestEonothem,latesEonOrHighestEonothem,
earliestEraOrLowestErathem,latestEraOrHighestErathem,
earliestPeriodOrLowestSystem,latestPeriodOrHighestSystem,
earliestEpochOrLowestSeries,latestEpochOrHighestSeries,
earliestAgeOrLowestStage,latestAgeOrHighestStage,lowestBiostratigraphicZone,
highestBiostratigraphicZone,group,formation,member,bed

4.8.2 Darwin Core terms not in the NSCF standard

The following terms are not included in the set of required or recommended terms of the NSCF standard. However, they can be included in datasets provided to individuals

requesting data, the NSCF, SANBI or GBIF. In such cases, care should be taken to make sure that terms are used appropriately for the data represented in those fields, following the Darwin Core definitions provided at dwc.tdwg.org/terms. Kindly note though that they will not be included in automated quality checking processes of the NSCF.

The terms not included are:
type, language, license, rightsHolder, bibliographicCitation, references, datasetID, datasetName, informationWithheld, dataGeneralizations, dynamicProperties, individualCount, reproductiveCondition, behavior, establishmentMeans, occurrenceStatus, disposition, associatedReferences, associatedSequences, associatedTaxa, organismID, organismName, organismScope, associatedOccurrences, associatedOrganisms, previousIdentifications, organismRemarks, materialSampleID, eventID, parentEventID, eventTime, startDayOfYear, endDayOfYear, year, month, day, sampleSizeValue, sampleSizeUnit, samplingEffort, fieldNotes, locationID, higherGeographyID, higherGeography, continent, waterBody, islandGroup, island, countryCode, county, municipality, minimumElevationInMeters, maximumElevationInMeters, minimumDepthInMeters, maximumDepthInMeters, minimumDistanceAboveSurfaceInMeters, maximumDistanceAboveSurfaceInMeters, locationAccordingTo, locationRemarks, coordinatePrecision, pointRadiusSpatialFit, verbatimLatitude, verbatimLongitude, verbatimCoordinateSystem, footprintWKT, footprintSRS, footprintSpatialFit, geologicalContextID, lithostratigraphicTerms, identificationID, taxonID, scientificNameID, acceptedNameUsageID, parentNameUsageID, originalNameUsageID, nameAccordingToID, namePublishedInID, taxonConceptID, acceptedNameUsage, parentNameUsage, originalNameUsage, nameAccordingTo, namePublishedIn, namePublishedInYear, higherClassification, infraspecificEpithet, verbatimTaxonRank, vernacularName, nomenclaturalCode, nomenclaturalStatus, taxonRemarks, measurementID, measurementType, measurementValue, measurementAccuracy, measurementUnit, measurementDeterminedBy, measurementDeterminedDate, measurementMethod, measurementRemarks, resourceRelationshipID, resourceID, relatedResourceID, relationshipOfResource, relationshipAccordingTo, relationshipEstablishedDate, relationshipRemarks, earliestGeochronologicalEra, fromLithostratigraphicUnit, latestGeochronologicalEra.

4.8.3 Additional requirements for data

In addition to the standards described above, it is important that values are included in the correct fields in databases, and that duplicate specimen records are identified and removed. In some cases, data values accidentally find their way into the wrong fields in a database; and data cleaning processes should aim to identify such cases.

Examples include locality names that look like people's names being recorded as collectors. Collector numbers (dwc:recordNumber) might be recorded as station numbers (dwc:fieldNumber) or vice versa.

4.8.4 Formatting standards

- Items in lists, e.g., dwc:recordedBy and dwc:samplingProtocol, must be separated by the pipe character | as per the convention for the Darwin Core.

- Date fields, e.g., dwc:eventDate and dwc:dateIdentified, must be in ISO 8601-1:2019 and ISO 8601-2:2019 format (see en.wikipedia.org/wiki/ISO_8601, and examples in Table 1 for dwc:eventDate).
- The coordinate fields dwc:decimalLatitude and dwc:decimalLongitude must be expressed to a maximum of six decimal places. More than that is redundant and implies false precision.
- Strings must be trimmed of white space, have any double spaces, tabs, new lines, and invisible characters removed, and must not be quoted or all shown in uppercase.
- Special characters must be correct and not be accidentally transformed as data are moved between character encoding systems.
- When values are unknown or not recorded, they should be represented by null values in a database, not blank strings, or strings 'null', 'unknown', 'not recorded', etc.
- Agent names (dwc:recordedBy, dwc:identifiedBy, etc.) must have the format [surname], [initials with full stops and spaces] - for example 'Smith, J. L. B.'
- Terms from standard, controlled vocabularies (see below) should all be lowercase. For examples, values for dwc:sex can be `male`, `female`, or `male/female`. Use proper case for standard vocabularies of proper nouns such as country names, and upper case for acronyms.

4.8.5 Standard vocabularies

Standard vocabularies should be used for the following fields:
- dwc:typeStatus (a list of accepted type names, e.g., holotype, allotype, etc).
- dc:license (the Creative Commons licence types, listed at https://creativecommons.org/licenses).
- dwc:identificationQualifier (cf. and aff. See Sigovini et al. 2016 Methods Ecol. Evol. 7, 1217–1225 for details of their use).
- Identification certainty (certain/uncertain or true/false).
- dwc:identificationVerificationStatus and dwc:georeferenceVerificationStatus must also be verified/unverified.
- dwc:geodeticDatum (EPSG codes, or WGS84, Hartebeeshoek, Cape, NAD27, NAD83).
- dwc:georeferenceProtocol (Chapman & Wieczorek, 2006; Bloom et al., 2018).
- Standard vocabularies are under active development by the TDWG Biodiversity Data Quality Interest Group's Task Group 4. Data managers in institutions should keep track of these developments, which are available at github.com/tdwg/bdq, and implement them in specimen databases, as necessary.

4.8.6 Order of fields in datasets

When extracting data from databases to service data requests or to share data to the NSCF or SANBI, the data should be ordered as follows:
- Record level terms, and catalogNumber should be first.
- dwc:recordedBy and dwc:recordNumber.
- Taxon fields.
- Identification fields.
- Location fields.
- Geological context fields for palaeontological records.

- Georeference fields (these are separated from the Location fields as they should arguably be a separate class).
- Event fields and any additional Occurrence class fields, excluding dwc:occurrenceRemarks.
- dwc:occurrenceRemarks should be last.

Ordering fields in this way is only a recommendation, and not a strict requirement for datasets provided to the NSCF or SANBI, but ordering them in this way makes the data more readable and will facilitate ease of use.

4.8.7 Namespaces

To ensure that the origin of terms is clear and allows for users to refer to the sources of those terms, ontology namespace prefixes should be used as far as possible, in datasets. For example, dwc:scientificName means that the term or property 'scientificName' originated from the Darwin Core (namespace prefix 'dwc').

The definition for this term is available at dwc.tdwg.org/terms/#dwc:scientificName. Specifying terms in this manner should become standard practice in the collection data management community. The namespaces used in this document are as follows:

- dwc: Darwin Core (see https://dwc.tdwg.org/terms/).
- dc: Dublin Core Terms (for record level metadata; http://dublincore.org/documents/usageguide/).
- ac: Audobon Core Terms (used for multimedia resources; https://www.tdwg.org/standards/ac/).

Another important standard to be aware of is the Ecological Metadata Language (namespace prefix 'eml', eml.ecoinformatics.org), which is used as a metadata standard for Darwin Core datasets. Other important standards that may be of interest are listed at w3c.github.io/web-annotation/model/wd/#namespaces and schema.org.

4.8.8 Institution and collection codes

Institution and collection codes should also be standardized globally, to ensure that they are consistent across different datasets and data portals. The Global Registry of Biodiversity Repositories (www.gbif.org/grscicoll) provides standard identifiers and codes for collections.

Institutions not included in the Registry should contact the Registry and have their institutional details included. These should then be included in datasets using the fields dwc:institutionID and dwc:collectionID.

4.9 Guidelines for Field Data Collection

While the data standard presented here is intended to guide the digitization, cleaning and upgrading of existing specimen collection datasets they can also be used to derive guidelines for field data collection for new specimens.

4.9.1 Locality data

Try to be as precise as possible in forming the locality string. Don't assume that recording coordinates means that precise locality strings are not necessary. The two should corroborate each other.

Recommended practice for locality strings is to include a named place, such as a farm name, hill, dam, etc., as well as a distance and direction from the nearest town. If a distance is given along a road includes the road name (e.g., R353, N12, D1452) and indicate the distance as 'by road' and indicate a starting point for that measurement, usually a junction with another road. Don't guess the distance. If measurement of the distance along the road is required then refer to Google Maps or a GIS on returning from the field.

For insect labels or other very small labels, use an additional field in the database to record an abbreviated version of the locality string. Don't compromise the full locality string to fit it on a label.

For coordinates, make sure to record the coordinates source explicitly (e.g., GPS or Google Maps), and the datum. The datum is vitally important for maintaining accuracy of coordinates (see the NSCF georeferencing protocol in Appendix 3). It is almost always WGS84, but we cannot assume this by default if it not explicitly stated.

Also, very important is that collectors should record an estimate of the coordinate uncertainty in the field at the time the coordinates are taken, and the specimens collected. The uncertainty is the distance from where the coordinates are recorded to the location of the furthest specimen collected. If this distance is several tens of meters (i.e., not hundreds of meters), add the GPS accuracy to the uncertainty.

Coordinates should be represented on specimen labels as [coordinates] 3 [uncertainty] [source] [datum]. E.g., '32 43 42.2S 24 26 48.6E 3 200m GPS WGS84' or 'S28°44.6096 E30°27.6908 3 400m Google Maps WGS84'. This leaves no question as to the details or accuracy.

4.9.2 Habitat data

Habitat is multidimensional, scale dependent and the important variables depend on the taxon being recorded and the purpose of the data collection. Habitat data have not been standardized historically. If the data are not being recorded in a systematic way for a specific purpose or project then it is recommended that collectors record the data as a single string, including the variables that the collector feels are important; assuming that he/she is sufficiently knowledgeable to record these accurately. In terrestrial environments this can include terrain variables, slope, aspect, rock types, plant community descriptions, etc. For aquatic taxa important variables might be water temperature, turbidity, visibility, and channel types or forms. Some habitat variables are consistent at a locality, such as geology or landform, whereas others may change between site visits, such as bare soil percentage or river flow.

4.9.3 Weather conditions

Like habitat, weather conditions are quite complex and interact and thus affect the behaviour of organisms. Weather conditions can often affect collecting success significantly. As with habitat, weather conditions should be recorded by the collector, as they see fit. Typical values to record are temperature, humidity, wind speed and direction, cloud cover, precipitation and soil moisture.

4.10 Data Quality Tests and Assertions

A standard set of data quality tests is needed for identifying potential errors quickly in datasets before they are provided to users or published publicly. The tests indicated here are based on the work of the TDWG Biodiversity Data Quality Interest Group (github.com/tdwg/bdq/projects/2), the tests from Antweb (antweb.org) and the NSCF standards presented above. The order follows the order they are presented on the TDWG Github site, and not in the order of the fields presented above. These tests do not specify which fields are required but are intended as a list of tests that can be selected from to apply to a dataset.

For example, you would only apply TG2-VALIDATION_GEODETICDATUM_EMPTY if you have a dwc:geodeticDatum field in your dataset and you want to assert that it is never empty. These tests are intended to be implemented in code and run on a dataset. The NSCF will be developing tools to help collection and data managers with the task of data cleaning, using these tests.

4.10.1 Taxonomic data (17 tests)

- There must be identification data (NSCF standard). At least one taxonomic data field, up to subgenus, is present, and at least one of those present is not empty.
- If a dwc:taxonID value is present, it is not an empty string and it must indicate the resolving authority (i.e., it needs to be a URL).
- If dwc:taxonRank is presented, it must have a value AND it must be a valid taxon rank, according to the authority being verified against.
- Higher taxon ranks must be presented up to the given dwc:taxonRank. Standard ranks to include are dwc:kingdom, dwc: phylum, dwc:class, dwc:order, dwc:family, dwc:genus, and dwc:specificEpithet.
- The combination of higher taxon values must correspond with those in the resolving authority.
- If there is a dwc:scientificName value and its atomic parts (i.e., dwc:genus, dwc:specificEpithet, dwc:infraspecificEpithet), these must correspond.
- If there is a dwc:scientificName value, it must correspond to a name in the resolving authority.
- There must be no identification qualifier in the dwc:scientificName, dwc:specificEpithet, or dwc:infraspecificEpithet fields.

4.10.2 Geography (25 tests from TDWG/BDQ)

- There must be some form of location data (also NSCF standard).
- Geography names (dwc:country and dwc:stateProvince) must match an authority, and their combination must be correct.

- Decimal coordinates must be within valid ranges (-90 to 90 for latitude, -180 to 180 for longitude).
- Coordinates must not be zero.
- Coordinates for terrestrial organisms should be on land; those for marine organisms should be in the sea or on a coastline.
- Coordinates, country and province must be consistent.
- Geodetic datuma is required (otherwise amended to a default of WGS84) and must be valid EPSG values or another standard vocabulary.
- Minimum elevation and maximum elevation must be in the range (-423 to 8850m). Depth values must also be within valid bounds.

4.10.3 Event (13 tests from TDWG/BDQ)

- dwc:eventDate must be consistent with dwc:year, dwc:month, and dwc:day, if both are supplied.
- Dates must not be in the future. An earliest possible date can also be specified (suggested 1753, the date of Linnaeus publication of Systema Naturae, or the date of the earliest known collected specimen for the collection).
- dwc:eventDate must be in ISO8601-1:2019 and ISO 8601-2:2019 format.
- year, month and day values must be within valid ranges.
- dwc:dateIdentified must be in ISO8601-1:2019 format and cannot be before dwc:eventDate.

4.10.4. Other tests (17 tests from TDWG/BDQ)

- A record must have a value for dwc:accessRights and it should be standard, relative to an authority (e.g., a valid Creative Commons license).
- dwc:occurrenceID must not be empty and must be formatted as a resolvable GUID.

4.10.5 Additional data quality assessments

In addition to these standard tests above, which can be run automatically on a dataset to detect errors, the following data quality checks can be performed manually or in a semi-automated way, and errors corrected in the source dataset:

- Geographic outliers for a species can be identified and verified.
- Environmental outliers for a species can be identified and verified.
- Taxon names can be updated, with new identifications where taxonomic changes warrant re-examination of specimens.
- An assessment of a sample of records (perhaps a few hundred), drawn at random from the database, can be validated against their records in a catalogue book, or on the specimen labels, and the number and type of errors recorded. The error rate should then be reported in the metadata for the dataset.
- When dates are extracted from a database like Specify, where full dates are recorded and date precision is recorded separately, the extracted dates should be checked to see whether they have it has the right precision (i.e., year only, year and month, or full date). It has happened that full dates have been provided in serving data requests where partial dates should have been provided.
- Catalogue numbers should not be duplicated.

- For any single dataset, the following data quality metrics may be reported to facilitate wise and appropriate use of the data (in addition to the standard Ecological Metadata Language metadata properties):
- The percentage of the records from the original collection that are present in the dataset at the time that the dataset is created or extracted from the database.
- The error rate in the dataset based on sampling database records and confirmation against catalogue book entries and labels.
- The percentage of records georeferenced.
- The percentage of records identified at the taxonomic ranks of family, genus and species.
- A table indicating the TDWG/BDQ tests run on the dataset, and the percentage of those tests passed or failed.
- An indication of whether the records have been checked for outliers in geographic or environmental space.
- Percentages of records that have had their georeferences and identifications verified.

4.11 Process Requirements for Data Management

In order to meet the standards described above, it is important that institutions develop standard processes for their data related activities. The exact details of these processes are expected to vary from one institution to the next, depending on the capacity available and other factors. Rather than specifying the process details, the NSCF recommends that processes meet the following requirements.

4.11.1 Digitizing historical specimen data

An important component of data management in institutions is digitization of existing specimen records into an electronic database. Here records are typically captured into electronic format from existing specimen labels or catalogue books. The goal should be to have all specimen records digitized and available in these databases, but this is always a function of the capacity and resources available for digitization work. An important consideration in digitization projects is to ensure the highest possible levels of data quality. As a principle, data should be captured as they are, i.e., verbatim, from specimen labels or catalogues, and these data should remain unchanged during data cleaning or upgrading processes. For example, if a specimen label indicates 'Pietersburg, Transvaal', this should be recorded as is, in the database, even though neither of these two names are currently valid. Separate fields should be used to record the new place name (`Polokwane`) and administrative boundary (`Limpopo`).

For digitization projects, the NSCF recommendation is that some form of data quality assurance step be included in the digitization workflow, where newly captured data are is systematically checked for errors shortly after data capture and those errors corrected. Ideally this should be done by a different person than the data capturer; someone who has experience in detecting errors in datasets.

4.11.2 Data cleaning

Possible tools for data cleaning are described in the section on data cleaning above. The primary goal of data cleaning should be to identify and correct errors in the

database. Data cleaning projects should ensure that the workflows are efficient and thought should be given to how records in a dataset can be sorted and grouped before data cleaning starts, so as to minimize duplication of effort. Consideration must also be given to how changes will be made in the main specimen database if records are cleaned outside of that database using tools like OpenRefine or Kurator. The NSCF requirement for data cleaning projects is that any changes made to a dataset when cleaning data outside of the source database, are applied back in the main database.

4.11.3 Georeferencing

Georeferencing is the process of adding geographic coordinates to locality records that lack such coordinates, which enables the data to be mapped and used for a wide range of other research purposes. It is important that anyone carrying out georeferencing of locality records applies a valid protocol. In most instances, the point-radius method for georeferencing (Wieczorek et al., 2004; Chapman & Wieczorek, 2006), or a simplified version of it, is sufficient.

The NSCF requirement is that a measure of uncertainty, the source of the coordinates, the name of the person making the georeference and the date of the georeferencing must be recorded. Remarks related to the georeference, particularly indicating uncertainty, should also be included. See Table above for the relevant Darwin Core terms and their definitions for georeferences.

4.11.4 Handling born-digital records

With newly collected specimens, the associated data are often captured electronically to begin with (termed born-digital) and are then provided with the specimens to the institution where they will be deposited. Collectors providing such datasets and specimens might not conform to any kind of data standard, but institutional staff should encourage them to do so at the outset of their collection expeditions. The summarised list of required and recommended Darwin Core terms above can provide a guideline.

When working with born-digital records, institutional staff should check that all specimens have matching records in the dataset, and that there are no records in the dataset that don't have specimens associated with them. The data should be passed through a cleaning process to identify any errors, such as misspelled taxonomic names or inconsistencies in agent name and date formats (see Data Cleaning above).

Once the data are cleaned and any curatorial processes associated with the specimens are completed, the records can be imported into the specimen database. Specify and Brahms both have functionality for bulk data import from spreadsheets. Data should not be digitized from specimen labels into the collection database if the data have already been provided electronically. The data should be cleaned and imported so as not to duplicate the effort already put into creating the digital dataset. Copies of the original datasets provided by collectors should be saved before any changes are made, and these, together with the edited datasets used for import into the database should be backed up and archived.

4.11.5 Identifications

As with georeferences, identifications should include supporting data that can be used to assess the fitness for use of records for research and practical applications. Identifications that only include a name and no other information can be problematic, especially for records that might be highly influential on a statistical model (like geographic outliers in species distribution modelling), or which may strongly influence the result of a Red List assessment. When doing identifications, taxonomists and other experts should record their name and the date of identification and indicate whether there is any uncertainty about that identification (see identificationCertainty in Table). Ideally, the method of identification (morphological examination, key, or molecular data) should also be recorded, as well as any reference material used, which can include published descriptions, keys, or reference specimens. Specimen identifications are one of the core sets of information in a specimen record and should be paid the same level of attention as georeferences.

4.11.6 Serving data requests from users

Very often requests for data are sent directly to collection managers or curators by potential data users like researchers, staff in conservation agencies or students. In addition to serving requests with data that conform to the standards outlined in this document, clients should be informed to provide appropriate acknowledgement to the institution and data originators should they use the data for any scientific publications or other products (see the section on data attribution and ethical conduct when using data above). This is to ensure that the institution is properly attributed for providing data. Clients should also be requested to alert the institution of any errors encountered while working with the data, or to submit any corrections or improvements made to the data, such as georeferences, back to the institution, to be updated on the main database. Users should also be informed to use an appropriate protocol consistent with that of the institution, should they want to georeference any records. Where specimens are loaned, or taxon experts visit the institution, the requirements for identifications should also be provided so that any new identifications also conform to these standards.

Additionally, institutions need to keep track of the number of data requests that are served, and the number or records included in each dataset sent out. This is important for reporting processes within the institution and for the NSCF. Lastly, workflows for processing data requests should include a step towards ensuring that data embargoes and the need to protect sensitive species records are respected.

Institutions should strive to publish their data to public platforms such as GBIF, in the spirit of open data access and contributing to resolving the global biodiversity and environmental crisis. Published datasets should be correct, complete, consistent and comprehensive. In other words, the data should be maintained in a high state of data quality and published datasets should include as many data fields as possible.

Institutions should ensure that datasets published to public repositories have all records for sensitive taxa and embargoed records removed.

Data publication should take place at regular intervals, so that the publicly available data are up to date. GBIF allows for versioned datasets to be published so users can see that they are working with the most up to date version. Publishing new versions of a dataset should take place on a timeframe appropriate to the dataset, given the rate of change of data (addition of new records, data cleaning, etc.) and available capacity for the institution and within the NSCF network, to facilitate publication.

4.11.7 Data backup

It is important that proper data backup processes are in place to ensure that institutional data are properly protected and preserved. The exact mechanisms of data backup will depend on the data management capacity, IT infrastructure and the rate of changes made to the database. For large server systems like the Specify platform hosted by SAIAB, backups are made daily and the backup process is automated. The NSCF standard for backing up databases is that backups should be made regularly, on a schedule appropriate to the rate of changes made to the database, and that there should be duplicate backups with at least one backup kept off site.

4.12 Specimen Imaging Standards

There is a global move towards imaging museum specimens in order to serve these online and in this way increase access to the collections for researchers, as well as scholars and the general public (see iDigBio (https://www.idigbio.org/) and ZooSphere (http://www.zoosphere.net/). Increased access results in increased use of the collections and this increases the value and appreciation of these. Sharing digital images of collection objects with researchers rather than posting objects on loan also reduces the risks and impacts associated with the handling and transporting of objects. Images can also serve as a permanent record of the object, including information about its condition, and the information as is stated on the label. This means that even if the object is destroyed or lost, there is still an image of the object and its label. Images therefore have value for GRAP 103 and the collection inventory, and for verifying data in the collection object record. The collection object images should therefore be linked to the object record in the collection database. In South Africa there have been several imaging projects for museum collections and imaging has also been carried out on an ad hoc basis in some institutions. Unfortunately, no documented standards for the images produced or for the archiving of the images have been applied.

For imaging projects there needs to be consideration of the purpose of the images because this will influence the resolution and in the case of animals and fossils, the number of views that are imaged. While high resolution images are valuable for detailed research, the file size may mean that they cannot be easily transferred or stored and retrieved, and the imaging process may be considerably slower. It might be pragmatic to capture higher resolution images for types and lower resolution images for other collection objects, unless there is a request for a higher resolution image for a particular collection object. The NSCF aims to image all type specimens in the collections, starting with the fossils and vertebrates, as part of the development of a virtual museum. Standards and workflows for this work

have been developed and some are included here and in Appendix A4.4, but it is recognised that with more experience in imaging different types of collections these will need to be expanded and updated.

Imaging of herbarium collection objects has a longer history in South Africa than the zoological collections and a large project to image all the type specimens held at SANBI's herbaria was completed more than 10 years ago. Imaging of herbarium collection objects is simpler than for three dimensional and very diverse animal and fossil objects, but a range of different processes and standards have been applied in South Africa. For details of standards for herbarium collection object images, Nieva de la Hidalga et al. (2020) provides some useful guidelines.

Imaging standards can vary widely, but Appendix A4.4 provides a baseline standard that can be used to develop standards and workflows within institutions. Important considerations are that images should be produced and archived as TIFF files (not JPEG), image background and specimen orientation in images should be consistent, images should include scale bars and colour charts, showing the institutional name and logo, they should be properly tagged/keyworded, and image metadata including license and use terms should be completed, and workflows for generating images should be efficient, while ensuring image quality.

APPENDICES

A4.1 NSCF Participating Institutions Collections Data Management Policy and Workflow Guidelines

Purpose
The purpose of this template document is to provide policy content related to biodiversity data management that may be incorporated into the collections management policy framework of NSCF participating institutions. The content provided here may be modified and adapted to the requirements of the participating institution. This content has been developed in collaboration with the NSCF Data Working Group, which constitutes representatives of natural science collection institutions with biodiversity data management expertise, and a broader range of collection staff. It also draws upon existing policies of both local and international institutions. It is intended that the biodiversity data management policies of participating NSCF institutions constitute a broad and succinct set of guiding and governing statements and principles regarding data and digital asset management, and do not include institution-specific details of the processes and standards applied at those institutions. Such process and standards documents should be developed separately based on the principles described in the policy.

Overall, the policy should remain a relatively static, unchanging document once it has been finalized (although review is always possible if a need is identified), whereas processes and standards may be reviewed and updated more regularly, according to institutional needs. Implementation of these policy statements should bring the institution in line with international best practice in collections data management.

Policy document structure
It is recommended that institutional policy documents be structured as follows:

- The Purpose of the policy: a description of the purpose of the policy document will provide guiding and governing principles for data management within the institution, which in turn will provide a basis for the development, implementation, evaluation, and review of systems, work processes and standards for data management.
- The Spirit of the policy will provide a sense of the intention of the institution in developing and adopting the policy document, in relation to general international practice and trends. The template wording is shown below.
- Definitions of key terms used in the policy, should be provided, so that readers may clearly understand the policy content.
- The policy itself, which comprises the set of policy statements, should start with 'It is the policy of the [institution name] to:' followed by a numbered list of policy statements, based on the template policy statements provided below.
- Supporting information for the policy, which can include general information on the history of the institution and its collections, as well as the size and scope of the collections, should be provided. It will also contain an overview of the relevant legal framework that supports the policy. This section is not intended to burden the reader who wants to understand the policy with additional, and possibly extensive and technical, reading.

NSCF requirements

The NSCF requires that participating institutions use Brahms as their collections data management platform for plant collections, and Specify for animal, fungal, and paleontological collections. This requirement was decided during the early stages of the development of the NSCF, and it is a stipulation for support from the NSCF in terms of funds for infrastructure, support and capacity development for biodiversity data management in institutions. It was felt in making this decision that building user communities around these two platforms would better facilitate improved data management practice within institutions than having multiple, disparate systems as it would allow for mutual learning within the community; centred on these two platforms, their vocabularies, workflows, and standards.

The second NSCF requirement is that participating institutions provide open and free access to their collections data for non-commercial research as well as conservation related purposes. The template policy statements below provide for this, as well as for proper attribution of the institution in the use of their data through the relevant data usage licences, and for the protection of sensitive data such as rare species occurrences. This requirement is important as the NSCF is committed to provide target data volumes derived from participating institutions through the public SANBI data portals. It is also the spirit of the NSCF to promote free and open access to data, in line with current international trends, and to promote more extensive utilization, research and conservation of African biodiversity for the benefit of its people.

Process

In developing their own biodiversity data management policies it is recommended that institutions follow the processes described here. The NSCF Data Coordinator can provide support where necessary.

1. Use the contents of this document to develop a draft policy for data management in the institution or include these policy statements in a broader collections management policy, as required by the institution.

2. Circulate the draft for review within the institution.
3. Incorporate comments from the review and provide the draft to the NSCF Data Coordinator for review.
4. Incorporate comments from the NSCF coordinator and submit them for review by institutional management.
5. Incorporate comments from management and resubmit for final sign off by management into institutional policy.

This process will typically be undertaken by a data management champion within the institution, which in several cases will be the institutional representative on the NSCF Data Working Group. Where institutions do not have such a person in place, the process will be facilitated by the NSCF Data Working Group coordinator.

Why is a policy required?
The most important reason for having a data management policy document in place is to create a common understanding and sense of purpose, ownership and responsibility amongst staff within that institution regarding data management practice. Data management is currently a neglected aspect of general curation practice in many South African collection institutions, which in turn deprives these institutions of its benefits. A policy also states the guiding and the governing principles that govern data management practice, and promotes progress and problem solving by minimizing the requirement for discourse, regarding these principles. Through coordination from the NSCF collections policies will also promote a degree of consistency in data management practices across different institutions, and a sense of civic responsibility in ensuring that data housed within the institution are of good quality and generally available.

Development process
This document was developed in large part based on the policy documents of the South African Institute for Aquatic Biodiversity, the Iziko Museums of South Africa, and the herbaria of the South African National Biodiversity Institute. It also draws on the template policy clauses provided in the institutional data preservation policy study of Beagrie et al. (2008), and the principles outlined in the Digital Preservation Handbook (Digital Preservation Coalition, 2018). Relevant extracts from these sources were synthesized to produce a first version of this document, which was then reviewed by the NSCF Data Working in March 2018.

Spirit of institutional policies
In general, data management policies should be developed and implemented in the spirit of promoting greater access to and use of the institution's collections, contributing to broader research, education, and monitoring initiatives, improving the standing and the reputation of the institution, and elevating current practice to international standards. This is in line with current international trends in the management of biodiversity and other scientific data, and supports the Department of Science and Technology agenda, to promote open data access.

Legal context
It is important that institutional policies are congruent with national legal and policy requirements. While there is no legislation specifically relating to natural science collections and the way that their associated data are managed, several bodies of

legislation govern collection institutions, data and information more broadly and should be given cognisance. These are listed here:

- The Cultural Institutions Act, No. 119 of 1998, which defines one of the functions of a Council of a Declared Cultural Institution as "to receive, hold, preserve and safeguard all specimens, collections or other movable property placed under its care and management ...". Digitization is an important part of the strategy for the preservation of these items.
- The Promotion Access to Information Act, No. 2 of 2000, which "gives effect to the constitutional right of access to any information held by the State and any information that is held by another person and that is required for the exercise or protection of any rights". The PAIA may have some effect in terms of how data are made available for public access.
- The Protection of Personal Information Act, No. 4 of 2013, which effectively requires organizations holding personal information to "conduct themselves in a responsible manner," regarding the collection and management of such data. In the collections institutions sphere this may have a bearing on how collectors' names are used and shared as they are associated with location information, and it may be necessary to make provision for this moving into the future in data management related process, such as accepting loans and accessioning new material.
- The Public Finance Management Act, No. 1 of 1999, which institutes the Accounting Standards Board, who developed the Generally Recognized Accounting Practice for Heritage for Heritage Assets (GRAP 103), which requires collections institutions to implement proper accounting measures for their assets, including specimen collections.
- The Intellectual Property Rights from Publicly Financed Research and Development Act, No. 51 of 2008, and the Intellectual Property Laws Amendment Act , No. 28 of 2013, which govern intellectual property arising from public funding of research and development projects such as those that are often undertaken in natural science collections institutions.
- The Natural Heritage Resources Act No. 25 of 1999, which in the context of relevance of natural science collections, states that palaeontological items are the property of the state and must be deposited at appropriate museum institutions with acceptable collections management policies, which may include data management.
- Provincial Heritage Legislation, promulgated by provincial authorities in part to meet the requirements of national legislation, may also have a bearing on the collections data management policy within institutions.

The importance of good data management

The data associated with specimens should be recognized as an asset of equal value to the specimens themselves. By digitizing and properly curating specimen data, collection institutions will improve their core business processes such as producing research outputs, specimen preservation, loans processing, staff training and capacity development, performance management and asset auditing. Extensive resources are invested in field sampling and specimen curation, and collections institutions have an obligation to maximise the return on investment of those resources. Proper care and curation of specimen data assists in doing this, as it facilitates ongoing work and research innovation.

This is particularly true as biodiversity science moves into the age of Big Data, where datasets from multiple sources are aggregated through platforms such as the Global Biodiversity Information Facility, facilitating research into the impact of human activity on the environment, on a scale that has not been possible in the past. In doing so, collections institutions elevate their value to society as a whole.

Well managed data also allows for improvements in workflow efficiencies. For example, responses to data requests are streamlined, samples required for particular research purposes are more easily located, and specimen loans are more easily tracked, monitored and reincorporated into collections. When collections are properly digitized and data are complete and correct, the institution has a better picture of the total extent and value of the specimen collections it is responsible for. This in turn facilitates better human resources and financial planning related to collections management, allowing the institution to carry out its responsibilities in the proper curation of its collections. Overall, good data management practice promotes the reputation of the institution within the wider community it serves.

The OAIS archival data management model

It is well recognized that data management practices in many collections institutions take place in a largely uncoordinated, ad hoc manner, where individual datasets are developed and maintained by operational staff such as scientists or curators and are held in spreadsheets or small database files on single computers. This is not a situation unique to collections institutions. It is common in universities and governmental, parastatal and NGO organizations too. It arises from the fact that organization wide data management processes often lag behind the needs of staff in fulfilling their duties and improving their work processes by exploiting new technology.

Another important consideration is that digital data might not be seen as being as important or significant an asset as the physical objects that such institutions curate within the historical organizational culture. In preparing this document, it was confirmed that few collection institutions in South Africa, or abroad, have formal policies and processes in place which govern their data management practices (with some notable exceptions).

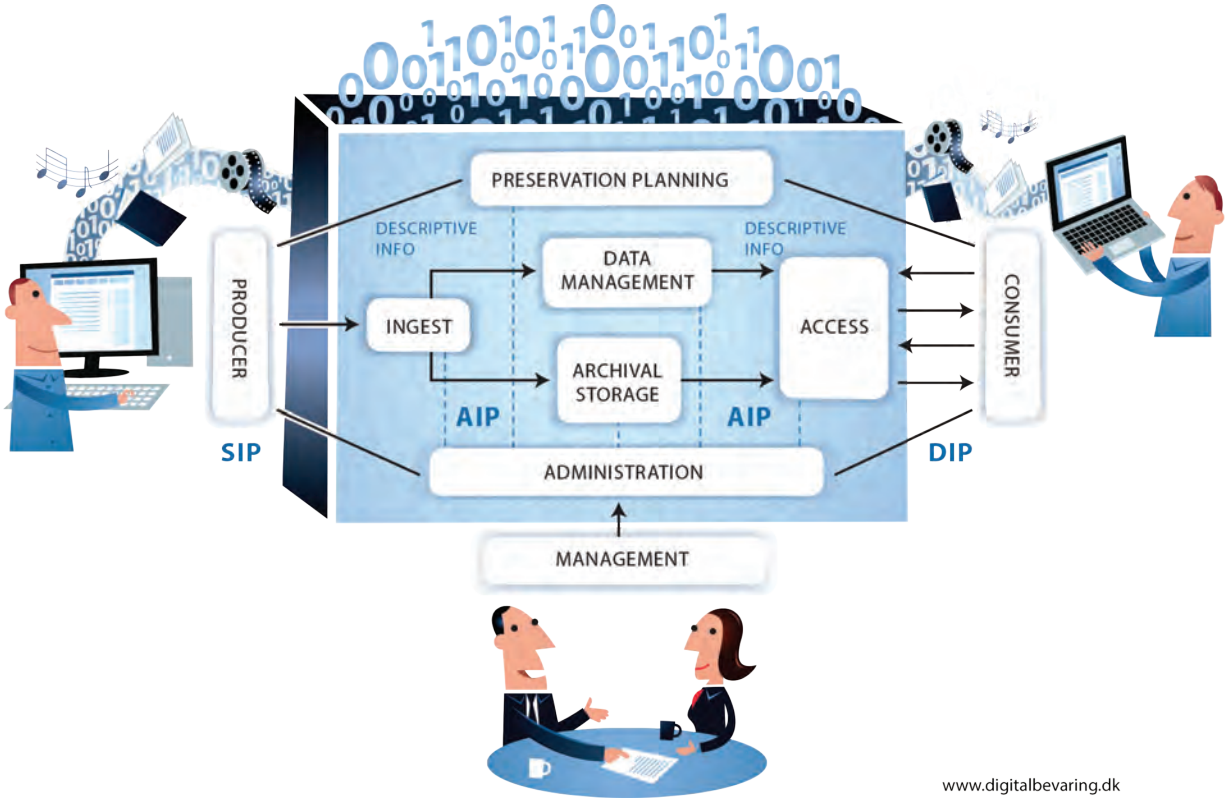
A first step towards addressing this shortcoming is to recognize two important attributes of digital data. First is that digital data can be voluminous, i.e., there is often a lot of data stored in multiple different locations in the organization, and the total size of the collection of data entities grows rapidly as individuals undertake their work. Second, is that digital data are highly sensitive to corruption and loss as a result of hardware and software failures, and can thus be considered more fragile and potentially transient or ephemeral than their associated physical counterparts. Developing a set of standardized and widely applied data management practices within an organization largely aims to address these factors, to ensure that digital data are preserved in the long term.

A good conceptual model to use in developing an understanding of what this broader data management practice might look like is the Open Archival Information Standard (OAIS). Despite its name the OAIS is not a true data management standard, nor does it specify open access to data, and the term archival might be

misleading. In essence, it represents the overall system of organizations, people, processes, software and hardware that curate a particular data store of some kind for the long term. These are divided into several 'functions', each of which performs a specific role within the overall system, to achieve the system goals.

It was initially developed as a model for developing systems to handle the large volumes of data generated by space missions but has subsequently become accepted and widely applied in long term data preservation and management practices worldwide. It is purposely conceptual and does not stipulate any requirements for the structuring of organizations or staff, or the information technology used. Rather, it expects that these will change over time, but that the seven core functions will remain intact and operational. These functions and their relationships are indicated in Figure 1 below.

The key quality of the OAIS model is that it calls for digital assets to be managed in a holistic, comprehensive fashion, specifically focused on proper data acquisition, storage, and access for the long term. For the purposes of developing data management policy in collection institutions, it provides some indication of how the vision might be moving forward from current ad hoc practice towards a well-structured, well defined, holistic and sustainable approach.



The OAIS data management model describing the seven 'functions' associated with long term, archival data management. This model is intentionally conceptual, and does not prescribe the specific processes, software and hardware tools or standards required to meet the long term data preservation and quality management goals of an organization. Rather, it provides the framework outlining the processes that must be addressed in developing and implementing such systems, recognizing that data management is as much about the organizations and the human resources involved as it is about the technological components. SIP = submission information package, AIP = archival information package, and DIP = dissemination information package.
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For more information on the OAIS, the reader is referred to Lavoie (2014), which provides a succinct and understandable overview. Briefly, the Ingestion function describes the processes, systems, people, and standards associated with the acquisition of data. In the collections management arena, this might include the acquisition of new material from field excursions, specimen databasing, and quality control. It ensures that the data are properly captured for storage and use. The Archival Storage function ensures that the data are properly stored and accessible in the long term, while the Access function represents the processes involved with access and use of the data, by a designated user community (which can be very broad in the context of collections institutions).

The Data Management function describes the processes of moving data between the Ingest, Storage and Access functions, maintains the systems necessary for each, and monitors these functions, including reporting to other functions within the overall system. The Administration function manages the day-to-day operations and coordination of the overall OAIS system, interacts with data producers and users, ensures that policies and processes are adhered to, and monitors overall system performance. The Preservation Planning function is responsible for the long term existence and operation of the system, develops and implements strategy, and continually evaluates the role of the system in the greater external environment. It is also responsible for managing changes in technology (such as software migrations) and the other functions over the long term, so that the longevity of the system is ensured.

In addition to Lavoie (2014), interested readers are referred to the Digital Preservation Handbook, available at https://dpconline.org/handbook, for more information on long term digital data management practice.

Definitions

In support of the policy content, the following definitions are provided:

i. "data management" refers to the processes, standards, and policies, and systems that govern the creation, use, archive and disposal of digital data assets, such as datasets, recordings, or images.

ii. "metadata", which refers to supplementary data about a dataset, other digital asset, or physical object. Typically, metadata describes and provides important information about other data, such as origination, creators, created and modified events, and possibly also fitness for use. Several metadata standards exist and are applicable to varying types of data or objects.

iii. "processes" refers to the series of actions or steps that are taken to achieve a predefined outcome, typically governing routine and repetitive tasks. In a formal sense, standard operating procedures are processes that are accepted and generally applied within an organizational context, to ensure that quality standards are met, and that staff are aware of the requirements needed to meet those standards. Processes and standard procedures also aim to prevent errors and unnecessary cost where possible.

iv. "standards" refers to specifications of content or quality, preferably in written format, which in the digital data context may refer to required data or metadata fields; as well as the structure and content of the data entered into those fields. An example of a well-known standard in the biodiversity data sector is the Darwin Core, which provides a standard set of field names that refer to concepts

that are commonly used in specimen collections databases, as well as their definitions, and is intended to facilitate the integration of data from disparate sources.

v. "digital asset or object" refers to any object that exists in binary format, intended to be used primarily through computing technology. Examples include databases, sound recordings and images, and digital documents and files.

vi. "born digital" refers to digital assets that originated in digital format, such as images recorded on a digital camera, or a digital document created on a computer. Many digital assets are born digital, but some are digital copies of physical objects, such as pages in a catalogue book or museum specimens.

vii. "OAIS" refers to the Open Archival Information Standard which provides broad guidelines and standard terminology for the creation of long term data stores that typically outlive any of the technologies, systems, or human resources that are responsible for those data stores. It provides a valuable model for ensuring long term data preservation in natural history collection institutions.

viii. "digitize" refers to the process of transforming a physical object into a digital representation of that object. The exact nature of the process will depend on the type of object and the goals of digitization and may include the capture of specimen data from labels or a catalogue book into a database, or the digital photographic imaging of whole specimens.

ix. "free and open access", in the context of digital data, means that data are made available to potential users, free of any monetary charge, and that data can be provided to those users without any discrimination of any sort. It does not preclude any requirements for registration, or other administrative and regulatory requirements for use of the data, and it must cater for data sensitivity considerations.

Policy content

The policy items below should be considered for inclusion within institutional policies related to data management or general curation practice more broadly. Each statement should be phrased as if preceded by 'It is the policy of this institution to'. This is intended to ensure that the policy statements do not include specific operational or technological constraints. Important though are the provisos for NSCF partnership funding for the institution, which are that the institution must use Specify or Brahms as its collection data management tools, and that the institution must facilitate free and open access to its data (see NSCF requirements above).

The content below can be extracted from this document and included in institutional policy documents. As a general principle, policy documents should be succinct and concise so as to encourage readership and adoption with the institution.

"It is the policy of this institution to:

- Recognize the place and importance of digital data management practice within its broader policy framework, and to ensure that the data management policy itself is implemented and enforced in its entirety, in the work practices of the institution.

- Designate a data management policy champion within the institution, at the appropriate level of authority, who's role and responsibility it is to ensure that relevant internal and external stakeholders are made familiar with the policy, to ensure that the policy is understood by the relevant management structures, and that the policy is properly implemented during the development of any relevant strategies or processes, and that the policy is enforced during the day to day business of the institution.
- Take primary responsibility for the management and curation of its digital assets in the long term, including [please specify the primary types of assets at your institution], using the OAIS model as the conceptual model, including specimen databases, images, sound recordings, and other digital forms of its collection holdings.
- Develop and implement strategies, standard operating procedures, and standards that support world class data management practices within the institution. The OAIS functional model is used as the primary tool for identifying what processes and standards are required by the institution.
- View the data management process, from digital asset creation, through storage and access, as an important component of the preservation process as it produces digital versions of collection objects or their associated data; which may be referred to in the event of deterioration or loss of the original objects, and provides an alternative object for examination, thereby minimizing directly handling and use of the object. Recognizing this it is also acknowledged that digital objects are not equivalent to their physical counterparts, and that digital asset management does not overshadow or replace physical specimen curation practice in any way.
- To store and curate digital objects in their entirety, making available the highest quality versions of those objects whenever possible.
- Prioritize the creation and the maintenance of appropriate metadata for all digital assets, according to accepted standards.
- Strive to digitize all of its collection holdings, including catalogue books, image libraries, specimens, and other data stores, acknowledging that progress in this regard will depend on available funding and human capacity.
- Insofar as possible within the constraints of the institution, make provision for the funds and resources required for data management processes and to meet standards,
- Recognise and acknowledge the inherent property of digital data as fragile, corruptible, and potentially transient or ephemeral, and to make provision for proper protection and backup of data resources to prevent loss or damage in the long term; resulting from system failure, data corruption, theft, catastrophes, or acts of God.
- Provide free and open access to its collection object data and digital asset repositories, while considering the intellectual property of the organization, the research commitments of its staff, students and associates, and data sensitivity considerations.
- Recognize the sensitivity of certain data in their potential to be used for exploitation of wild species for illegal or unethical purposes, such as use of precise locality data for the harvesting of threatened species from the wild, and to institute measures to adequately prevent such data from being used for such purposes.
- Promote and instil a culture of integration of data management practice within broader collections management processes, and to ensure that ownership and

advocacy responsibilities of these processes rest primarily with the curators or the managers of those collections, who are in turn supported by institutional management functions.

- Recognize and acknowledge that the digital assets it is responsible for have a lifetime commensurate with that of the physical objects they are associated with, and that this lifetime typically exceeds that of the hardware and software technologies used to create, store and access them. Accordingly, management planning must include periodic migrations to new technologies, and must properly manage the risks associated with migration.
- Ensure that data management processes and systems are as efficient, simple, and user friendly as possible. Systems must be people oriented, and facilitate optimal workflows, rather than having to modify workflow excessively to conform to system requirements.
- Minimize digital duplication as far as possible within its data management systems, so as to avoid the requirement of keeping multiple working copies of the same dataset.
- To use Brahms software for managing plant collection data and Specify software for managing animal and other natural science collections data.
- To allow staff to participate in training and capacity development opportunities, where this will improve their ability to meet the data management requirements of their performance agreements with their employer.
- Include scientists, technicians, and other operational staff who may be affected, in the decision-making processes related to data management in the organization.

A4.2. Standard mappings of the Darwin Core Terms to fields in Specify and Brahms

**Note that the Brahms field mappings are still under review.*

Specify database field mappings for the Darwin Core Geological Context terms

Darwin Core Class	Darwin Core Term	Specify Field Mappings	Brahms Field Mappings
Occurrence	occurrenceID	collectionobject.guidurl (a custom field) + '/' + collectionobject.GUID.	None in Brahms V7.
Record-level	institutionID	Uncertain, possibly institution.Uri or institution.GUID or custom field; must match GRSciColl. Note this not the institution code but a GUID of some kind.	Database identifier for datasets in system wide settings.
Record-level	collectionID	Uncertain, possibly collection.GUID or custom field; should match GRSciColl. Note this not the collection code but a GUID of some kind.	None, must be added manually, must match GRSciColl.
Record-level	basisOfRecord	none, default is `PreservedSpecimen`.	None, default is `PreservedSpecimen`.
Record-level	accessRights	institution.TermsOfUse; should be `CC-BY` or similar.	None, default is `CC-BY` or similar.
Record-level	licence	institution.Licence, which should be the URL of an actual CC or other licence document.	None should be updated manually.

Darwin Core Class	Darwin Core Term	Specify Field Mappings	Brahms Field Mappings
Record-level	ownerInstitutionCode	None, but will usually be the same as institution.Code, except for collections held by other institutions. Must use the same code as GRSciColl. No apparent way of flagging collections as originating from another institution in Specify. A custom field or separate collection may be required.	None, so should be updated manually. Default is institution ID from GRSciColl.
Record-level	modified	collectionobject.TimestampModified.	None, but can be extracted from the edit history of a record.
Taxon	scientificName AND the appropriate combination of taxon fields (family, genus, specificEpithet, etc)	scientificName: taxon.FullName + taxon.Author; for individual rank fields it is taxon.FullName for those ranks, e.g., dwc:specificEpithet = taxon. Name for the species rank.	scientificName: fullname; genus, family. Possible issue with nominal varieties and taxon authorities.
Identification	typeStatus	determination.TypeStatusName.	specimens.hastype? specimens.sptype? Check type in the table heading (typecat). This could be problematic because we don't link typestatus to specimens in the Darwin Core.
Location	country	The geography.FullName for the country rank.	country.coname.
Location	locality OR decimalLatitude and decimalLongitude	locality.LocalityName OR locality. LocalityName + locality.NamedPlace + locality.RelationToNamedPlace OR same fields with additional custom fields that include locality name data. See below for dwc:decimalLatitude and dwc:decimalLongitude.	Not constistent – locnotes is being used as equivalent to dwc:verbatimLocality and often includes values should be included in dwc:country, dwc:stateProvince and dwc:county. gaz.locprefix + gaz.locality not suitable as this often only represents the nearest named place, and not the actual locality.
Event	eventDate	Must be constructed from collectingevent.StartDate + collectingevent.StartDatePrecision + collectingevent.EndDate + collectingevent.EndDatePrecision.	Must be constructed from collections.day + collections.month + collections.year. There can be date ranges as well for plants, but not recorded in Brahms.
Record-level	institutionCode	institution.Code.	Uncertain, should match GRSciColl.

Darwin Core Class	Darwin Core Term	Specify Field Mappings	Brahms Field Mappings
Record-level	collectionCode	collection.Code.	None, but could be extracted from barcode prefixes. Should match GRSciColl.
Occurrence	catalogNumber	collectionobject.CatalogNumber.	Can be collections.uniqueid (which is a barcode in SANBI) OR specimens. barcode OR specimens. accession. After discussion with the community the decision is to use the barcode number.
Occurrence	otherCatalogNumbers	collectionobject.AltCatalogNumber.	Possibly specimen. oldbarcode. Note likely to be used in South African institutions.
Occurrence	recordedBy	Aggregate of agent.LastName + agent.Initials from a join across collectionobject, collectors and agent tables, OR just agent.LastName if agent.AgentType is an organization. Agent. Must be properly formatted.	collections.coll + collections.addcoll. Must be properly formatted.
Occurrence	recordNumber	collectionobject.FieldNumber.	Must be constructed from collections.prefix + collections.number + collections.suffix. Must be s.n. if s.n. in the database.
Occurrence	occurrenceRemarks	collectionobject.Remarks.	collections.notes? Problematic as it's not used consistently. But it is an important field. Lots of information record. Might need cleaning after extraction.
Occurrence	organismQuantity	collectionobject.countAmt OR preparation.countAmt.	Not applicable to botanical specimens.
Occurrence	organismQuantityType	collectionobject.Description OR pretype.Name (joined on preparation).	Not applicable to botanical specimens.
Occurrence	sex	Custom field on collectionobject or preparation.	Not applicable to botanical specimens.
Occurrence	lifeStage	Custom field on collectionobject or preparation.	Not applicable to botanical specimens.
Occurrence	preparations	A merge on the preparations table indicating type and preservation method.	Decision is to separate by type of preparation. Sheets are all one preparation. Tissue samples another preparation. specimens. category. Standardising the vocabulary is important.

Darwin Core Class	Darwin Core Term	Specify Field Mappings	Brahms Field Mappings
Occurrence	associatedMedia	Must be constructed from attachments table using attachment. AttachmentLocation or attachment.GUID.	specimens. imagelist. Might not be a URL – this will need to be generated.
Taxon	taxonRank	taxonTreeDefItem.Name for the taxonTreeDefItem linked to the preferred taxon, if present, or the taxon used in the current identification.	Only available for ranks below species. Above that needs to be generated.
Taxon	scientificNameAuthorship	taxon.author.	Must be selected from people table based on the lowest rank of identification in the species table.
Taxon	taxonomicStatus	Best is to construct this using taxon. isAccepted.	species.taxstat.
Taxon	acceptedNameUsage	Construct from the preferred taxon of the current identification if this exists.	Must be obtained from the taxon backbone.
Identification	identificationQualifier	determination.Qualifier.	collections.detstatus.
Identification	identifiedBy	Constructed from agent.LastName + agent.Initials OR only agent.LastName if agent.AgentType is 'organization', on a join to the determination table.	Constructed from people. surname + people.initials on join to dethistory table.
Identification	dateIdentified	Constructed from determinations. DeterminedDate and determinations. DeterminedDatePrecision.	Constructed from dethistory.detday + dethistory.detmonth + dethistory.detyear.
Identification	identificationCertainty	determination.Confidence.	The current convention is to use cf, but this is ambiguous (see Sigovini et al. 2016).
Identification	identificationReferences	A custom field.	Not recorded.
Identification	identificationRemarks	determination.Remarks.	dethistory.detnotes.
Identification	identificationVerificationStatus	Not available, but a custom field can be used.	Not available –not generally used.
Identification	identificationVerificationBy	Not available (not possible to link an additional agent to an identification).	Not available.
Identification	identificationVerificationDate	Not available (no custom date fields are available for an identification).	Not available.
Location	stateProvince	The geography.FullName for the State rank.	gaz.major.
Location	verbatimLocality	collectingevent.VerbatimLocality or custom field on collectionobject or locality tables.	collections.locnotes.
Location	verbatimCoordinates	locality.VerbatimLatitude + locality. VerbatimLongitude OR locality. Lat1Text + locality.Long1Text.	Constructed from collections.lat + collections. long + collections.llunit or extracted from locnotes.
Location	verbatimSRS	geocoorddetail.OriginalCoordSystem.	Not recorded.

Darwin Core Class	Darwin Core Term	Specify Field Mappings	Brahms Field Mappings
Location	verbatimElevation OR verbatimDepth	locality.VerbatimElevation.	Constructed from collections.alt1 + collections.alt2 + collections.altunit, or use max and min dwc fields. At SANBI this is recorded in the general notes field.
Location	decimalLatitude and decimalLongitude	locality.Latitude1 and locality. Longitude1, assuming point coordinates in locality. LatLongType, otherwise an average of locality.Latitude1 + locality.Latitude2 and locality. Longitude1 + locality.Longitude2, and including uncertainty in dwc:coordinateUncertaintyInMeters.	Calculated on extract.
Location	geodeticDatum	locality.Datum.	collections.lldatum.
Location	coordinateUncertaintyInMeters	Must be calculated from georefdetail. GeoRefAccuracy and georefdetail. GeoRefAccuracyUnit.	Must be calculated from collections.llres.
Location	georeferencedBy	Constructed from agent.LastName and agent.Initials, joined on georefdetail.	None.
Location	georeferencedDate	georefdetail.GeoRefDetDate.	None.
Location	georeferenceProtocol	georefdetail.Protocol.	None.
Location	georeferenceSources	georefdetail.Source.	Llorig.
Location	georeferenceRemarks	georefdetail.GeoRefRemarks.	None.
Location	georeferenceVerificationStatus	georefdetail.GeoRefVerificationStatus.	Llchecked.
Location	georeferenceVerificationBy	Not available.	For SANBI same as editwho, otherwise not recorded.
Location	georeferenceVerificationDate	Not available.	For SANBI same as editdate, otherwise not recorded.
Event	fieldNumber	collectingevent.StationFieldNumber.	Not applicable to botanical specimens.
Event	verbatimEventDate	collectingevent.StartDateVerbatim, which must be used to record the full verbatimDate (it's incorrect to split verbatim fields).	collections.datetext but doesn't get used.
Event	samplingProtocol	collectingevent.Method.	Not applicable to botanical specimens.
Event	habitat	Custom field on locality, collectingevent or collectionobject fields (recommended to use collectingevent).	collections.habitattxt, some may be custom fields. Prioritize images over capturing data off the labels, like habitat.
Event	eventRemarks	collectingevent.Remarks.	Not recorded for botanical specimens.

** Note that the Darwin Core doesn't include a term for lithostratigraphic supergroup.*

A4.3 NSCF Georeferencing Protocol

Darwin Core Term	Specify Mappings
earliestEonOrLowestEonothem and latesEonOrHighestEonothem	Not available
earliestEraOrLowestErathem and latestEraOrHighestErathem	geologictimeperiod.Name where rank = 'Erathem/era'
earliestPeriodOrLowestSystem and latestPeriodOrHighestSystem	geologictimeperiod.Name where rank = 'System/period'
earliestEpochOrLowestSeries and latestEpochOrHighestSeries	geologictimeperiod.Name where rank = 'Series/epoch'
earliestAgeOrLowestStage and latestAgeOrHighestStage	geologictimeperiod.Name where rank = 'State/age'
lowestBiostratigraphicZone and highestBiostratigraphicZone	geologictimeperiod.Name = geologictimeperiod.IsBiostrat = true
group	lithostrat.Name where rank = 'Litho Group'
formation	lithostrat.Name where rank = 'Formation'
member	lithostrat.Name where rank = 'Member'
bed	lithostrat.Name where rank = 'Bed'

Georeferencing tools

A comprehensive suite of software tools is recommended for the georeferencing process. The tools described below can be downloaded from the NSCF website under Resources >> Standards and protocols.

Terrestrial and freshwater georeferencing

- QGIS software with the following layers and plugins:
  - African countries
  - Administrative boundaries for southern African countries (provinces, districts, etc.)
  - For South Africa:
    - Magisterial Districts
    - Farms and farm centroids
    - Quarter degree squares
    - Protected Areas
    - 1:250 000 and 1:50 000 topocadastral maps
    - Rivers
    - Google Maps background layers (standard, terrain and satellite)
- QGIS Plugins:
    - SANBI Gazetteer
    - Lat Lon Tools
    - The following websites are open for working with:
    - Nominatum (nominatim.openstreetmap.org/)
    - Fuzzy Gazetteer (http://isodp.hof-university.de/fuzzyg/query/)
    - Google Maps
    - Georeference Calculator (http://georeferencing.org/georefcalculator/gci3/source/gci3.html)
    - Google Search (for web searches)

Marine georeferencing:

- QGIS software with appropriate layers and plugins.

For coordinates obtained from sources outside the QGIS project provided by the NSCF or Google Maps, make sure to copy and paste the coordinates into QGIS, check that they are in the right place (they very often need to be adjusted) and select the coordinates to use for the georeferenced; again, using Lat Long Tools in QGIS.

What constitutes a georeference?

Georeferencing specimen records involves adding coordinates to specimen localities as they are indicated on labels or in catalogue books so that they can be mapped in geographic space and used for further analyses and modelling. Specimen localities can be described as qualitative data, while coordinates are quantitative specific numbers that represent precise locations on the earth's surface. Having coordinates means that specimen records can be integrated with other spatial datasets such as climate, geology and vegetation data. Including georeferences improves the value of specimen datasets significantly, as they can be used for a wide range of purposes, such as Red List assessments, distribution modelling, and spatial biodiversity planning.

An increasingly important consideration with biodiversity data like museum and herbarium specimen records is 'fitness for use'. Fitness for use is a measure of data quality based on evaluating the value of a record against a specific proposed use of that record. Records from different sources and datasets are being integrated and published through systems like the Global Biodiversity Information Facility (GBIF) and are used for a wide range of purposes, often far beyond the original purposes that the data were collected for; by users distant from the originators and holders of the data. Datasets should be comprehensive and of the highest quality possible so that they can be used by a broad audience. Ideally, users should not have to refer back to the originating institution or original collectors to determine fitness for use or to resolve data quality questions. Data should speak for themselves.

For this reason, georeferences need to be more comprehensive than just a pair of coordinates associated with a locality string. A georeference can be considered an entity in its own right (just like a taxon, a collection event, or a locality) with a set of properties that specifies the location, a measure of uncertainty of that location, and additional metadata that assist in the interpretation and the evaluation of the georeference. The location is represented by a spatial geometry like a point, a line or polygon, although points are the most commonly used and simplest to work with. Metadata should include when, by whom, and how the georeference was created. The uncertainty measure is particularly important (although often neglected) as it is the primary means for assessing fitness for use.

The Darwin Core standard for biodiversity data (http://dwc.tdwg.org) includes standard properties for georeferences, described in the table below. Any georeferencing projects should be standardized to use these terms. Note that the structure of the Darwin Core terms is as whole words and case sensitive - in or der for a column heading in a spreadsheet or field in a database to be a Darwin Core term it must match that term exactly without spaces or changes in upper or lower case.

Coordinate formats

Darwin Core Term	Definition	Examples	Notes
locality	A specific description of the location.	`25km SE Bloemfontein`; `Calvinia District`; `Farm Christiana 425, ca. 22km N Upington`	If old or misspelled place names are used these should be followed with the current, correct name in square brackets. The original textual locality as indicated in the catalogue book or on the specimen label should be captured in a separate field which can be mapped to dwc:verbatimLocality
decimalCoordinates or decimalLatitude and decimalLongitude	The geographic coordinates, in decimal degrees, using the spatial reference system given in geodeticDatum, of the geographic centre of the location described in dwc:locality.	`-23.12455, 25.12347`	Decimal coordinates are numbers only, without degree symbols or cardinal directions. When including both coordinates in decimalCoordinates they should be separated by a comma.Coordinates provided on a specimen label should be included in separate fields for verbatim coordinates, in their original format without changes, and decimal values calculated from those used here.
geodeticDatum	The ellipsoid, geodetic datum, or spatial reference system (SRS) within which the coordinates are recorded.	`EPSG:4326`; `WGS84`	Note that coordinates for the same location can be quite different in different spatial reference systems, so this information is important.
coordinateUncertaintyInMeters	The horizontal distance from the given coordinates describing the smallest circle containing the whole of the Location. Leave the value empty if the uncertainty is unknown, cannot be estimated, or is not applicable (because there are no coordinates).	`30`; `250`	Uncertainty is important for assessing fitness for use of data, and a georeference should be considered incomplete without it. Uncertainty is often more easily represented with different units of measure in specimen databases, like meters or kilometres. These values must be converted to metres when mapped to this term. Zero is not a valid value for this term. See the protocol for how to assign uncertainty values.
coordinatePrecision	A decimal representation of the precision of the coordinates given in the decimalLatitude and decimalLongitude.	0.00001 (normal GPS limit for decimal degrees). 0.000278 (nearest second). 0.01667 (nearest minute). 1.0 (nearest degree).	Where used in practice this is better represented with a picklist including terms for 'nearest second', 'nearest minute', etc, and then converted when mapped to Darwin Core.

Darwin Core Term	Definition	Examples	Notes
georeferencedBy	A list (concatenated and separated) of names of people, groups, or organizations who determined the georeference (spatial representation) for the locality.		This will usually just be one person. Recommended format is `[Surname], [initials]`. Best practice is to separate different names with a pipe (|).
georeferencedDate	The date the georeference was made	`2020-01-23`	Dates should be extracted in ISO8601 format from databases.
georeferenceProtocol	A description or reference to the methods used to determine the and uncertainties.	`Chapman and Wieczorek, eds. 2006`; `MaNIS/ HerpNet`; `SANBI Georeferencing Protocol 2020`	Very important is not to include a protocol and then actually use a different protocol or modified version of that protocol. Protocols used for georeferencing should be documented and made available online, preferably in the published literature..
georeferenceSources	A list of maps, gazetteers, or other resources used to georeference the locality, described specifically enough to allow anyone in the future to use the same resources	`1:50k topo map`; `Fuzzy Gazetteer`; `GeoLocate`.	This should be the map or other source that the coordinates are actually recorded from. It is not necessary to record the trail of sources used to get to the final coordinates.
georeferenceVerficationStatus	A categorical description of the extent to which the georeference has been verified to represent the best possible spatial description.		The use of this term in this protocol differs from the examples provided in the Darwin Core documentation. Here additional fields are used for who verified the record
georeferenceRemarks	Notes or comments about the spatial description determination, explaining assumptions made in addition or opposition to the those formalized in the method referred to in georeferenceProtocol.	`Assumed distance by road`; `Assumed this farm based on species recorded -cf -18.12458,22.32456`; `assumed [placeName]`; `too vague, thats a 150km river`	These comments should provide any additional information needed by users of the data to know why the coordinates are at this location where they may have been elsewhere. It is also important where coordinates are not assigned to note the reason.

Geographic coordinates can be recorded in a number of different formats, for example:

Format	Abbreviation	Example
Decimal degree numbers	DD.DDDDD or DD	-28.63336, 17.01162
Decimal degree string	DD.DDDDD or DD	28.63336°S, 17.01162°E
Degrees and decimal minutes	DD MM.MMM or DM	28° 38.0016’S 17° 0.6972’E
Degrees, minutes and (decimal) seconds	DD MM SS or DMS	28°38'00.1"S 17°00'41.8"E

A variety of symbols can be used for degrees, minutes and seconds. For example, the symbols • º ° are all used to represent degrees and ′ ′ ´ ’ for minutes. Sometimes no symbol is used, and the terms are written out in part or fully, as in “27deg 15min 45.2sec S 18deg 32min 53.7sec E”. Unconventional formats can also be used, for example, degrees, minutes and seconds are sometimes separated by colons, as in “23:26:46.302S 33:56:55.903E”.

For georeferences the only valid format is decimal degrees as raw numbers, without any symbols or directional (N, S, E, W) indicators. Latitude south and longitude west are indicated with a minus (e.g., ‘-23.446195, 33.948861’ indicates coordinates in the southern and eastern hemisphere). If both coordinates are to be included together in a string, then they must be separated by a comma. In spreadsheets or databases there are usually separate columns or fields for the latitude and longitude values.

Where coordinates are to be converted from another format to decimal degrees, there are calculators available online. The NSCF also provides an Excel plugin at bit.ly/convertcoords which can read any coordinate format, thus alleviating the need for standardizing coordinates. Alternatively, individual coordinates can be mapped in QGIS using the Lat Long Tools plugin and copied again from the map.

Georeference uncertainty

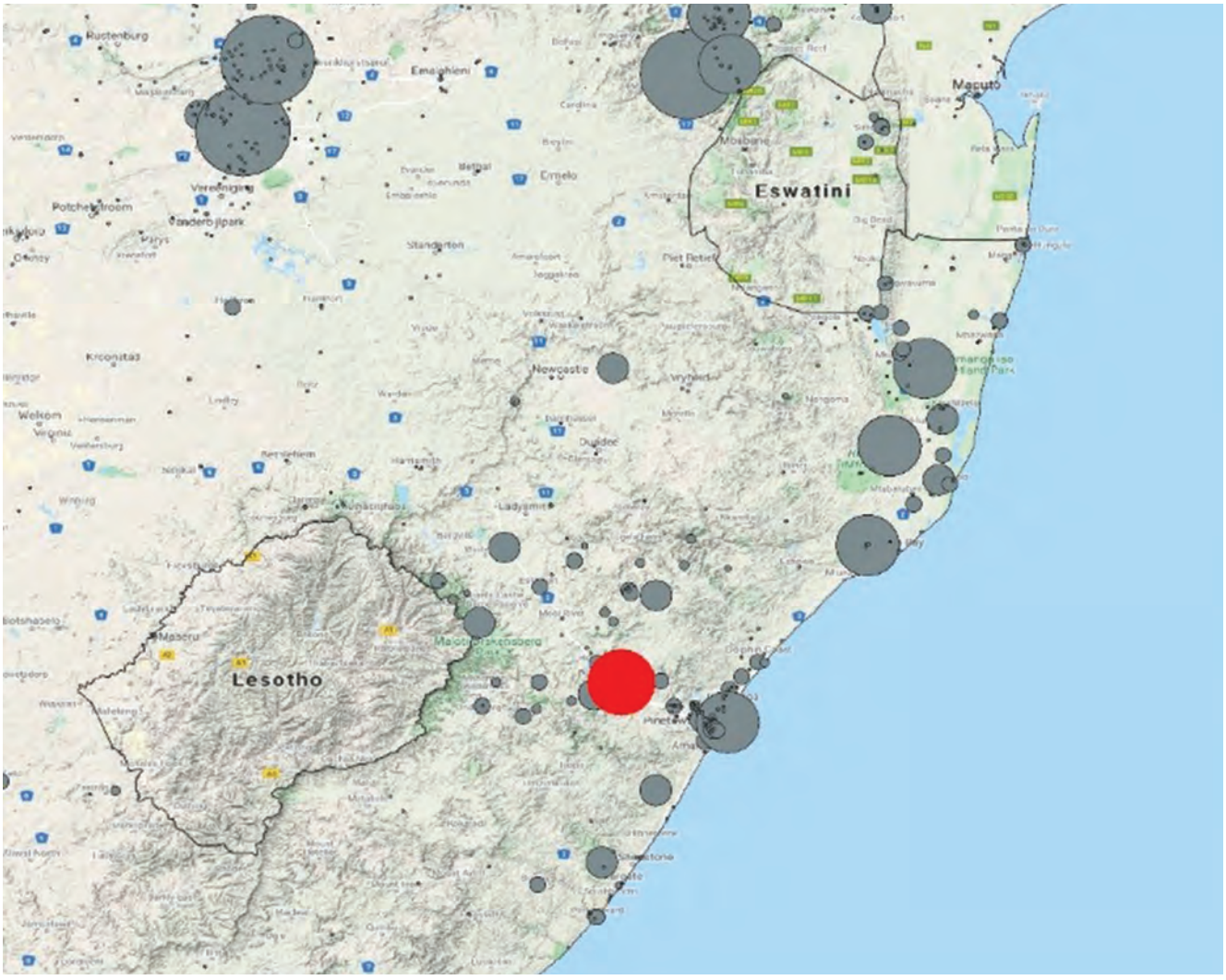
Georeferencing involves two primary steps, identification of the point coordinates of the location described in the specimen locality string and determining the actual geographic area around that point from where the specimen was most likely collected, termed uncertainty. A georeference is therefore best thought of as a disc placed on the surface of the earth where that disc covers all the possibilities of where the specimen may have been collected. The coordinates indicate the exact placement of the disc, and the uncertainty measure, usually in metres or kilometres, describes the size of the disc.

Geographic coordinates represent a very specific point on the earth’s surface. The size of that point is determined by the number of decimal places included in the coordinates. Five decimal places is a point about 1m2, approximately the size of a hula hoop. Six decimal places is the size of a saucer. Seven decimal places is the size of a 20c coin.

Because we typically record coordinates with five or more decimal places it is important to recognize that those coordinates will not represent the exact point where the specimen was collected (the specimen was unlikely to have been found exactly under that hula hoop, saucer, or 20c coin).

Therefore, we need to add a distance measure around that point that represents the total area where the specimen could have been collected. The guiding principle whenever deciding what uncertainty to use; is whether the circle represented by the point and the radius captures the specific point on the ground where the specimen was collected.

Assigning this uncertainty measure will depend on the amount of detail included in the locality description. We can describe this as the precision of the locality string. The locality string 'near Upington' is much less precise than '12.2km N of Upington on R360 to Kalahari Gemsbok NP'. The second locality string allows you to pinpoint the area where the specimen was collected more precisely.



This map shows points of varying uncertainty. The greater the uncertainty, the larger the size of the circle. The coordinates are placed at the centre of the circle, and the uncertainty measure determines the radius of the circle. These localities are for museum and citizen science records for baboon spiders. The citizen science records have significantly lower uncertainty than museum records because the coordinates are captured at the time of the observation by the observer and appear as very small points on the map.

The simplest way to assign uncertainty is to have a set of rules based on the type of locality under consideration, but there are some cases where it can be calculated more precisely. The rules for determining uncertainty are described in the Protocol section below.

Protocol

Locating features

The first step of the protocol is to find the location described in the locality string on a map and assign coordinates to the approximate centre of that location. The NSCF provides a set of GIS data layers for QGIS, as well as the SANBI place names Gazetteer to assist with georeferencing. For feature types such as farms or rivers where we have GIS layers, the best starting point is to search for the feature in the appropriate GIS layer, using the Select Features function in QGIS.

For other locality names you can search in the SANBI Gazetteer in QGIS, Google Maps, OpenStreetmap, and Fuzzy Gazetteer. With practice you will get a sense of which tools work best for finding particular kinds of localities. Remember that there can be spelling mistakes or spelling variances in locality strings, missing or extra letters, and alternative spellings for place names. Examples are 'Gaborone/Gaberone', 'Mafeking/Mahikeng' and 'Buffelsdrif/Buffelsdrift'. The SANBI Gazetteer allows you to conduct a search that considers such potential issues by using spaces in the search strings you enter. For example, searching for 'Vin riv' will return 'Vink River', 'Vinkriver', 'Vinkrivier' and 'Vink rivier'. Fuzzy Gazetteer has algorithms for searching for similar place names that consider spelling variations. For example, searching for 'Masiene' in Mozambique returns the correctly spelled locality 'Maciene'.

Try as many sensible variations of the place name in your search terms as possible when searching; using these tools to increase the chance of finding the relevant place names. Also, where there might be different spellings of a place name, search using all possible spellings in Google Maps and SANBI Gazetteer to get all possible options for the locality before selecting one. The best method for finding a location will be dependent on the type of locality described in the locality string. For example, you might use different methods for finding a farm, a mountain pass, or a waterfall. Finding the locality often involves searching through different sources until the feature is found.

Features located in Google Maps or the Fuzzy Gazetteer should always be verified against topocadastral maps or the SANBI Gazetteer. To get the centroid of named places like towns use Nominatum (nominatim.openstreetmap.org) so that the centroids are standardized. Coordinates must always be placed at the centroid (best possible approximated centre) of a named place or location.

Importantly, remember that place names do change, particularly in South Africa. Examples include 'Pietersburg' which is now Polokwane, and 'Shabane' in Zimbabwe which has been corrected to the pre-colonial name Zvishavane. If you suspect you have an old name you can do a search for that name in Google to learn more about it and try to work out where the place is situated, and then return to using the geographic sources to get its coordinates. Wikipedia has a good list

of place names that have changed in South Africa. The QGIS project provided also includes old maps of South Africa used by John Acocks during his vegetation surveys which include many old place names.

Lastly, this protocol is intended to facilitate rapid georeferencing of large numbers of specimen records from museums and herbaria, in a short period of time. For that reason, only the locality information is considered in this protocol. Georeferences apply to the locality, not to the full specimen record. For the bulk of specimen records this is acceptable, but it means that in some cases specimens with erroneous locality data will be georeferenced. It is also sometimes the case that the species distribution, collectors' notebooks, and other such sources need to be consulted to resolve localities.

This is again not included in this protocol (see ambiguous localities below) because of the time required to do so. It is recommended that these extra efforts only be taken for important specimens such as types, specimens of potentially threatened species, or for particular datapoints used in statistical analyses that unduly bias the analysis results.

This protocol also doesn't allow for inference of where a specimen was collected, beyond what is provided in the locality string (something which taxon experts are inclined to do). In such cases, where it is necessary, it is better that localities are physically ground-truthed and new, precise locality records taken for this purpose.

Cultivated or captive specimens

Action: Only georeference if the original wild locality is provided.
Sometimes samples are taken from plants in botanical or urban gardens for preparing herbarium specimens. For animals, captive specimens also sometimes find their way into collections. For plants this is usually indicated with the garden name on the label, or with an indicator like 'cult'. In these cases, only add a georeference if the original, wild locality for the specimen is also included on the label. In these cases, georeference the specimen for the wild locality using the rules below. Otherwise leave coordinates, accuracy, and source field blank, record your name and the date, and indicate in the georeference remarks 'cultivated' or 'captive'.

The locality value

Action: dwc:locality should have 'oldname [currentname]' if the locality uses an old name.
If you have a locality string and the name is incorrectly spelled or represents an old place name, copy the locality string to a dwc:verbatimLocality field. Then place the correct, new name in square brackets after the locality string in the locality field. For example, if the locality says 'Marrandera', this should be recorded in verbatimLocality and the locality field should be updated to 'Marrandera [Marondera]'. Similarly, if the locality is 'Pietersburg, Tvl', move this to the verbatimLocality and locality becomes 'Pietersburg [Polokwane]'. In this case we remove the 'Tvl', representing 'Transvaal' as the Darwin Core uses other fields to record administrative divisions, 'Tvl' is now captured in verbatimLocality, and the

Transvaal is no longer a valid administrative division. Spelling mistakes should be corrected in the locality field but left unchanged in verbatimLocality.
Districts, regions, cities, large mountain ranges, and uncertain localities
Action: If no QDS then don't add coordinates.

For any locality string that is less precise than a town name or uncertain (usually indicated with a question mark) and no Quarter Degree Square (QDS) is provided, do not add coordinates. These localities are too imprecise to be useful for mapping or analysis. Complete the remaining georeference fields (also leaving uncertainty empty) and add a note to indicate 'too imprecise for georeferencing'. Examples include 'Barberton District', 'Pretoria', 'Magaliesberg', and Bokkeveld, between Calvinia and Vanrynsdorp'. If a QDS is provided, please refer to the section on QDSs below.

Suburbs

Action: Use Google Maps, point and feature radius.
Google Maps indicates most suburb boundaries. Search for the suburb in Google Maps and then select the coordinates in the approximate centre of the suburb and measure the distance from the centre to the further boundary, for the uncertainty measure.

Georeference for suburb Rondebosch in Cape Town in Google Maps.

Towns

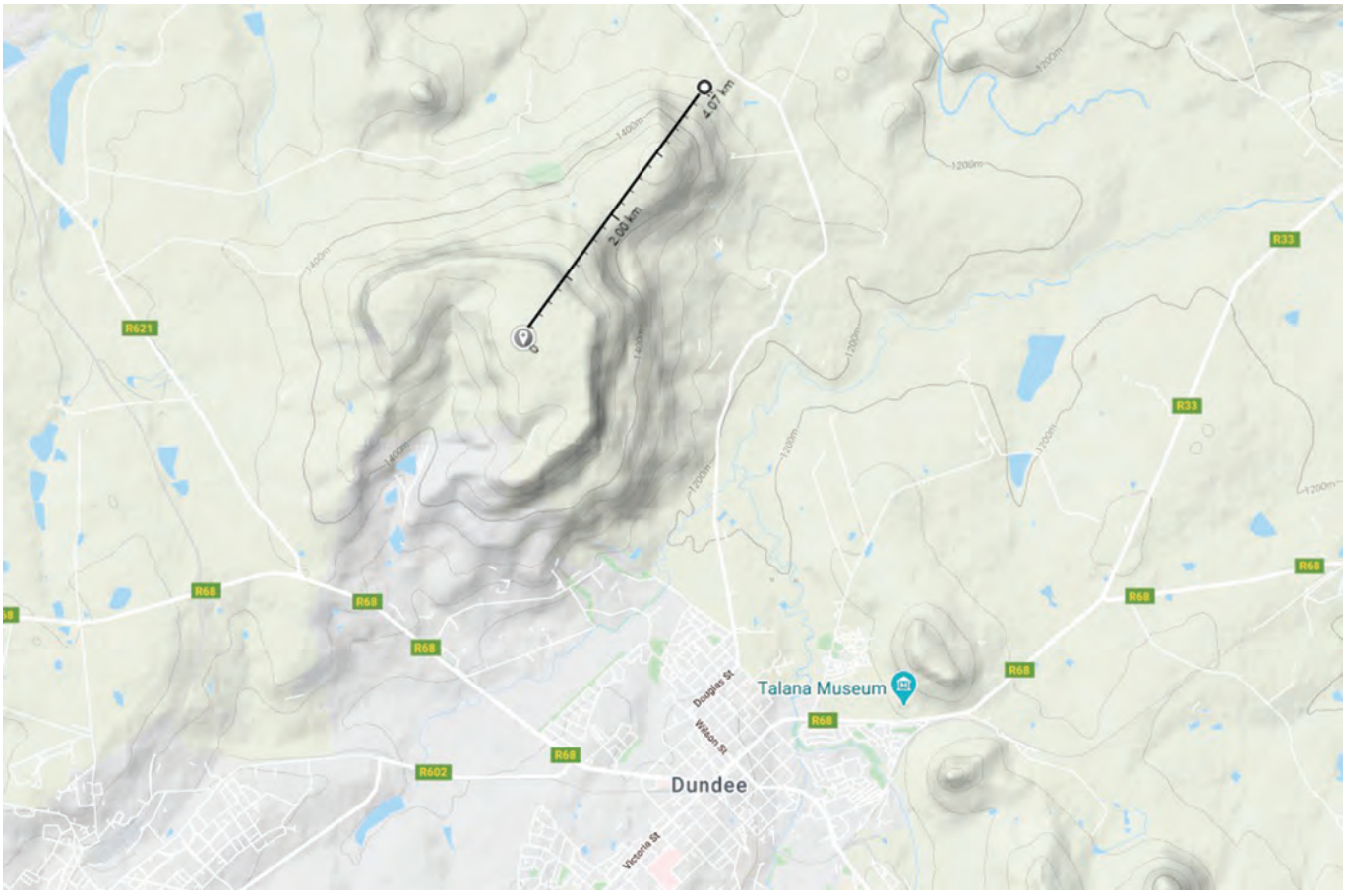
Action: Point and standard uncertainty of 10 or 20km.
For localities that only indicate the town name, locate the coordinates at the approximate geographic centre of the town. Nominatum (nominatim.openstreetmap.org) can be used to obtain consistent place name centroids. For larger towns such as Queenstown, Port Nolloth, and Richards Bay (towns with a radius of more than 2km), set the uncertainty to 20km. For smaller towns such as De Rust, Loxton, Wupperthal, or Pilgrims Rest, set uncertainty to 10km. This applies also for locality strings that indicate 'near' the town, without any additional information, such as 'near Queenstown'.

In cases where an approximation is included with a named place, the coordinates are still located at the centroid of a named place. For example, 'Queenstown', 'near Queenstown', and 'Queenstown area', would all have their coordinates at the centroid of Queenstown. Uncertainty is calculated the same way.

Named places other than towns

Action: For point locations, use point and 2km uncertainty. For larger locations, use point and feature radius.
For specific named places, such as homesteads, railway sidings, bridges, hills, small villages, dams, river mouths, etc., search for the named place using the various tools you have available such as your GIS layers, gazetteers, and Google. Confirm search results from Google against maps in the GIS. Place the coordinates at the centre of the place. To assign a certainty value, consider whether the specimen would have been collected at that specific place or close to it. If for example the locality string says 'Nxwala hill', you would capture the whole of Nxwala hill with a radius of approximately 1.2km around coordinates placed in the middle of the hill. If it is a very specific location such as a bridge, the specimen is unlikely to have been collected on the bridge, but probably near the bridge. Here an uncertainty of 2km would probably be sufficient to cover the area where the specimen was collected. Consider that in some cases different places can have the same name (see section on ambiguous locality names below). Also, similar place names might not refer to the same place. For example, 'Hluhluwe' and 'Hluhluwe Game Reserve' might refer to different places, as there is a town called Hluhluwe as well as a protected area. In these cases, you will have to use other information to work out which locality is referred to (see section on ambiguous place names below).

In cases where you have a specific place name and a more general place name, such as 'Keate's Drift, near Mpofana', and you can't find the more specific place name, find the less specific place name on the map and scan the topocadastral maps near that location for the more specific place name. If you struggle to find the more specific place name and you have a QDS included in the locality string then find the QDS in QGIS using the Select Features function and then scan the topocadastral maps for the specific place name inside that QDS, as well as neighbouring QDSs.



Georeference for 'Mpathe hill, near Dundee' in Google Maps, with the radius capturing the entire hill.

Where there are groups or clusters of the same place name in close proximity (a few km) on a map, as sometimes happens around farms or railway sidings, choose the coordinates at the centroid of the cluster of named places and use an uncertainty radius that captures them all.

Named place with distance and direction from another named place.

Action: Georeference the most specific named place using the rules as for named places above. Distance and direction is just a guideline to find the named place but increase uncertainty if warranted.

The coordinates must be situated at the most specific place indicated in the locality string and not at the named place itself. Use the same rules as for named places above to place the coordinates and assign uncertainty. Very often the distance and direction from the named place are intended as a rough indication of the location of the locality. For example, for 'Greytown, 20mi NE, KwaMazongwane Forest' the coordinates must be placed at KwaMazongwane Forest, even though in this case KwaMazongwane Forest is 16mi NE of Greytown. Also note that the direction might be imprecise too. For example, the locality string might indicate 'N' of a named place, but the actual locality string could be NE or NW of the named place. This is because collectors often only approximate distances and directions when recording localities. What is important is the most specific named place.

Distance and direction from a named place only

Actions:

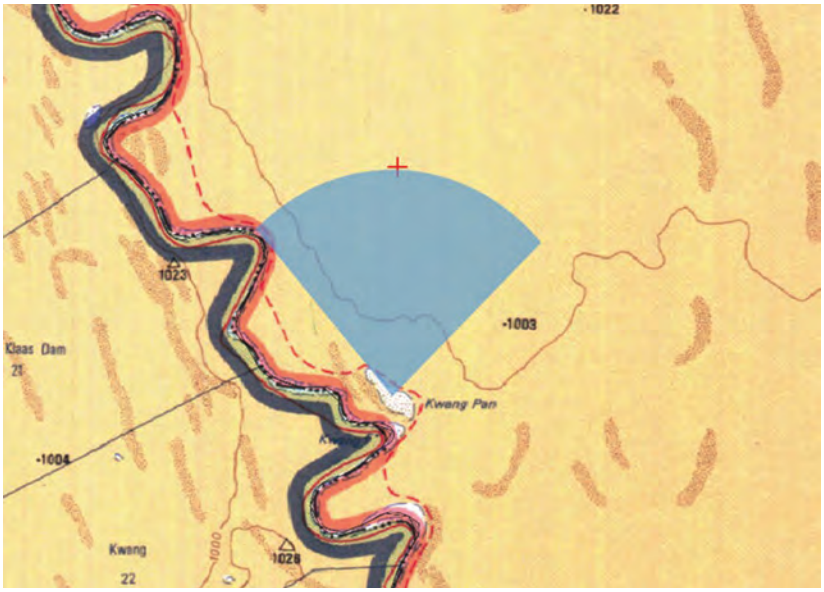
- If 'by road', measure along road, uncertainty depends on the distance value (multiple of 100, 50, 10, 5) measured along the road. Then add named place radius.
- If 'by air' use georeference calculator for coordinates and uncertainty.
- If neither specified, and there is a road, do both and use point and radius that captures all options.

Many localities are indicated with a distance and direction from a named place, such as 'Kwang Pan, 5mi N'. This indicates that the specimen was collected five miles 'north' of Kwang Pan. If there is no more specific named place included in the locality string, then you add coordinates for the distance and direction from the named place. Unless it is stated in the locality string that the distance is by road, you cannot assume that the distance was measured along the road on the basis that there is a road heading in that direction, even though it may be very probable that the specimen was collected along the road. Likewise, unless the locality string says 'due', 'by air', or 'as the crow flies' to indicate that the distance was measured as a straight line, you cannot assume that it was indicated as a straight line. Such localities also seldom indicate where the distance was measured from, i.e., the edge of the place or town or the middle of it. In such cases you need to consider the locations of all these possibilities and place the coordinates in the approximate centre of those possibilities and use an uncertainty value that captures all of them.

Calculating uncertainty for these cases requires several steps because the locality information is quite imprecise. The factors that contribute to the uncertainty are as follows:

- No statement as to whether the distance was measured along a road or as a straight line.
- No indication of where the distance was measured from, i.e., the middle or the edge of the named place, such as a town.
- Uncertainty associated with the direction indicator, as described next.

There is inherent uncertainty in directional indicators as indicated by the various compass directions. N is less precise than NE, and NE is less precise than NNE. N can refer to anything between NE and NW, an angle of 90°. As the distance from the named place increases, so the uncertainty increases because the area between NE and NW gets larger. N, S, E, W are called cardinal directions, and all refer to an area of 90° from the named place. The four ordinal directions (NE, NW, SE, SW) have an angle of 45°. The cardinal and ordinal directions together are called the principal winds. We then have eight half winds or secondary-intercardinal directions (NNE, NNW, ENE, WNW, ESE, WSW, SSE, SSW). The half winds have an angle of 22.5°.



An example where compass directions are used, in this case 'Kwang Pan, 5mi N'. The blue area shows the 90° area of uncertainty for the coordinates. In this case there is a track heading NW from the named place, but even though it's most likely that the specimen was collected on that track, we can't assume that. Use the georeferencing calculator for these localities.

The process for georeferencing this type of locality strings is as follows:
If a distance is indicated as 'by road', or the locality string indicates a distance and direction from one named place towards another, like '8 km. SE. of Nelspruit towards Uitkyk', and there is a road from the one named place towards the other then we measure the distance along the road. The starting point for the measurement should be halfway between the middle and the edge of the named place.

To calculate uncertainty:

- If the distance unit is a multiple of 100, 50, 10 or 5, then use this value (i.e., 100, 50, 10, or 5) as the uncertainty, unless the distance equals that value, in which case use half that value for the uncertainty (but see the next step). For example, with '200m N of x by road', the value to use is 100m. With '100m N of x along path' the value is 50m. For '15km N of x by road' the value is 5km. Otherwise, as in '17km N of x by road' the value is 2km. For '5.2km N of x', here the collector is measuring in units of 100m, so the uncertainty is 100m.
- Measure this value again from the coordinates you've selected in both directions from those coordinates along the road. We need to do this because distances along roads and straight-line distance of the uncertainty measure are often different. Then measure the straight-line distance from the central coordinate to the furthest distance along the road. That is the uncertainty.
- If the distance is measured from a large named place, like a town, then the radius of the town needs to be added to the uncertainty.

If the locality string states a direct, straight line distance and direction from a named place, e.g., '10km N by air Giyani', then use the georeferencing calculator to calculate the coordinates and the uncertainty. If the distance measure is a factor of 100, 50, 10 or 5 then round up the uncertainty provided by the calculator to the nearest unit of that factor. Otherwise, round up to the nearest single unit. For example, for '10km N Giyani' the calculator provides an uncertainty of 8678m. This should be rounded up to 9km.

If the locality string does not indicate straight line distances or distances by road, then both possibilities by road and straight-line directions must be considered. The coordinates should be plotted at the centroid of those possibilities and a radius that captures them all used as the uncertainty.

Note that in some cases roads may have changed since the specimen was collected. An example is the N1 highway in Limpopo Province. The original road passed through the main towns of Warmbaths (Bela Bela), Naboomspruit (Mookgopong), and Potgietersrus (Mokopane), and is now the R101. The larger, more direct current route is now the N1. For older records, check roads against older maps such as the Acocks maps provided in the NSCF QGIS project.

Farms and protected areas

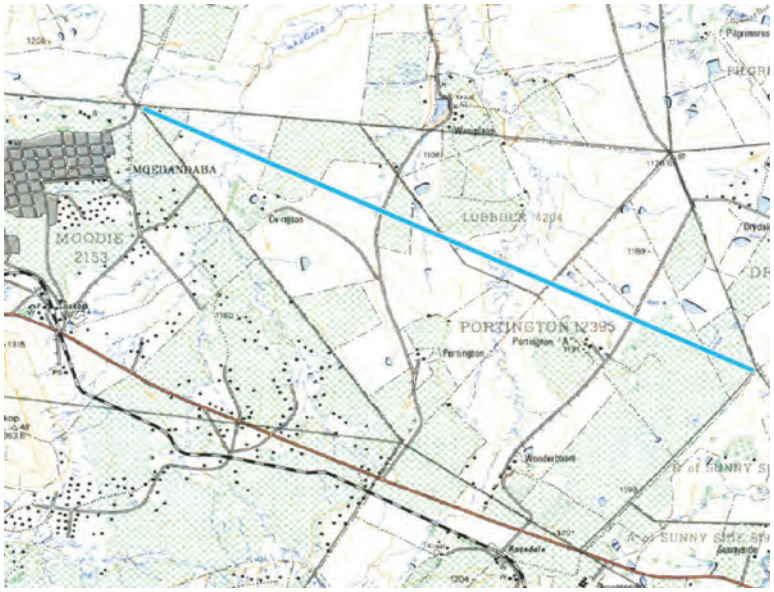
Actions:
- If a farm only use centroid and radius.
- If a farmhouse locate farm building and 1km.
- If a farm gate, find gate and 250m.
- If near farm gate, find gate and 1km.

Many localities are indicated as farm names or protected areas. Both farms and protected areas vary widely in size, so determining uncertainty on a case-by-case basis is required. Locate the farm or the protected area and measure the distance across its widest portion. The uncertainty is half that distance. In some cases, the boundary of a farm might not be indicated on the available maps. In these cases, measure the distance to the nearest indicated farm boundary.

With farms in particular, it is important to note that many farms often have the same name. Sometimes the farm number is provided, but often, it is not. The farm number helps to resolve the particular farm, however if no farm number is provided then additional information (such as a distance and direction from a town) must be used to resolve the location of the farm. This is an example of why it is important that verbatim locality data from specimen labels or catalogue books be transcribed in full and unchanged during data capture processes.

If the locality indicates the farmhouse or a point near the farmhouse, locate the primary farm buildings using Google Satellite view or Google Earth and use 1km uncertainty. If there is more than one set of buildings on the farm and it's not clear which is the main homestead, then place coordinates at the centroid using a radius that captures them all, plus 1km.

When a locality indicates a farm gate, locate the road to the main farmhouse and place the coordinates where that road enters the farm boundary. It is usually easiest to identify the main farm entry road on Google Satellite view. If the locality says 'near' the farm gate, or similar, use an uncertainty of 1km, otherwise use 250m. If it's not clear where the farm gate is use the farm centroid and radius and add the additional uncertainty as the specimens may have been collected outside of the farm boundary.



Example with distance measured across the longest portion of a farm. The uncertainty is half of this distance.

Mountains, hillsides and mountain passes

Action:
- If 'bottom or top of pass' then:
- If 'bottom of the pass', and the pass has two bottoms, point between and radius to both bottoms plus 1km.
- or else point plus 2km uncertainty.
- If just 'pass' then mid-point and radius.
- For mountain/hill sides and summits, mid-point and radius.

In addition to the rules for named places above, some additional considerations are important for mountains and hills. Collectors might indicate that the specimens were collected on a particular side of a hill, or at the summit of a mountain. In these cases, place the coordinates in the centre of that part of the hillside or summit, and measure uncertainty across the whole hillside or summit.

For mountain passes take careful note of what is said about the pass. If only the pass name is provided, then place the coordinates at the middle of the pass and measure the straight-line distance from there to the end of the pass for uncertainty. Very often though, the locality will indicate where along the pass the specimen was collected and is then georeferenced accordingly. A special case is where a locality indicates 'bottom of the pass' and the pass goes over a mountain, therefore having two bottoms.

In such cases it may be necessary to consult an expert on the species to determine which side it was likely to have been collected on, or you may need to locate the coordinates exactly between the two ends of the pass with an appropriate uncertainty value. Always indicate your choice for these cases in the georeference remarks field. Wikipedia is a good resource for searching for mountain passes and provides coordinates, but those must be mapped back in QGIS and the georeference created, using the rules indicated here.

Localities with coordinates

Action:

- If degrees and minutes only, georeference in full, using the coordinates as a guide.
- If more precise:
  - If there is a QDS and coordinates are QDS centroid with no other locality info, georeference in full using QDS as a guide.
  - Otherwise plot coordinates in QGIS and confirm that they match the locality.
  - If they match the locality then use coordinates as they are (converted to decimal degrees) stated with 1km uncertainty.
  - If no datum recorded (there almost never is), add 500m uncertainty.

Sometimes a locality string includes coordinates, which may or may not have been recorded by the collector with a GPS in the field, but these almost always lack a measure of uncertainty or an indication of where those coordinates originated and therefore don't satisfy the requirements of our georeferencing standard.

If the coordinates are indicated as degrees and minutes then georeference the locality again, using the protocol as outlined above, but use the coordinates as a starting point to find the locality. This is because coordinates with degrees and minutes only, are almost always added retrospectively, and are quite imprecise (only around 2km precision).

The purple points are a set of coordinates that change by one minute in either direction. Those points are fixed in space. Degrees and minutes can't represent any other point within that area. Decimals or seconds must be used for more precise locations. The distance between the points on this map is approximately 1.6km so the minimum uncertainty possible for degrees and minutes only is +/- 800m. Map scale, lack of a datum and uncertainty as to whether the coordinates are provided by the collector or added retrospectively all increase the georeference uncertainty further.

If the coordinates are as decimal degrees, degrees and decimal minutes, or degrees, minutes and seconds, then plot the coordinates in QGIS and check that the location they indicate matches the locality string. If not, then it is most likely the result of a coordinates transcription error during data capture, but GPS malfunctions and other errors are also possible. Georeference the locality

again using the rules above, then compare your georeferenced coordinates to the specimen coordinates. This might indicate whether there was a transcription error. If a transcription error is detected, then correct these and use the corrected coordinates and determine uncertainty as below. If not, then use the new georeferenced coordinates and indicate in the remarks that the verbatim coordinates appear incorrect.

Once the verbatim coordinates have been corroborated or corrected, use these as the coordinates for the georeference after converting to decimal degrees and set the source field to 'verbatim coordinates' and add an uncertainty of 1km. This may seem excessive but without a specific indication of uncertainty from the collector, there is a risk of implying false precision with a lower uncertainty value. Real accuracy can range from a few metres in cases where the collector records the coordinates at the specimen in the field, to hundreds of metres when collectors take a single coordinate for the whole area they visit in a collecting event. The same collector can also do different things at different sites, depending on the purpose of the collecting. Where needed, as in the case of Red List assessments, individual records can be scrutinized, and uncertainty values updated in consultation with collectors or other knowledgeable collections staff.

In addition to the uncertainty above, unless there is an indication of the datum that the coordinates were recorded in, add another 500m to the uncertainty. This is because coordinates recorded in different spatial reference systems refer to different places on the surface of the earth and in southern Africa the commonly used datums (Cape, Clarke 1880, WGS84 and Hartebeeshoek) can be up to 500m different from one another.

If a QDS is provided, and the record includes coordinates, make sure to check if those coordinates are not at the centroid of the QDS. If they are, then ignore those coordinates and georeference the locality again, following the rules of this protocol.

See the section on Quarter Degree Squares (QDSs) below for how to handle cases where a locality includes coordinates as well as a QDS.

Quarter degree squares (QDSs)

Action:

- Use QDSs to start finding place names. Search surrounding QDSs as well.
- If QDS and the area like a protected area, and QDS falls completely or almost completely within the named area, use the QDS centroid.
- If QDS intersects with a larger area like a city or mountain range AND date collected is after 1970, point and radius for the section within the QDS.

Sometimes there will be a QDS included with the locality string. QDSs may have been recorded by the collector while in the field, taken from topocadastral maps or calculated from coordinates provided. This uncertainty as to their origin means that QDSs need to be treated with some caution in the georeferencing process. The QDS system was put in place in the early 1970s, so any records earlier than that including a QDS must have had it added later.
If there are no coordinates provided, then use the QDS as a starting point to

find the most specific place name indicated in the locality string. If you cannot find it within the named QDS, then search the surrounding QDSs. Uncertainty is calculated as normal, using the rules for the type of locality. If there is no other locality information other than the QDS then use the QDS centroid of the coordinates, with 20km uncertainty.

If you have a place name that refers to a large area, such as a city, farm or a mountain, as well as a QDS, then use the area of the feature within the QDS as the area to georeference. For example, if the QDS intersects with a mountain, place the coordinates at the centroid of the part of the mountain that falls within the QDS and use the radius of the part of the mountain within the QDS as the uncertainty. Do the same for other feature types.

Using habitat information and elevation

Action: Use habitat to refine location if possible but be careful.
Sometimes locality strings will include topographic or habitat information that might be helpful in assigning accurate coordinates. For example, if the locality string includes 'bottom of mountain', the bottom of the mountain can be located on topocadastral or terrain maps quite easily. On the other hand, habitat information might also not be helpful in assigning coordinates. For example, 'bush clumps next to the side of the road' could refer to any bush clumps along the road, including bush clumps that existed at the time of the collection and don't exist now. When deciding whether to use habitat information in allocating coordinates the principle should be to use permanent fixed features only such as mountains, rivers, and dams, and to avoid using impermanent features like patches of vegetation. An exception might be forest patches which are relatively permanent. Avoid using geology or soil types in making georeferences as outcrops of particular rock types are not accurately mapped on most geological maps.

Elevation is sometimes provided with locality or habitat information for specimens collected on mountains and may be helpful in assigning coordinates accurately but should be used with care if not accompanied by an indication of aspect or specific side of the mountain where the specimen is collected (see calculating uncertainty below).

Ambiguous or contradictory localities

Action: Don't add coordinates and state 'ambiguous' in remarks.
For ambiguous place names, i.e., those that can refer to multiple places, you need to use additional information to try and resolve the correct location where the specimen was collected. Examples include 'Nooitgedacht' and 'Buffelsdrif(t)'. If there is no additional locality information in the locality string, and you only have the ambiguous place name, then you might need to look for other localities sampled by the collector at around the same time as this locality was sampled.

This may require additional work and it might be better to set these examples aside for georeferencing separately in favour of keeping momentum with the more precise localities. You might also need to consult a taxonomic expert to narrow down the possibilities, based on the distribution of species collected at the locality.

Beware of examples like 'Mpumalanga', which might seem obvious but could refer to the province or to the township near Durban. There are also examples where different towns in different provinces have the same name, like 'Heidelberg' (Gauteng and Western Cape) and 'Middelburg' (Mpumalanga and Eastern Cape). Also be careful to consider cases like 'Hluhluwe' which might refer to the town of Hluhluwe or Hluhluwe Game Reserve. In these cases, don't assume it's one or the other. If you select one over the other, make sure to include the justification in the georeference remarks field.

Where a locality string includes two possibly contradicting place names, first consider whether one might refer to a broader region, and the second to a more precise location within that region. For example, 'Komatipoort, Barberton', can be taken to refer to the specimen/s being collected at Barberton, which falls within the Komatipoort magisterial district. If, however, the relationship between the place names cannot be resolved and they appear contradictory leave the coordinates blank, complete the remaining georeference fields and indicate in the notes that the locality cannot be resolved.

Georeference sources

It is important to record the maps and other resources used to identify the location of the coordinates used for the georeference. For example, if you look up a place name in the SANBI gazetteer and then verify it on the 1:250 000 topocadastral maps then both the gazetteer and the topocadastral maps must be recorded in the source field. When recording more than one source use a pipe character "|" to separate them. Abbreviated names for the sources, such as '1:250k topo maps' are acceptable as long as it is clear what they refer to.

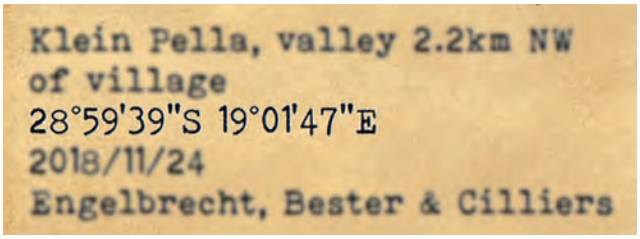
Georeference remarks

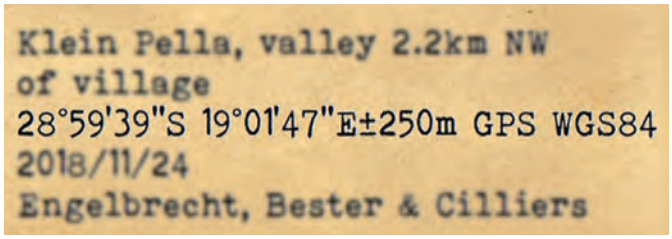
The remarks field is very important during georeferencing and should be used to record anything important about how a georeference was made, particularly any assumptions made in the placement of the coordinates. Any departures from the protocol used must also be noted.

Completing the remaining fields

After adding the coordinates and uncertainty complete the remaining georeference fields. These fields provide record-level metadata on when and how the georeference was made and are important for evaluating fitness for use of the data. See the table on the Darwin Core georeference terms above, for what should be included in each of the fields. Make sure to indicate the version of the protocol followed if it is a versioned protocol such as this one. In general, georeferencing should be done using the WGS84 datum and this should be recorded in dwc:geodeticDatum. The datum for the QGIS project provided by the NSCF and Google Maps is WGS84. WGS84 should also be used as the standard datum for field data collection using a GPS and should be indicated on specimen labels and in collection databases.

Common abbreviations in location strings


Klein Pella, valley 2.2km NW
of village
28°59'39"S 19°01'47"E
2018/11/24
Engelbrecht, Bester & Cilliers


Klein Pella, valley 2.2km NW
of village
28°59'39"S 19°01'47"E±250m GPS WGS84
2018/11/24
Engelbrecht, Bester & Cilliers

A comparison of specimen labels showing coordinates with no supporting information, leading to increased uncertainty, and coordinates with supporting information leaving no doubt as to their certainty. Ideally collectors should always provide the supporting data indicated on the second label.

- btw. = between
- C. Col. = Cape Colony (approximately all the current Cape provinces)
- Distr. = District
- Div. = Division
- F.R. = Forestry Reserve
- Ft = Feet
- Ftm = Fathoms
- Gt = Great
- int. = intersection
- k, km = kilometres
- m = metres OR miles
- mi = miles
- Mt, Mtn, Mts = Mountain/mountains
- nr. = near
- N, S, E, W, NE, SW, etc = these are compass directions, north, south, etc.
- Nat. Res. = Nature Reserve
- N.P. = National Park
- prob. = probably
- Pt. = Point
- Riv, riv. = river
- St = Street or Saint

A4.4 Collection object imaging standards

Image standards

- Specimens must be imaged on an appropriate, uniformly coloured background: dark coloured specimens on grey; light coloured specimens on black. The specimen must be clearly visible against the background.
- Specimens must be oriented appropriately and consistently in the images, either facing left, right, top or bottom, depending on what is most appropriate for the specimen as a whole. Considerations for specimen orientation include the view, ensuring that the specimen is not upside down in the image. If labels are included in the image, the preference should be to keep labels readable. Preference should be for the head to be oriented to the left unless this clashes with other requirements.
- The specimen should take up as much of the image frame as possible with enough space around the specimen when using focus stacking. This accommodates for focus breathing as changing the focus on your lens causes a slight change in focal length (most lenses will magnify the image as the focus distance is adjusted).
- Scale bars and standard colour charts must be included in images. Preference is at

the bottom of the image, but other positions can be used if this is not ideal for the particular specimen.

- The scale bar should include the logo of the institution and an appropriate copyright indicator for the image. There should be a consistency in the distance of the scale bar to the camera lens. In dorsal, ventral and lateral views, the scale bar is to be placed preferably midway alongside the specimen. With regard to the anterior views of fossils, scale bars are to be placed towards the bottom of the eye socket. Scale bars give an estimated scale measurement as perspectives shift through the image stacking process.
- With regard to copyright, with the exception of fossils, images should be made available freely under the Creative Commons CC BY-SA 4.0 license category (see https://creativecommons.org/licenses/by-sa/4.0/).
- Lighting should be consistent and should not reflect excessively off the surface of the specimen. When imaging fossils consider the contours of the specimen (less diffusion/contour lighting/single light source/slightly more contrasting light as to avoid the specimen appearing flat). Using continuous lighting when focus stacking is recommended.
- Labels should be horizontal, in landscape orientation in the images. If labels have text on both sides, these should be photographed separately and then combined into one image for each structure.
- Capture and edit images in RAW file format. This allows for the highest possible image resolution and additional editing options which are non-destructive.
- Vertebrate specimen images must be created using the focus stacking technique and relevant software (e.g., Helicon).
- Edit specimen image files (e.g., colour and lens corrections, cropping, dust removal, etc.) with appropriate image editing software such as LightRoom and PhotoShop CC (Creative Cloud).

File naming for vertebrate specimens and fossils

Image files must be named starting with the specimen catalogue number, an underscore and a code indicating the target structure and the view (e.g., TM1235_HV.tif indicates Transvaal Museum (Ditsong) specimen 1235 head ventral). If needed, additional numbers can be appended with an underscore if there are multiple images of the same structure (e.g., TM1235_HV_1.tif). Catalogue numbers must include the collection code (e.g., TM) if there is one. If the collection code ends with a number (e.g., BP1), then separate the code from the catalogue number with a dash (e.g., BP1-1234_HV).

Codes for structures and views are as follows:

Structures:

H: head
S: skin
L: skull (cranium and mandible together)
C: cranium
M: mandible
P: postcranium
K: skeleton (skull together with postcranial material)
W: whole specimen

Views:

L: left
R: right
D: dorsal
V: ventral
L: lateral
O: occlusional (for dorsal surface of mandible)
C: occipital
A: anterior
P: posterior
R: proximal
S: distal
M: medial
U: unspecified
label: all determination and collecting information labels.
Where a view is intermediate between the above (e.g., dorso-lateral), then use both letters (e.g., DL).

For lateral views, the side of the specimen is indicated first, then the view. See examples below.

Examples:
- TM1235_HLL.tif indicates head left lateral.
- TM1235_label.tiff indicates all labels.
- TM1235_MO.tif is the occlusional surface of the right mandible.

Note that a mandible has a lateral and a medial (i.e., interior) view.
The views required per taxon group (reptiles, mammals, fish, etc) are specified under 'Views/images per taxon' below.

For fossils, a single specimen may be separated across several pieces of rock or several fragments. These rock pieces/fossil fragments may have unique catalogue numbers, one catalogue number with letters or roman numerals appended to indicate each piece (e.g., TM1234a, TM1234b, etc), or share a range of catalogue numbers (e.g., TM1234-1238) where the range is indicated on each piece. If they have one catalogue number with letters or roman numerals appended AND each piece is imaged separately, then these numbers can be treated the same as unique catalogue numbers in the file name (e.g., TM1234a_PU and TM1234b_PU). If they are photographed in groups, or if there is a catalogue number range shared across pieces, then use the group code convention described below. Some fossils may have missing, partial or obstructed parts/views (e.g., a partial skull that is missing its anterior (nasal) region or its nasal area is completely covered with matrix (rock matter)). If no part of the fossil is visible in a particular view it is not necessary to image that view. If a fossil specimen has additional unique numbers (e.g., numerals, letters, etc.) these can be added to the file keywords.

For fossils, where a single specimen comprises different parts or pieces and those have been given different catalogue numbers, we assume that those catalogue numbers are sequential and can be indicated as a range in the file name (e.g., TM1234-38). If not sequential, indicate each catalogue number in full.
For postcranial fossil material with multiple pieces and where the pieces are not

labelled and imaged individually, append and indicate a group number as G1, G2, etc in the file name, (e.g., TM1234_PU_G1. Groups are defined as different parts or different sets of parts of the postcranium. If there is more than one view of that group and the view is unspecified) (i.e., U) then append an underscore with a view number as V1, V2, etc. to the file name (e.g., TM1234_PU_G1_V1). If closeup or zoomed images are taken of parts of a larger view then append an underscore indicating the section number as S1, S2, etc. (e.g., TM1234_PU_G1_V1_S1). If more than one image is taken of that particular view or section of the view, append an underscore and indicate the image number as I1, I2, etc. (e.g., TM1234_PU_G1_V1_S1_I1). The individual parts of this code are not mandatory and must not be included unless they are needed to indicate more than one group, view, section of a view, or image. For example, TM1234_PU_S1 being used to indicate a section image of the only view of unspecified postcranial material of TM1234, TM1234_PU_V1 would indicate that there is more than one view of TM1234_PU, and TM1234_PU_I1 would indicate that there is more than one image of TM1234_PU.

More examples are as follows:

- **Multiple postcranial parts, all imaged together:**
  - TM1234 postcranial; view 1 = TM1234_PU_V1
  - TM1234 postcranial; view 2 = TM1234_PU_V2
  - TM1234 postcranial view 1 image 1 = TM1234_PU_V1_I1
  - TM1234 postcranial view 1 image 2 = TM1234_PU_V1_I2

- **TM1234 postcranial view 2 = TM1234_PU_V2**
  - TM1234 postcranial view 3 = TM1234_PU_V3

- **Multiple postcranial parts, different parts imaged together:**
  - TM1234 postcranial group 1 view 1 = TM1234_PU_G1_V1
  - TM1234 postcranial group 1 view 2 = TM1234_PU_G1_V2
  - TM1234 postcranial group 2 view 1 (only one view) = TM1234_PU_G2

- **All postcranial material in one image, and zoomed in images on particular sections:**
  - TM1234 postcranial view 1 = TM1234_PU_V1
  - TM1234 postcranial view 1 section 1 = TM1234_PU_V1_S1
  - TM1234 postcranial view 1 section 2 = TM1234_PU_V1_S2

- **Multiple postcranial parts, different parts imaged together, with zoomed images of that view:**
  - TM1234 postcranial; group 1; view 1; section 1 = TM1234_PU_G1_V1_S1
  - TM1234 postcranial; group 1; view 1; section 2 = TM1234_PU_G1_V1_S2
  - TM1234 postcranial group 1 view 1 section 1 image 1 = TM1234_PU_G1_V1_S1_I1
  - TM1234 postcranial group 1 view 1 section 1 image 2 = TM1234_PU_G1_V1_S1_I2
  - TM1234 postcranial group 1 view 1 section 2 = TM1234_PU_G1_V1_S2

Image File standards

Keeping a master image with the highest specifications possible allows the file to be converted at a later stage to whatever format is necessary. This facilitates the use for a range of print or web applications and allows for possible future improvements in screen, web and print technologies.

Recommendations are as follows:

- Master image file: TIFF format (uncompressed), 16-bit colour depth, Adobe RGB colour space and a minimum of 300 DPI resolution.
- Files for print: JPEG (depending on the print size and usage and printer requirements, possibly TIFF), 8-bit colour depth, Adobe RGB colour space, and minimum of 300 DPI. Where images are to be published, the publisher will likely suggest the image format required.
- Web display: JPEG, 8-bit colour depth, sRGB colour space (sRGB IEC61966-2.1), 72 DPI resolution or 102 DPI where images will be displayed on high resolution screens or projectors. See https://digital-photography-school.com/choose-right-color-profile-sharing-images-online for more information.

Note that the master file should be tagged first before creating other files from it, in order to propagate those tags.

File storage

A systematic, robust and simple system should be put in place for storing image files. These should be stored in an appropriate system for the institution and treated as an institutional asset, rather than being stored on computers and hard drives of individuals. Folder structure should be simple and should not be used for arranging images beyond the collection level, or the family level in the case of herbaria. Higher levels of image organization of retrieval can be achieved through appropriate image tagging/keywording (see Metadata below), allowing much more flexibility than what is possible using folder structures.

Master/archival files, lower resolution files, and files generated during the imaging workflow should be kept separately. Subfolders named RAW, TIFF and JPEG can be used for this purpose. For palaeontological specimens where additional 3D information may be required to interpret the image, create an additional GIF folder and store GIFs of the stacks there. Use the same file naming conventions indicated above for the GIFs.

Metadata

- All images must include full IPTC metadata, including the photographer name, rights, focus stacking, etc.
- The Image Title should be the specimen catalogue number. The Image Description field should state 'See image tags/keywords for more information'.
- Images must be tagged/keyworded with the following values: the resolvable specimen GUID from the database, catalogue number, view, class, order, family, current genus, species, taxon GUID, "NSCF", "Natural Science Collections Facility", "museum", institution name, institution code, collection name, collection code, country, State, Province, the collectors name, "type" if it's a type, type Status if it's a type, common names in as many official languages of the originating country as available, a broad common name descriptor in as many languages as possible (e.g., snake, inyoka); "focus stacking" if the image was stacked, and the URL of the Creative Commons license applied.
- Images for non-sensitive and non-fossil specimens should be geotagged also.

Recommended views/images per taxon:

The NSCF has developed the following set of standard views for vertebrate taxa. Standards for some invertebrate taxa are available through the scientific communities working on those taxa (e.g., AntWeb). The NSCF will develop additional standards when imaging of invertebrates begins.

- Fish:
  - Whole specimen - Lateral (right and left), dorsal and ventral; 4 views.
  - X-ray - Left lateral; 1 view.
  - Label/s - Front and back of all labels merged into one image.
- Reptiles:
  - Whole specimen - Dorsal, ventral and lateral (right side); 3 views.
  - Head - Lateral (left and right), dorsal and ventral; 4 views.
  - Label/s - Front and back of all labels merged into one image.
- Birds:
  - Whole specimen - Dorsal, ventral and lateral (right and left); 4 views.
  - Label/s - Front and back of all labels merged into one image.
- Frogs:
  - Whole specimen - Dorsal and ventral; 2 views.
  - Head - Lateral (right side) ; 1 view.
  - Label/s - Front and back of all labels merged into one image.
- Mammals:
  - Skins - Dorsal, ventral and label/s (front and back merged into one image); 3 views.
  - Craniums - Dorsal, ventral, lateral (preferentially right), anterior, posterior and label/s (front and back merged into one image); 6 views.
  - Mandible - Occlusional (i.e., dorsal), lateral (priority right mandible, alternatively left); 2 views.
- Vertebrate fossils:
  - Skull/cranium - Dorsal, ventral, lateral (left and right), anterior and occipital; 6 views.
  - Mandible - Dorsal, ventral and lateral (left and right); 4 views.
  - Postcrania - Views of fossils are dependent on what is possible for the particular fossil. Ideally two views of mixed postcranial material, placed neatly with similar bones (e.g., ribs) facing the same direction; 2 views.
  - Long bones - Anterior (i.e., dorsal), posterior (i.e., ventral), distal and proximal; 4 views.

Institutional image storage

Institutions should have a system in place for storing and managing their images. Recommended practice is to store images in different folders for different collections, with one folder per collection. Collection folders should have a simple structure without excessive hierarchical levels. Instead of using subfolders to organise images, image tags are much more efficient for organising and searching (see Metadata above). For herbaria, images can be structured according to the families rather than the collections.

CHAPTER 5: COLLECTION CARE

5.1 Background

The foremost duty of any responsible institution that holds natural science collections in its care is the prevention of their physical deterioration. However, accessing and handling of collections is an essential part of a working institution and this often leads to the damage or the deterioration of collection objects. It is therefore essential that suitable guidelines and procedures are in place and implemented. The information presented in this Chapter is based on documented international guidelines, standards and procedures (see reference list) developed by global experts in the field of natural science collection preservation and management.

The most common and critical "10 Agents of Deterioration", include:

- Physical forces (earthquakes, physical damage from staff and users, vibrations from drawers or while being transported, repair work).
- Fire (flame, heat, soot, smoke).
- Water (floods, plumbing or roof leaks).
- Crime (robbery, theft, vandalism).
- Pests (rodents, insects, mould causing fungi).
- Contaminants (dust, gases, chemicals).
- Light and UV radiation.
- Incorrect / extreme temperature.
- Incorrect / extreme relative humidity.
- Custodial neglect (data loss, misplacement of collection objects, sample mixing).

The 10 agents of deterioration in a museum. With permission. © *Copyright is owned by ICCROM and the Government of Canada, Canadian Conservation Institute, 2016, as published originally in https://www.iccrom.org/wp-content/uploads/Guide-to-Risk-Managment_English.pdf*

Preserving the collections so that they are available for future generations of researchers requires that the impacts of these agents be removed or at least minimised. This Chapter provides general and specific information about the care of natural science collections in order to manage the impacts of the '10 Agents of Deterioration' so that the useful life of the collection objects is maximised. Some aspects are covered in other chapters in more detail. The standards include physical measures required to minimise conditions that may cause damage to collections as well as procedures that are also required to preserve collections. The Society for the Preservation of Natural History Collections (SPNHC) provides the following statements for care of collections and these provide overarching principles for the norms and standards developed for the institutions participating in the NSCF:

- Collection objects must be protected against unnecessary damage, loss, or alteration that might affect future research potential.
- Collection management and care should meet the highest professional standards. It must be compatible with and enhance access to collections for the intended scientific and educational uses of the collection objects.
- Every effort must be made to minimise the level of risk facing collection objects as a result of storage and use.
- Generally, the preferred approach for research collection objects will involve preventive conservation. Physical or chemical modifications to a collection object may adversely affect its analytical potential. Methods that alter collection objects as little as possible are preferred. Techniques and materials selected should be those that are the most stable and have the greatest longevity.

Adherence to the standards and practices presented here will improve collections management, enhance accessibility and preserve the value of natural science collections.

Principles

5.2 The 41 Principles for Collection Care

General

1. No collecting department shall obtain or accept donations of collection material that requires facilities or resources beyond the institution's allocated budget and staffing for the management and preservation of the collections.
2. Collection object/s should be fully documented (in hard copy accession register, labelled and databased) before incorporation into or removal from the collection.
3. All historical data, scientific and conservation actions relating to collections and objects must be fully recorded/documented.
4. Dissection, restoration or any other intervention must not be carried out without thorough consultation.
5. Archival / conservation grade material must be used in the study, storage and display of collections.
6. Loans of material should only be made to borrowers who can satisfy conditions for safe and secure storage, study or display.
7. All collection items (newly acquired material, returning loan material, material loaned in) brought into collection areas must be treated in an appropriate way,

to ensure that they are free of pests (i.e., treated or frozen as necessary) before being moved to and incorporated into the main collections.

8. A routine, documented monitoring / checking system for pests and preservative concentration levels must be implemented, according to best practice guidelines.
9. Appropriate pest management / control / eradication treatments must be applied, according to a documented Integrated Pest Management Plan for the institution.
10. Preservative levels must be monitored and topped up according to a documented schedule and faulty containers replaced as required and according to best practice guidelines. A register must be maintained to record when and who topped up the levels.
11. All institutional staff, from security guards to research staff, must be made aware of their responsibilities regarding the care and maintenance of the collections, whether on display or in storage.
12. Appropriately trained staff should be responsible for ensuring collection objects are adequately protected against all agents of damage or deterioration, including fire, theft, vandalism and pests.
13. The risk to the collection will be minimised through the use of specified standards for display materials, loan packing material, transportation, destructive sampling and through staff training and compliance with best practices.

Collection storage

14. Collection objects should be stored and displayed only in conditions suitable for their preservation.
15. Storage areas must be adequate to accommodate the particular characteristics and quantity of collection objects in the collection.

Collection storage area with metal shelves and white fibre tanks - *image provided by SAIAB.*

16. Collection storage areas should be housed in a pest-free environment that is climatically controlled, to avoid fluctuations in temperature and humidity. The recommendations are humidity between 45 to 55% and temperature between 16 to 22°C, depending on the collection type. Temperature and humidity should be kept as constant as possible (within above parameters), throughout the year to avoid extreme seasonal fluctuations.
17. Collection storage areas must be used exclusively for storing collections and must be separate from all other uses, including office space and research and work areas.
18. Flammable liquids and materials, curatorial supplies, and other materials must be stored outside the collection storage area to lessen clutter and thereby reduce the risk of fire.
19. Collection cabinets, shelving units, and other storage equipment must be arranged so that access to collection objects and interior space is not obstructed, allowing for safe access and inspection and cleaning.
20. Storage areas must provide adequate space to accommodate reasonable growth of the collection over the next ten years.
21. Important collections should be stored furthest from windows and water or electrical pipes.
22. Collection storage areas must be kept sealed off from external exposure as far as possible (doors and any windows kept closed at all times, any other openings well sealed). This will protect the collection from pests, dust and temperature fluctuations.
23. Collection storage areas must have appropriate fire detection and control systems that are tested and maintained regularly. Storage cabinets should be constructed of fireproof materials, but if this is not possible, collection storage areas should at least have fire resistant doors.

Fire suppression system (red steel pipe) in a collection storeroom in the National Herbarium, Pretoria.

24. HVAC (heating, ventilating and air conditioning), electrical power points and other climate control equipment must be located or positioned outside the storage area.

Air-conditioning condenser units outside a building housing collections. This is useful in case of a leak as the potential flood will be kept outside the collection storage area
- image from Ildar Sagdejev (Specious), Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=4370335

25. Fluid preserved collection objects should be housed separately from dry preserved collections and in a storage area that provides appropriate ventilation and fire protection.
26. Storage equipment, cabinets and containers used must meet the best practice standards. They must be acid-free and of neutral pH (unbuffered) or alkaline pH (buffered). Plastics must be made of polyethylene or polypropylene and be non-reactive. Cabinets should preferably be made of metal.
27. Collection objects must be returned to cabinets or other secure storage at the end of each day and no collection items should be left in direct sunlight or under any strong illumination. Delicate collection objects must not be left exposed and unattended, even for short periods of time.
28. No eating, drinking or smoking should be allowed in collection storage areas.
29. No living or organic material should be brought into the collection storage areas.
30. No unsupervised children, or pets should be allowed in the collection storage areas.

Organisation of collection

31. Ideally, the entire collection, including the primary type material, should be stored in the same location. The type collection may be stored in fireproof cabinets within the same storage area as the rest of the collection. Where there are strong rooms, or separate storage areas for type collections, ensure that the collection is not left out of any curation activities.

A fireproof cabinet holding type material housed in the same storage area as the rest of the non-type collection objects - *image provided by ARC.*

32. All type material must be marked with colour codes denoting its status (e.g., red coloured labels for primary type, yellow-coloured labels for secondary types). Types also form part of the inventory priority list.
33. Where applicable, the collection is arranged systematically at the higher taxonomic levels, or alphabetically by order and family, and alphabetically at genus and species level. The approach to organisation of the collection must be clearly documented.
34. Unidentified material should be kept separately from identified material, but it may be integrated at the taxonomic level to which it has been identified.
35. The location of each collection object in the collection must be included in the collection database and movement of the collection object must be documented.

Entrance to the National Arachnida Collection storage area, and metal cabinets with drawers holding vials - *images provided by ARC.*

Updating information on collections

36. Taxonomic updates on collection object labels and in the database must be done according to the latest peer-reviewed publication.

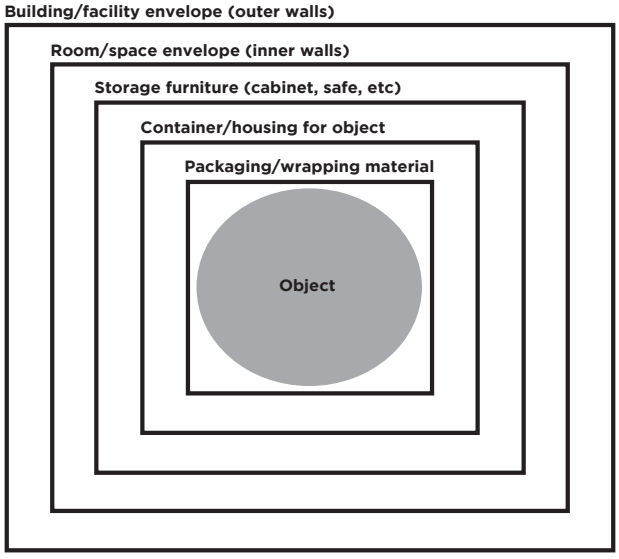
37. Both hard copy and electronic versions of records must be updated when the taxonomy / identity of a collection object changes through publication or when a collection object is re-identified by an expert. The source of the update (name of person who re-identified / determined identity or publication reference) must be included on the label, in the database and in the hardcopy register.
38. All recorded changes / updates must be done on the same day in the catalogue book and accession register, on the labels and in the database to avoid discrepancies.
39. When renewing labels or numbering, or correcting spelling errors, all old labels must be retained with the collection object.
40. The catalogue book and accession register entries must not be erased, but changes must be indicated by a note below or above the name that is being changed.
41. The catalogue books and accession registers must have two lines to record an entry record to allow for future changes to be added to collection object information.

5.3 Standards for Collection Storage

5.3.1 Collection storage area

The features of the collection storage area are important for providing protection from theft, vandalism and disasters, for providing appropriate environmental conditions to preserve the collection and for ensuring that the collection objects can be readily accessed.

The collection storage system can be considered to be multi-layered, with the actual building itself forming the outer layer, the storage room a second layer, cabinets a third layer and the container in which the collect object is held is a fourth layer. The greater the number of layers, and the more secure and sound these layers, the more protection collections objects will have.



Multi-layered protection of a collection object. ***Image from Museum Handbook, Part I, published by the National Park Service (2012).***

- It is best practice that dry collections and fluid preserved collections should not be stored in the same storage area due to their different storage environment requirements, shelving configuration, health and safety requirements, and because of potential risks from chemical spills.
- The storage, laboratory and office areas should be separated.
- In order to ensure that the collections are protected from theft and vandalism, all outer windows must have security bars or be appropriately secured, and access to all collection storage areas should be controllable, either with electronic access control, or manual locking systems.

5.3.2 Environmental conditions for storage of collections

Environmental conditions that are most important for natural science collections are temperature, relative humidity, exposure to light, to dust and to dirt. Storing natural science collection objects in the wrong environmental conditions may result in damage to collection objects.

- **Relative humidity (RH)**
  - Very dry environments can cause cracking or delamination of collection objects such as turtle / tortoise shells, horn, and bone and can also make botanical collection objects very brittle. Delamination occurs when the horn/bone begins to flake away in extremely thin layers.
  - Dry collection objects such as fossil, bone, shell and coral may appear robust, but such objects can swell and contract with variations in relative humidity (RH).
  - Where fluctuations are too rapid or severe, collection objects can split and break apart.
  - Low RH particularly affects teeth, causing them to crack and flake.

- **Damp can also cause a number of other problems including:**
  - Mould growth which releases enzymes which break down organic matter, and damage labels and paper mounts of botanical collection objects.
  - Verdigris - copper and brass pins used in entomology collections can break down and react with the fats inside an insect's body. This can lead to the growth of blue-green, hair-like verdigris crystals on the pin. These can grow through the collection object, eventually breaking it apart.

Verdigris, where metal reacts with insect fats or lipids, spreading on a clearwing moth
- image: Oxford University Museum of Natural History ©
- (with permission) (https://morethanadodo.com/2018/08/09/from-pin-to-paper/).

- Byne's disease - wooden drawers holding dry collections of eggs, shells or bones may release volatile organic compounds. In even a slightly damp atmosphere, these compounds react with the collection objects and cause an acidic crystalline growth that can be gradually corrosive. Bird eggs and mollusc shell collections are particularly vulnerable to this problem.
- Pyrite disease – pyrite is a very common mineral found in a variety of rocks when they are exposed to humid air. Pyrite reacts with oxygen and water to create iron sulphide, corrosive sulphuric acid and harmful sulphuric dioxide gas. This chemical reaction is called pyrite disease and it causes collection objects to crack and crumble. The sulphuric acid emitted from this process in palaeontology and geology collections also contaminates storage materials and damages other collection objects nearby. Collection objects suffering from pyrite disease should be isolated from the rest of the collection.
- Recommended relative humidity levels for collections
- The goal is to keep RH levels in collection storage areas moderate and stable, which means close to 50%, with short-term variation limited to between 45 and 55%. This may require a humidifier or dehumidifier (depending on the climatic conditions where the collection is located).
- It is best practice to have appropriate monitoring devices for RH.
- In fluid-preserved collections, as RH decreases, the potential for static electricity increases, which is a fire risk for collections with poorly sealed containers that allow ethanol vapour to accumulate in the storage area. Relative humidity should also be monitored in such collections and should be maintained at the levels described above. Note that the flash point of ethanol is 16 °C at 100% concentration.

- **Temperature**
  - Warm environments can cause the release of residual fats in skins resulting in hair/feather loss.
  - Warm, damp environments are conducive to pest infestations which can damage or destroy objects and even entire collections.
  - In fluid preserved collections, temperature fluctuations will accelerate the failure of seals on containers and will subject collection objects to stress.

- **Recommended temperatures for collections**
  - For dry collections (botanical collections, skins, pinned insects) temperature levels should be as stable as possible between 18°C and 22°C.
  - For palaeontology and geology collections and fluid preserved collections, temperature in the storage area should be maintained at a constant level between 16°C and 22°C, as fluctuations will subject collection objects to stress.

- **Monitoring temperature and relative humidity in collection storerooms**
  - Data loggers should be placed throughout the collection storage areas to record and monitor temperature and RH on an ongoing basis, with recordings taken at scheduled intervals. Records should be kept and reviewed regularly in order to detect problems and changes in the storage environment. Integration of the monitoring instruments with an alarm system which would notify appropriate staff to any problems in real time, is desirable.

- **Light exposure**
  - Exposure to ultraviolet (UV) light in daylight and artificial light causes pigment in collection objects to fade.
  - Most geological collection objects are not directly affected by either visible or ultraviolet light, but mineral components of a collection can change colour, change phase, or decompose in response to high light levels. In palaeontology collections, light is able to affect the adhesives used in the preparation or preservation of a collection object.
  - Curation supplies, such as mounting boards for plant collection objects, will discolour and deteriorate if exposed to light for long periods. This impacts the integrity of the collection object.

- **Recommended lighting conditions for collections storage areas**
  - Lighting should be sufficient to provide a safe working environment and to allow collection objects to be accurately put away and retrieved. Collection storage areas must be kept dark when not in use.
  - Windows are a source of both light and temperature fluctuations and should be kept closed and blocked or covered with light-blocking curtains or blinds or bricked up if possible.
  - Well-sealed cabinets that are kept closed are effective at protecting collection objects from light exposure.

- **Dust and dirt build up**
  - Build-up of dust and dirt on almost all types of collection objects is damaging and obscures delicate and important features.
  - Dust can be abrasive and attract pests and removing it can cause damage to fragile fossils and other collection objects.

- **Avoiding dust and dirt build up on collection objects**
  - All types of collection objects, with the exception of fluid preserved collections, should be protected from exposure to dust and dirt by being stored in sealed cabinets or containers.
  - For very large objects that are too big or heavy for cabinets or containers, a heavy-duty plastic roller cover should be used to cover these.
  - Note that well-sealed cabinets greatly reduce the dust and pest problems but can create other problems if the cabinet material or the stored collection objects inside give off gases. This could lead to a build-up of harmful gaseous pollutants. Contaminants can also be chemicals used in the preparation of collection objects (e.g., acids or salts not rinsed away after treatment), or materials used in treatment such as adhesives and consolidants.

5.4 Standards for Storage Furniture, Equipment and Consumables

5.4.1 Botanical storage consumables

- Acid-free, cotton fibre (minimum of 25%) paper should be used for mounting sheets and collection object labels, fragment packets, and annotation labels.
- Collection objects that cannot be satisfactorily mounted on sheets should be stored in acid-free boxes. Examples include outsized flowers, fruits, cones, and bark.

Archival box with plant collection objects that cannot be mounted on herbarium sheet
- image from Conserve O Gram 11/12, Preparing and Storing Herbarium Specimens.

- Fragment packets should, ideally, be included on every individual sheet, whether loose material is present at the time of mounting or not, as material is likely to fall off throughout the life of the collection object through regular use.
- Archival quality pens should be used for any annotations not printed from a digital document, and all labels should be printed using archival ink.
- Collection objects should be mounted onto acid-free sheets of archival quality paper of an appropriate thickness and size (lightweight 145gsm, 292 x 419mm or standard weight 187gsm, 292 x 419mm) to provide adequate support. Sheets holding the same species are best stored in lightweight one-fold archival card covers, called 'species folders'.
- The different species of the same genus are stored together in 'genus folders'; made from thin archival quality cards and scored with a spine. These folders should be slightly larger than the herbarium sheets when closed, to protect the edges of the sheets.
- Acid-free, archival quality glue and/or thinly cut strips of archival, pre-gummed linen tape should be used for mounting the collection object and for the attachment of all packets and labels.

Adhesives, species and genus covers used in a herbarium.

- Bryophytes (mosses), fungal collections and lichens should be stored in cotton packets, acid free paper envelopes or boxes. The original label should be kept with the collection object and stored in a polyester envelope (for the boxed samples).
- If storing herbarium collections in boxes, an archival box with a drop-down front is recommended.

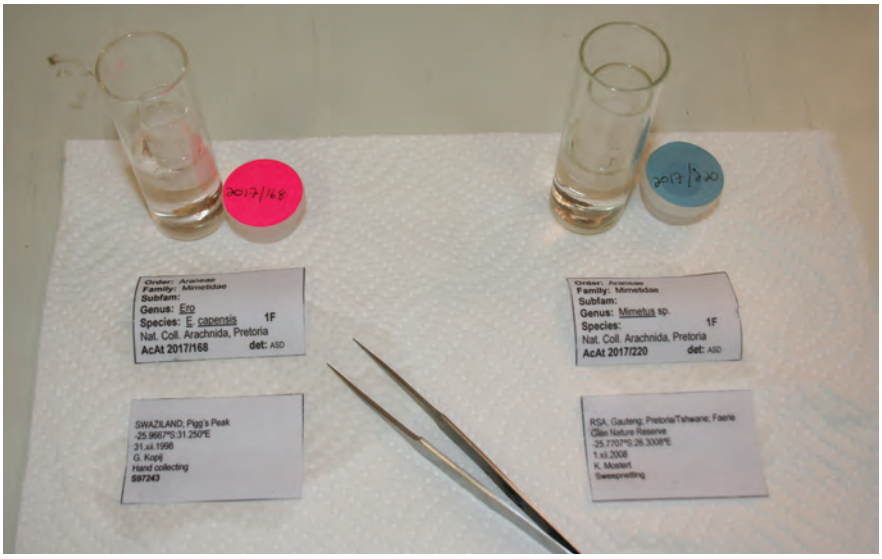
5.4.2 Storage furniture for botanical collection objects

- Cabinets should seal securely to protect and preserve collection objects from light, insects, dust, water and all other agents of deterioration.
- If the cabinets are coated, it should with a non-off-gassing, non-reactive, solvent free finish, and have a waterproof top seal.
- The shelving arrangement should allow safe access to the collection objects and ease of collection object retrieval.

A metal cabinet holding herbarium collection objects.

5.4.3 Fluid preserved collection storage consumables

- Fluid preserved collections must be preserved in ethanol, and those in propanol or formalin need to be transferred following the correct procedure. Where additives such as glycerol are used, the impact of these on DNA analyses needs to be understood.
- Labels should be made of acid-free paper of 160gsm thickness (e.g., goatskin parchment). Synthetic label material (e.g., thermal printer label material) is increasingly being used because of its chemical resistance to the solvents used in preservation fluid.



Collection object labels printed on an acid free goatskin paper -*image provided by ARC.*

- Archival quality pens should be used for any collection object data that is not printed from a digital document, and all labels should be printed using archival ink. Permanent Indian ink and Micron archival ink should be used for handwritten labels or record entries.
- Small collection objects should be housed in smooth sided glass vials that are closed with a polyester fibre plug or a polyethylene cap with small holes punched in it and submerged in a larger jar of preservative (note that cotton wool tends to absorb lipids and does not remain as flexible as polyester fibre). The base of the larger container should be lined with a layer of cotton wool or other conservation grade padding to protect the smaller vials from breaking.
- Containers for fluid-preserved collections objects should be made of clear glass, which both provides protection and allows for visual examination of the contents without disruption of the container seal.
- Polypropylene screw-on lids for glass jars provide protection against preservative loss or contamination by providing a stable microenvironment.
- For collection objects that cannot fit into the locally available glass jars, fibreglass or stainless-steel containers are recommended rather than plastic. If plastic containers are used, these must be high-density polyethylene (HDPE) buckets or drums that seal well. These containers are opaque which makes them susceptible to deterioration from exposure to ultraviolet radiation and they are somewhat permeable to oxygen. They should be closely monitored.
- The lid gaskets of fibre glass and stainless-steel tanks and containers must be replaced periodically as they deteriorate from contact with preservatives and the stress of compression from the lid. Steel lids should also be checked periodically for warping, and polypropylene lids will need to be checked because these may perish.
- In large containers, collection objects may be grouped together in nylon or polyethylene mesh bags for ease of retrieval.

5.4.4 Storage furniture – fluid preserved collections

- High-density, mobile storage systems (compactors) that are capable of holding the weight of fluid collections should be used for storage, especially where there are space constraints.

- Shelves must be flat and wide enough to accommodate collection object containers, and they should have a rim or other form of barrier to prevent bottles falling off the shelves.
- The shelving arrangement should allow safe access to the collection objects and ease of monitoring fluid level and condition, preferably without having to move containers in the front to see the containers stored behind them.
- The shelves should be spaced so that there is enough room to remove a container from the back of the shelf without the need to move the containers in front of it.
- Shelves must be sturdy enough to support the weight of the collection object containers (a 3-litre container of collection objects in fluid can weigh about 3.5kg).
- Racks for large containers (e.g., drums, tanks) must be constructed so that the containers may be accessed easily for servicing and collection object retrieval.
- Drawers are not ideal for storing large fluid preserved collections because of the weight and vibrations and shock caused by opening and closing of the drawers. Vibrations may be reduced by lubricating the drawer mechanism (where applicable) and padding the bottom of the drawer with a layer of polyethylene foam. Even with drawer padding, it will be necessary to check and tighten vial caps and jar lids periodically for a collection that is actively moved back and forth.

5.4.5 Dry collection storage consumables (fossils, bones, pinned collections, skins)

- Controlling pollutants in the environment of a dry collection is done by using the correct material that comes into contact with the collection objects, which means that all materials must be of archival quality.
- Use only acid-free paper and card with the collections.
- No PVC plastics must be used for collection storage; these give off chlorine gas that damages the collection objects. They can also cause static electricity which is not good for delicate collection objects such as pinned insects.
- Vials with screw caps (e.g., rodent skull vials) should be stored upright and supported by dividers. If vials are kept in drawers (compactor storage with shelves), vibrations from drawer movement may loosen lids.
- For dry collections stored in boxes, a drop-down front is recommended.
- For pinned collection objects, use only good quality stainless-steel pins.
- If glues are used for mounting small insects on card, water soluble vegetable glues or an archival grade adhesive must be used.
- For pinned insect collections, boxes or drawers should be lined with white, cross-linked polyethylene foam, commercially known as Plastazote, with a thickness of 9-12mm. In old collections where drawers are lined with cork, a layer of archival quality paper must be laid over the cork and glued down with an archival quality glue.
- All dry collection objects should be cushioned with conservation grade foam or padding.
- Unless the storeroom is very well sealed and climate controlled, dry collection objects that are not stored in cabinets should be covered with a suitable material to protect them from pests and dust.
- Where steel shelving is used, shelve covers can be used to enclose the shelving units for dust protection and for providing a partial micro-climate control. Although the covers are not completely air-tight, they do provide some protection (e.g., for humidity-sensitive collection objects).

Shelf covers used on steel shelves to create a barrier between agents of deterioration and the collection objects - *image provided by Museum of Culture and Environment at Central Washington University. (https://stashc.com/the-publication/covers/shelving-covers/).*

- Collection object covers provide physical protection and segregation for collection objects that cannot be housed in cabinets/shelves. Covers create enclosures that can be tailor made or altered to provide a unique fit.
- Depending on the nature of items requiring cover, the covers can be constructed from Tyvek, polyethylene sheeting or Gore-Tex [made of polytetrafluoroethylene (Teflon)].

5.4.6 Storage furniture - dry collections

- Metal cabinets are recommended as they do not release volatile organic compounds (VOCs) like wooden cabinets do. The metal shelves can be easily cleaned, and a well-sealed cabinet will provide a stable micro-climate for the collection objects.
- Some older collection cabinets in institutions were not constructed in a way that ensures that they are airtight and these may need additional monitoring.
- One of the simplest ways to reduce pests in dry collections is to seal the collection objects grouped in a box or in drawers (e.g., fossils, bones, pinned collections, etc.), and then place the box or drawers in a cabinet. This will prevent most pests from crawling inside. For pinned insects, drawers must be sealed, preferably with a tight-fitting framed glass lid.
- Dry collection objects can be stored in cabinets, in clear lidded polystyrene or archival quality cardboard boxes, and nested in acid-free tissue paper. Such boxes provide protection from dust and allows the collection object to be seen through the clear lid, thus reducing the need for handling it.
- Skins should be stored in sealed cabinets to prevent dust build-up and reduce the risk of pests.
- Well-sealed cabinets greatly reduce the dust and pest problem, but off-gassing of the cabinet material or the stored collection objects inside could lead to a build-up of harmful gaseous pollutants.

5.4.7 Slide collection storage

- Slide storage cabinets should be customised such that it is easy to locate the slides.
- The standard is to store slides flat with the cover slip side facing upwards to prevent slippage and running of the mounting medium, thus providing more stability for the mounted object. However, for slides with sound mounting medium, it is acceptable to store vertically.
- Slides should never be stacked directly on top of each other.

Closed metal slide cabinet (left) and with one door opened to show storage capacity and arrangement - *images provided by C. Grinter, California Academy of Sciences.*

Arrangement and positioning of microscope slides for storage
- images provided by C. Grinter, California Academy of Sciences.

5.5 Standards for Organisation of Collection/s

A well-planned and organised storage space reduces risks to the collection/s and provides accessibility. The most important factor in arranging the collection/s is that it should be usable. Collection staff need to be able to quickly find individual collection objects, and they also need to be able to browse the collection/s in a meaningful way.

- The arrangement of a collection in a herbarium or museum can be done according to a variety of systems, usually influenced by the herbarium/museum's culture and collection size.
- The system used for organising the collection should be clearly documented so that there is consistency over time, and so that it's clearly understood by all collection users. This is especially important when new staff are appointed.
- A sound inventory of collection objects requires that the location of each collection object be recorded in the database, and that movement of collection objects is also documented (this is also an audit requirement). This means that a coding and numbering system for collections, storerooms, cabinets, compactors, shelves and drawers is required. The simplest possible system is recommended.

Organisation of botanical collections

Current choices for organising a vascular plant collection include:

- Arranging the entire herbarium alphabetically by family, possibly recognising major groups such as monocots, dicots, lower plants.
- For flowering plants, following the current APG IV (Angiosperm Phylogeny Group, 2016) system, arranging the families in a linear representation of the current concept of relationships.
- Retaining a traditional scheme, such as Engler (1900).
- Creating a hybrid system, in which much of a traditional framework is retained and the newer family concepts are integrated into that scheme (see Pace et al., 2017).
- Below family level, genera and species are typically arranged alphabetically, though they are sometimes broken-down into large geographic areas first.

5.6 Procedures for Collection Object Handling

5.6.1 Removing collection objects from the collection

- When working with collection objects, after removing them from their position, place a card (with name of borrower, date and catalogue number) where they were, so that anyone else who looks for them before they are returned knows where they are. This is also to ensure that they are replaced in the correct place, thus minimising the chances of objects being misplaced.
- Moving collection objects must always be done with great care because this is when most damage can be done by dropping glass containers, insect drawers, plant collection objects or bones. If trolleys are used these should not be overloaded, and collection objects or containers must be protected from falling, vibrations and jarring.
- Appropriate personal protective equipment (PPE) should be worn at all times when handling collection objects. Collections must be handled in well ventilated working areas or in fume cabinets.

5.6.2 Working with dry collection objects

- Wearing disposable neoprene or nitrile gloves will eliminate any transfer of skin oils and perspiration to collection objects and protect the wearer from any toxins in or on the objects. If gloves are not worn, hands must be washed well with soap before and after handling collections. Older collection objects may have been treated with toxic chemicals, (e.g., lead, mercury, arsenic) to prevent pests. When working with collection objects whose preparation history is unknown, wear chemical resistant gloves and a mask, and work in a well-ventilated room.
- Always handle collection objects with gloves when cleaning them and use a fume cupboard or fume and dust extraction system and wear appropriate PPEs (e.g., a dust mask and safety goggles). Some collection objects may have been treated with arsenical soap (sometimes noticeable as a fine white powder), lead mercury and other toxic substances. The card on which the collection object is mounted and the collection object itself may contain chemical traces of these substances.

Pinned insects

- Pinned entomology collection objects are handled using fine, watchmaker's forceps to hold the pin, or if delicate collection objects are being handled directly, soft, lightweight forceps are recommended. Special curved pinning forceps are useful for holding the pins during preparation. In the case of more robust collection objects, the pin can be held between the finger and thumb.
- Pinned insects should always be held by the shaft of the pin and not by the pin head.
- Forceps should be sterilised between use on different collection objects.
- Old collection objects can be very dry and brittle and pins may be corroded so remove collection objects from their drawer very carefully.
- Open and close drawers very gently and never slam drawers.
- Collection personnel with long hair should tie it back. When wearing clothes with loose fitting sleeves, they should be rolled-up. Clothing with loose hanging attachments should be avoided.
- Limit breathing over the collection objects as even a slight wind can damage wings or loosen the legs of delicate insects.

Herbarium sheets

- Herbarium sheets are very fragile and should be handled with care. To minimise risk, the folder should be completely removed from the cabinet and placed on a flat surface. Open the folder flat out and always keep it horizontal so that the sheet does not bend during examination. Alternatively, use a special cradle-like holder for herbarium sheets (see image below).
- The herbarium sheets should always be held with both hands at the sides of the sheet, and the sheets must never be turned as though they were the pages of a book.
- Leaning on herbarium sheets, writing notes on top of them or placing heavy items or elbows on them can cause serious damage.
- Limit the height of stacked folders so that the weight of the top collection objects does not damage the lower ones.
- Herbarium sheets should never be exposed to sunlight.

A herbarium collection object holder recommended for working with botanical collection objects.

5.6.3 Fluid preserved collection objects

- Collection objects in alcohol-based preservatives should be kept moist with the preservative while being examined or handled; they must not be placed in water. Only collection objects in water-based preservatives (e.g., formaldehyde) may be placed in water for examination.
- Fluid preserved collection containers should only be opened, and collection objects removed in a properly ventilated work area or under fume cabinets. Alcohol evaporates rapidly from preservative mixtures, so containers should not be left open for prolonged periods.

5.6.4 Slides

- After use, slides must be returned to the shelf with the coverslip facing up. This is to prevent the labels on the slides from detaching - old glue deteriorates and labels pop off.

5.6.5 Checking collection objects for repairs and maintenance

- Before replacing in the collection, review collection objects for potential maintenance, (i.e., loose collection objects, existence of pests, broken fragments, incorrect labels, loss of preservative fluid). Make necessary repairs or top up with the correct preservative, and decontaminate collection objects that may have been exposed to pests, especially if the collection object has been out on loan.
- All collections should have a visual inspection schedule, as a way to monitor issues (e.g., cracked or popped lids, signs of pest infestation or issues that require attention). It is recommended that visual inspections be carried out on a quarterly basis, however, where necessary, such as if there is evidence of pest outbreaks, more regular monitoring is recommended. Make sure that dry collection objects have no damp or pests before returning them to the collection.

5.7 Procedure for Monitoring and Replacing Preservative in Fluid Preserved Collections

A digital density metre for checking the ethanol concentration - *image from the Anton Paar website (https://www.anton-paar.com/za-en/products/group/density-meter/).*

- Fluid loss is a major risk to fluid preserved collection objects, and loss of fluids is usually accompanied by a decrease in the concentration of the fluid preservative, which has a negative impact on the preservation of the object. A decrease in ethanol concentration is also caused by the loss of fluids from the collection object into the surrounding preservative, and so even if the level of preservative has not decreased, the concentration may have been reduced over time.
- A schedule for checking concentrations and topping up ethanol needs to be established and implemented, even if this activity is continuous because of the size of the collection. The recommendation is that collection objects should be checked at least once a year. Containers that show fluid loss should be marked and monitored to detect problematic seals and closures. Once the problem is identified, it should be corrected immediately to avoid further preservative loss.

5.7.1 Monitoring and correcting ethanol concentration

- The Alcomon Indicator System (red and orange pills) can be used to monitor the ethanol concentration in fluid-preserved collections. In the case of the red coloured pill, it will float when the ethanol concentration is below 50% and sink when the concentration is above 50%, and the orange pill will do the same but at concentrations of 60%. This means that if only the orange pill floats, there is no immediate risk, but if the red pill floats, the concentration must be adjusted urgently (the collection object will start to decay at concentrations below 50%). This system will not provide the exact concentration and so a digital density meter should be used to correct the strength of alcohol preservatives. This system is much more time consuming because the jar will have to be opened and some of the fluid removed for measuring. Digital density meters should be flushed with distilled water after checking alcohol concentration.

The Alcomon tablet system for monitoring ethanol concentration. The first bottle shows ethanol of concentration greater than 60%, the second bottle between 50 and 60%, and the third bottle, less than 50% - *image from the Alcomon website (http://alcomon.com/info/).*

5.7.2 Discolouration of ethanol

- The yellow-orange colour often seen in alcohol-preserved collections is due mostly to dissolved oils and fats (lipids), which are soluble in alcohol but not in water. If the alcohol concentration becomes too low (e.g., from evaporation of alcohol followed by topping up with regular strength preservative) these lipids may precipitate and form a coating on the collection objects or acidify sufficiently to pose a risk to the collection objects.
- Furthermore, as the fluid evaporates from a container and the concentration of an alcohol-based preservative drops, mould or bacterial growth may damage collection objects and data labels. Collection objects in alcohol will absorb water as the concentration of the alcohol declines, resulting in swelling and structural damage. For these reasons, replacing lost preservative fluid must be done cautiously.

5.7.3 Topping up fluid preservatives

- Containers that are low on fluid should be topped up to protect the collection objects by adding an appropriate concentration of preservative to achieve the desired storage strength (continual topping up with storage strength solution will result in an increasingly lower than desired concentration of preservative).
- If fluid loss is greater than 10%, or if the container repeatedly loses fluid, the preservative concentration should be checked and restored to storage strength. For this procedure to be effective, regular visual inspections of fluid levels must be made.
- In a large collection, measuring the concentration of every container that loses preservatives and preparing a mixture to bring it back to storage strength may be prohibitively time consuming. As a general rule of thumb, if the fluid level has declined by 10% or less, the container may be topped up with stock solution, marked, and monitored.

- Sendall and Hughes (1996) provided a formula for topping up alcohol preservatives in straight-sided containers: **z (x + y) = ax + by** where z is the desired concentration of preservative (percent); x is the measured height of fluid in the container; a is the measured concentration of fluid (percent); b is the concentration of the solution being added (percent); and y is the amount of fluid to add (relative to container height). The equation is solved for y: y = **(z − a) x ÷ (b − z)**.
- Containers should be filled to a standard height for ease in detecting preservative loss. A jar is considered 100% full when the preservative reaches the neck of the jar below the threading. Jars should always have at least 10 mm of headspace to relieve pressure on the lid (which can untwist if the pressure is too great).
- If the collection object is in an unknown fixative or preservative fluid, it generally should be left alone (until tested) unless there is a compelling reason to change the fluid.
- Containers should not be overfilled with collection objects. A ratio of preservative volume to collection object volume of 7:3 should be maintained.
- The preservative used in the collection should be documented. Any collection objects that are not in the standard preservative should then be marked.
- Containers that are topped up should be marked (e.g., using a post-it, initialled and dated by technician to indicate shelves or drawers that have been topped up) to facilitate monitoring of excess fluid loss over time. This can be done on the cabinet, row or shelf, not necessarily on every container (as long as the information can be accessed and understood by other collection staff).
- Topping up delicate collection objects may cause osmotic problems; this should be closely monitored.

Example of a jar volume template, developed by Braker, Emily M. (2017). *University of Colorado Museum of Natural History. With permission.*

5.7.4 Reasons for transferring collection objects to a new storage fluid

- When the preservative has become acidified (usually due to unstable products in the preservative such as formaldehyde).
- If extracted lipids cause sufficient acidification to damage bone or other tissues.
- If extracted lipids (particularly with oily marine species) discolour the collection object or make it difficult to handle or use for research purposes.

- For research purposes or other use for the collection object.
- When the preservative method has been deemed inappropriate.

5.8 Procedures for the Management of Pests in Collections

Pests pose an enormous threat to dry collections, including herbarium collection objects, skins, skeletal material and pinned insects. Pests also infest storage infrastructure such as buildings, cabinets and shelving and their management is therefore critical for ensuring the preservation of collections.

While the use of pesticides may be effective in the short term, these may leave a residue on collection objects, and most pesticides pose a health risk to staff working in collections. Pesticides also contribute to many broader environmental problems.

Globally, collection institutions are using more proactive, integrated approaches that involve preventing infestations in the buildings as a whole, monitoring pests, and environmentally friendly approaches or treating specific areas or objects, rather than simply using chemicals on a large scale, to repel and eradicate pests. It is essential that all collection institutions have an Integrated Pest Management Plan for vulnerable collections.

5.8.1 Integrated Pest Management (IPM) Plan

Integrated Pest Management (IPM) establishes a sustainable approach to managing pests by combining biological, physical and chemical tools in a way that minimises economic, health and environmental risks. Given the environmental concerns, institutions have become aware of non-chemical pest control methods for their collections.

- The plan outlines procedures to be followed to protect the health and safety of staff and collection visitors, as well as the housed collections from pest and pesticide hazards.
- The plan should be designed to comply with any policies and regulations that may be in place. For example, the plan should not include or promote the use of banned chemical products, and it should provide the correct disposal methods for used chemicals and their containers.
- The focus must be on the monitoring of pests through the use of pest traps, the practice of good housekeeping, maintenance of the building interior and exterior areas, and the development of a plan for the occasional active infestation.
- Pest removal methods are usually non-chemical and include freezing, high heat, and low oxygen (anoxic) environments. However, the most important thing is to be able to identify what pest is causing problems in the collections. Where necessary, appropriate chemicals may be used to eradicate specific pests.

Objectives of the IPM plan include:
- Elimination of significant threats (caused by pest control methods) to the health and safety of staff and the collection visitors.
- Prevention of loss or damage to collections, structures or property by pests.
- Protection of environmental quality, inside and outside buildings.

5.8.2 Roles and responsibilities

- IPM Coordinator. It is recommended that one staff member be designated the responsibility for the coordination and implementation of the IPM plan and related communication and training.
- IPM Committee. The institution should establish an IPM committee to review the IPM plan annually and to assist the IPM Coordinator in resolving pest-related issues. The IPM Committee must address IPM issues at least annually (or as needed). Where meetings are held, minutes should be taken and kept on file by the IPM Coordinator.
- Institutional Management: The institution manager/director is responsible for ensuring staff compliance with the IPM plan.

5.8.3 Activities for implementing IPM

- **Posting and notification of pesticide applications**
  - The IPM Coordinator is responsible for notifying staff of the scheduled fumigations, planned applications of pesticides, and procedures for requesting emergency applications of pesticides in buildings.
  - When pesticide applications are scheduled in buildings, the IPM coordinator shall provide notification including:
    - Emailing and posting pest control information signage with the date, time and location of the application and the product applied in an appropriate area and including their contact information for additional details.
    - Providing this information to all individuals working in the building and arranging for removal of personnel where required.

- **Pest monitoring**
  - Pest monitoring traps should be inspected according to a regular schedule. Trapping frequency may increase during peak breeding period, or when a problem is detected.
  - All vulnerable collections must be spot-checked visually for pests at least twice a year by the relevant collection manager / officer. Collections in high-risk zones (e.g., a collection that has been removed from the collection storage area, and a collection that is not in an environmentally controlled area) must be spot-checked every six months.
  - All staff are responsible for reporting sightings of pests to the IPM Coordinator or the member of staff responsible for pest monitoring.
  - The IPM Co-ordinator will maintain a register of monitoring results and infestation incidents and make the results of monitoring available for management purposes and to increase staff awareness of the threat of pests to museum collections.

- **Record keeping**
  - Documentation is essential; monitoring will be impossible and useless without it. The number of insects, the types of insects, and their life cycle stage should all be recorded for each trap. Dates and locations of trap replacements should be noted.
  - Detailed records should also be kept on Specify or Brahms (or recorded manually and filed where there is no provision on the database) of any other evidence of

Examples of a sticky trap for monitoring insect pests.

insect activity, such as live insects, insect droppings, or dead insects, as well as descriptions of any insect damage to collections or infrastructure (images should be taken where possible).
  - Records of all service provider visits, and pest control treatments must be retained.
  - The IPM Coordinator will record evidence of pests through the trapping process and sightings from staff members.

- **Training**
  - All staff must be provided with training on the institution's IPM plan upon being hired and during annual update training, as well as any other identified necessary training. Training will include the rationale for the IPM plan and programme and specific elements, including the use of the pest-sighting log and prohibition on pesticide applications by non-certified individuals.
  - Additionally, designated staff including the IPM Coordinator, and those who conduct regular inspections of buildings should receive advanced training on identifying pest infestations and pest-conducive conditions. This training will improve the ability of museum/herbarium staff to oversee service providers, as well as staff compliance with the institution's IPM plan.

5.8.4 General IPM strategies

Pest management strategies may include education, biological and mechanical controls, and pre-approved, site-appropriate pesticides. Pest-specific strategies will be included in the IPM plan.

An IPM decision at an institution shall consist of the following steps:
- Avoid and prevent access of pests to collection buildings.
- Identify pest species when they have successfully invaded a building.
- Where feasible, estimate pest populations and compare to established action thresholds.
- Select the appropriate eradication method based on current on-site information.
- Assess the effectiveness of pest management and repeat eradication if necessary.
- Keep appropriate records.

5.8.5 Avoiding and preventing pests

- Decisions concerning whether or not pesticides should be applied in a given situation will be based on a review of all available options. Efforts must be made to avoid the use of pesticides by adequate pest proofing of buildings.
- Deny pests food and havens for reproduction. This is easily achieved by adhering to sound housekeeping procedures that include the following precautions:
  - It is essential that all floors (including offices) are kept sufficiently clear to enable the effective cleaning of the whole floor space. An IPM Co-ordinator may inform the collection staff if a cluttered space poses a pest risk to the collections.
  - Regular floor cleaning must be undertaken using vacuum cleaners. Vacuum cleaners must be fitted with HEPA filters when used in galleries and stores. Vacuum bags should be changed at least monthly, and disposed of immediately outside of the building if, used in pest-affected areas.
  - The deep cleaning of areas requiring a higher level of cleaning (such as collection storage areas and galleries) should be programmed into the conservation cleaning roster.
  - Bins containing food waste should be emptied daily and must be emptied prior to weekends and holidays. Once collected, rubbish should be removed immediately from the building.
  - Where there are cafés, restaurants, kitchens and / or spaces used for events, it is the responsibility of the catering and events staff to keep the area clean and tidy after use, but the IPM Co-ordinator should check that this is being done adequately.
  - The consumption or storage of food and drink is not permitted in collections storage areas, including laboratories, visitor working areas, libraries and offices if collection objects are worked on therein.
  - Food storage is only permissible in designated kitchen/tearoom areas, not in offices. Any food kept overnight is deemed as being stored.
  - All food waste must be put in kitchen bins, not office bins; including chewing gum wrappers and drinks containers.
  - All staff are generally responsible for cleaning up after themselves in areas where they consume food and drink.
- Any live animals kept in captivity in the collection building can be a source of pests. Food such as seed and pellets must be kept in sealed metal containers and stored in an outside building.
- Field gear and equipment must be kept in a separate storeroom.
- Buildings should have properly fitting window and door screens to prevent pest access to the building. All other areas of pest entry should be blocked. Gaps and holes can allow insects, rodents or birds entry and provide them with a place to live. However, don't block ventilation holes. If they are used as points of entry for pests, cover them with mesh such as fly wire. It should also be borne in mind that not all potential pests can be restricted in this way.
- If there are windows in the collection storage area these must be kept closed. If the windows have insect screens these may offer some protection, but they need to be very well fitted and intact in order to be effective against pests.
- Overhanging trees and plants, blocked gutters, nesting birds and droppings are all breeding grounds for insects and need to be eliminated / controlled.
- Potential improvements to collections areas which may prevent or limit the access, dispersion and concealment of pests are to be reported to the person responsible

for pest monitoring (IPM Coordinator).

- Collection storage areas that have effectively controlled temperature and relative humidity are less likely to have serious pest infestations than those that do not manage climate.
- All material about to be placed in the collection must first be isolated and treated for pests before being incorporated into the collection. This includes returned and incoming loans and newly accessioned objects.
- Packaging material in which collection objects are received can also harbour pests and must be treated in the same way that the collection objects themselves are if the material is to be stored near the collection.
- Doors to collection storage cabinets should be kept closed, unless in use.
- Collection storage cabinets containing collection objects vulnerable to pest damage should be checked at least biannually by a collection manager. Faults, such as missing/defective door seals, should be discussed between curatorial staff and the relevant IPM Co-ordinator, and an action plan for completing necessary repairs (e.g., replacement of seals) agreed on.
- Collection objects vulnerable to pest damage that cannot be stored in sealed cabinets should be sealed in polyethylene bags, wherever practical. Zip-lock bags are suitable for short-term storage; for long term storage, bags should be heat sealed. The integrity of bags should be checked annually by a collection manager / officer and improved when necessary.
- All staff should be alert to potential or actual risks to the collections from pests. Issues, including building defects that increase the risk of pests in collections areas, should be reported to the person responsible for pest monitoring (IPM Coordinator).

5.8.6 Identifying pests

How do we recognise that our collections are under attack from insects, besides actually seeing the insect, which is a rare occurrence?

It is important to know what type of pest occurs or is frequently seen in a collection, so that accurate records can be kept and appropriate steps taken to eliminate it.

- Examination of collection objects for live pests, either adults or larvae: collection objects must be closely examined, as silverfish, booklice and other insects can be difficult to spot because of their size, colour and reclusive habits. Try not to squash insects that need to be identified; the live or dead specimen should be placed intact, in a vial with a lid. Knowing precisely what insect is being dealt with is critical because this will influence the specific treatment. For example, the fumigant exposure time needed to eradicate wood borer is longer than that needed for termites, so in the case of borers, standard fumigant exposure time will not be successful.
- Insect remains: dead insects; termite wings; casings or skins shed by larvae as they mature and moult; empty egg cases of cockroaches (a hard dark pod attached to walls or other surfaces), and webbing of clothes moths (a small cocoon or threads) are irrefutable signs of infestation.
- Visible damage: ragged edges and 'skinned' areas on paper, small holes with clean edges in objects where the larvae have emerged as adults indicate insect

damage. Once again, close inspection is sometimes needed to detect these signs. Subtle skinning of paper occurs as silverfish graze across the surface. Exit holes in wood are a sign that adults have emerged, and some damage has already been done. Since the activity occurs inside the wood, it is unlikely that you'll see any larvae at work.

- Frass: is a fine powdery sawdust or a hard sand-like material which collects in the holes and tunnels excavated by the insects. The colour of the frass will usually be similar to that of the food the insects are digesting. If a small pile of frass is found under an object, that object probably has an active insect population. It's important to note evidence like this before you sweep or vacuum the evidence away!
- Sound: some people are able to hear insects in wood. You can use your fingers to lightly tap across wood surfaces and listen for differences in sound to reveal hollow areas below, indicating tunnelling.
- Monitoring traps and pheromone attractants: To check for pest activity present within the collection storage areas, different styles of traps and attractants are used to monitor different species. Sticky traps capture pests that are moving between areas while baited traps use food or pheromone attractants to lure specific species of pest to a trap. Sticky traps have a sticky layer of adhesive inside that catches any insect that walks across it. The traps are only designed to catch a sample of the insect population present and are by no means a method of treating a pest problem. The data collected from the trap inspections is used to inform any changes that need to be made in terms of housekeeping, environmental management and building maintenance.

5.8.7 Common museum and herbarium pests and indicators of these

- Bookworms/cigarette and drugstore beetle larvae burrow through books and bindings, creating a hole in each page as they pass. They also eat dried plants and animal materials.
- Cockroaches damage paper, cardboard, clothing and furniture by eating starch, mould, proteins and other residues on the surface. They also stain materials with their droppings and adhere their egg cases to objects.
- Clothes moths: as they feed, the larvae of the case-making clothes moth enclose themselves in a case spun out of the material they are feeding on, whereas the webbing clothes moth larvae leave a trail of silk as they go. Both eat fur, feathers, wool and dried plant materials, gradually thinning the food source down by grazing on the surface.
- Booklice are tiny and a pale colour. They feed on mould and other dead insects but will also graze on paper.
- Termites create tunnels through wood as it is consumed by the adults, resulting in serious structural damage. There are no flight holes, as with woodborers, but there is a sand-like frass. Termites can move from structures into furniture, shelving, picture frames, floorboards and eat other cellulosic materials besides wood. They also tunnel through other materials on their way to a food source.
- Wood-boring beetles, including powder-post and death watch beetles, lay their eggs on wood, which is then tunnelled through by the larvae, sometimes for years before eventually emerging as adults through small holes. The powder-post beetle generates a very fine powder-like frass.
- Silverfish prefer high humidity and dark conditions. They move quickly and will eat anything containing starch, including adhesives and the coatings on papers, and

also digest cellulose (paper).

- Dermestids include larder and hide beetles which are voracious. The larvae consume animal skins and dried plant materials, then cause damage to wood as they burrow in to undergo pupation (metamorphose into adult form).
- Carpet beetles – there are several types of these. Adults feed on pollen and may be brought indoors on fresh flowers. The larvae prefer dark, dirty areas, and eat fabrics, plant materials, fur, and feathers, usually grazing across the surface, resulting in obvious damage, or a general shabby look.
- There are many images and descriptions of these pests available on the web and in the literature that can be used to identify pests and signs of these.

5.8.8 Assess and solve pest problems

- Once the pest has been identified, the source can then be investigated, and the life cycle determined, facilitating effective treatment.
- IPM experts can be asked to provide input on any institution/facility renovation or reconstruction projects, including reviewing plans for pest-conducive conditions, suggesting pest-proofing measures and inspecting construction where applicable, to prevent and avoid pest problems.

5.8.9 Non-chemical pest control methods

- **Detection of pests, isolation and bagging**
  - All incoming collection objects (e.g., incoming loans, acquisitions, collection objects for identification) must be inspected by an appropriately trained member of curatorial staff for pests. All problems identified must be rectified before allowing the collection object/s into a collection area.
  - All organic materials for use in collections areas (e.g., wood for shelving or boxes) must be inspected for pests by an appropriately trained member of staff before it is allowed to enter a collection area.
  - Bagging (placing collection objects in an appropriate plastic bag) and monitoring of collection objects suspected of being infested, is not an IPM treatment as it does not eradicate insects. However, it can indicate the presence of an active infestation and is an important part of an IPM programme. Bagging and monitoring serves to quarantine the collection object/s so that other collections nearby will not be affected.
  - When collection object /s require quarantine, this will generally be achieved by sealing in polyethylene bags (where applicable) and monitoring. This will be conducted by an appropriately trained member of staff.
  - Place collection object on a white sheet – blotter paper, paper board, tissue, or foam – and then seal in a polyethylene bag.
  - Over a period of several weeks or months, the collection object can be monitored for signs of infestation or of insect activity, which will be more visible on the white sheet.
  - These signs can include the presence of live adults, cast-off larvae skins, or deposits of frass, webbing or casings.
  - If the type of insect is known, then refer to the literature to determine the life cycle and ensure that the amount of isolation time covers the time needed for adults to hatch.

- **Freezing as a pest control measure**

The freezing method is simple, inexpensive, readily accessible, and non-hazardous to humans. It only requires the acquisition of a freezer.

When selecting a freezer, it is recommended that it should be capable of reaching and maintaining a temperature of -40°C. It should be a chest type freezer which when opened will not lose its temperature as would an upright freezer. Collection objects should not be put directly on the floor of the freezer as this could cause water damage if the freezer accidentally thaws.

  - Wrap collection objects in absorptive material such as muslin cloth and place in a sealable clear plastic bag.
  - Push out excess air and heat seal the plastic bag or use parcel tape to seal plastic bag.
  - In the case of herbarium sheets, ensure that the stack of plants can be easily frozen by keeping the pile relatively small. Use supportive cardboard on top and bottom of the pile, then place in a plastic bag and seal.
  - Store in the chest freezer at -18°C for at least 14 days or at -30°C for minimum of 72 hours.
  - For plant collection object pests, you may only need to freeze at -20°C for two weeks or at -40°C for three to five days.
  - A day (24 hours) should be given to acclimatise the collection objects to room temperature, still completely wrapped, until they are at room temperature.
  - Take care when freezing algae or lichens (can have delicate red pigments) or use anoxic pest control methodology if you are unsure about the stability of the materials.

- **What materials can be frozen?**
  - Collection objects which are made up of one material, such as horns, feathers, wood and plant materials (that have completely dried) can be safely frozen. Do not freeze objects which are made up of layers of materials such as ivory. Freezing could cause disruption and damage to the layers.
  - Extreme caution should be exercised when freezing objects that are made up of a combination of materials. Different materials have different strengths under extreme cold and some become more fragile than others. Also, different materials expand and contract at different rates.
  - During the freezing process, it should be noted that when temperatures go below –30°C, the shear strength of certain glues is altered; in some cases, the glue becomes stronger and in others, weaker.
  - Plant collection objects that are densely packed may freeze slowly enough that insects can shut down rather than perish, and freezing doesn't always kill the eggs.
  - After freezing, collection objects that are known to have been infested should be allowed to come to room temperature and then be held (in isolation) for a few days, giving any eggs triggered by the warm-up a chance to hatch, and then be re-frozen.

- **Anoxic Treatment (0.3 % oxygen for 21 days)**
  - This method starves the pests of oxygen.
  - Small anoxic environments are created, using sealed barrier films (such as Marvelseal™ or Escal™ or re-usable aluminium laminate) and placing oxygen

scavengers and relative humidity (RH) buffers inside before sealing. The kit is bought with all supplies.

- Use the Anoxibug Indicator monitor, which is placed inside bags with the oxygen scavenger to monitor the condition inside the environment.
- A cheaper alternative to this is a tent, purpose-made from any durable plastic. The collection object/s to be treated are placed inside, the tent is sealed as well as possible, and then pumped full of nitrogen or carbon dioxide.

Example of an oxygen scavenger (left) and an Anoxibug bag (right) used in anoxic treatment of larger sized collection objects - *images from Hanwell Solutions website. (https://hanwell.com/shop/hanwell-pro/anoxibug-oxygen-scavenger/)*

5.8.10 Chemical pest control methods

- **Fumigation**
  - Fumigation involves the release of a pesticidal gas / fumigant into the air in a closed space and will effectively kill pests that are exposed to the gas. There is no residual impact on pests and so fumigation does not prevent re-infestation. Fumigation must be carried out by a registered service provider.
  - Most fumigants have been found to have a negative impact on human health, and / or on the environment or collection objects. Methyl bromide has a negative impact on the ozone layer as well as paper and leather and has negative human health impacts. Pest resistance to some fumigants is also a problem that needs to be considered, especially if the same chemical is used repeatedly and widely in the collection.
  - Nitrogen exposure has been found to be effective against insect pests, but it requires that a sealed chamber be used, which means that the entire collection area cannot be fumigated in this way.

- **Repellents**
  - A range of chemicals, including camphor, naphthalene, para-dichlorobenzene, and Vapona (Dichlorvos) have been used as insect repellents in collections for many years. The vapours from these repellents do escape cabinets and pose a risk to human health, and there may be residues that affect collection objects. It is no longer acceptable to use moth balls or Vapona in collections.

- **Contact insecticides**
  - Pyrethrins or pyrethroids and derivatives of the chrysanthemum flower-head. These are commonly synthetically manufactured and are effective in killing crawling insects that come into contact with them, but they often have a short period of effectiveness, and may also be toxic to humans in forms that are longer lasting.
  - Other contact insecticides include carbamates, such as bendiocarb, and organophosphates, such as chlorpyrifos. These are often used to spray walls and floors or are used in a dust form and are effective in preventing pests from reaching collections, but they are not usually used in cabinets or drawers. Insects may develop resistance to these chemicals, and they may be harmful to humans.

In summary, all chemical pesticides have been proven to have potential negative impacts on collection objects and on human health and should be used as a last resort, and with caution.

APPENDIX

A5.1 Summary of documents required for collection care

- **Collection management policy.**

Covering the following points, with these adapted to specific institutional conditions and collections:

  - Acquisitions (only accept collections / objects in line with the focus of the institution, and for which resources are available to allow appropriate care).
  - All collections to be managed in line with institutional policies, standards and procedures, in order to reduce risk of damage and deterioration of collection objects.
  - Appropriate staff to be appointed and to be trained and supervised to allow the implementation of policies and processes.
  - All service providers or non-collection staff entering collection areas to be informed of the importance of the collections and their care and management.
  - Monitoring of environment and curation status of collections.
  - Storage and organisation of collections to be according to the standards and processes documents and plans.
  - Exclusive use of collection storage areas for collections, and statements about eating, drinking and smoking in collection areas.
  - Who can have access to collection areas and any conditions relating to access (e.g., tour groups, children, pets, unaccompanied visitors, workers).
  - All collection objects to be added to the inventory within a specified time, and this to be used for recording the location and the movement of objects, whether temporarily or permanently, as well as any objects lost.

- Organisation of the collection and requirement that this is recorded in the collection object inventory.
- Collection objects not to be left out of cabinets / storerooms or containers if not being actively worked on.
- A statement on which collections / objects are considered as the highest priority for allocation of resources and most secure storage (e.g., type collections).
- Requirement that all collection management / curation events (e.g., pest outbreaks, lost objects, damaged objects, and interventions, major rebottling or relabelling projects) are thoroughly documented.

STANDARDS AND PROCESS / WORKFLOWS

- Standards document for storage of each collection / collection type. This should include the storeroom standards, environmental conditions (temperature, humidity, light), type of cabinets / shelving or other storage systems; containers such as bottles or boxes, and all standards for any materials used in the collections, monitoring standards (how often, name of method to be used and could refer to detailed procedures document/s).
- Process document for monitoring of environmental conditions, fluid preservative monitoring, pest monitoring and management systems, and interventions required when thresholds are exceeded. Include steps, roles and responsibility, and any documentation required. Separate documents could be developed for different processes, or for different collections, depending on the type of collections held by an institution.
- Collection inventory standards and workflow for maintaining the inventory, including adding and modifying records, as well as what is recorded. This document should enable alignment with the requirements for GRAP 103 auditing (and 110 in the case of biobank samples).
- Standards and workflow document for numbering of collection objects. Ideally each collection object or collection lot (i.e., multiple objects stored in the same container, collected at the same collection event) should have a unique number. How numbers are allocated, recorded and linked to objects (labels, markings on objects) should be included in this document.
- Workflow and standards for labelling and relabelling of collection objects. Type of paper, type of print, size of font, how information is presented (i.e., verbatim or with added information or corrected or updated information), and what is done with old labels.
- Standards for organisation of collections. This is a critically important aspect of collection management and documentation, especially in terms of GRAP 103 and legislation such as ToPs and CITES. Without a solid understanding of how the collections are organised at different levels, it is very easy to lose objects, and for confusion and chaos to result when new staff take over responsibility for a collection. The specific location of each collection object should be recorded in the collection inventory.
- Workflow and standards for updating of taxonomic data on collection object labels and in the database and accession register.

NOTES:

CHAPTER 6: ACCESS TO COLLECTIONS AND ASSOCIATED DATA

6.1 NSCF Policy on Access to Collections

Natural science collections are considered research infrastructure, and institutions participating in the NSCF are required to provide access to the collections for research purposes to scientists both inside and outside the employ of the institution. In certain cases, collection object/s may be provided for public exhibit, and data may be provided for assessments (e.g., for Red Listing or Environmental Impact Assessments) and decision-making (e.g., government authorisations for land use change, and protected area expansions).

- Access may be in the following forms:
  - Loan of collection object/s, where collection object/s are sent to the institution of the requester (may be researcher and / or student).
  - Physical visits to the collection and examination of collection object/s.
  - Provision of subsamples / tissue samples from collection object/s.
  - Digital images of collection object/s.
  - Collection object data.
- Access must be provided openly, without charge to bona fide researchers and students.
- There are some restrictions or limitations on access that are aimed at:
  - Protecting research in progress.
  - Limiting the impact of use on the future potential scientific value of the collection in the case of physical access / subsampling.
  - Not compromising the conservation of species of concern, or the institution holding collection object/s that may be targeted for illegal trade (this is mainly related to access to collection object data or images).
- Decisions related to access must be made in a fair, transparent way, in the spirit of promoting the use of the collections by researchers outside the institutions. If a request for access is declined, reasons in line with this policy must be provided for the decision. An independent appeal process must be available, and the NSCF may mediate in such processes.
- The institutional procedures and NSCF guidelines for provision of access must be followed.
- Access to collection object/s must comply with international protocols (e.g., CITES, Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization), national legislation as well as Provincial Ordinances related to the export of biological material or supply to a third party. National legislation includes the National Environmental Management: Biodiversity Act No. 10 of 2004, any associated regulations (e.g., Biodiversity Access & Benefit Sharing Regulations) as well as the National Heritage Resources Act No. 25 of 1999 and associated regulations.
- The institution providing access must be acknowledged in any publication that includes collection objects / images / data from the collections.
- This policy must be reviewed and may be amended periodically, following due process.

6.2 Process for Decision-making on Applications for Access

- Institutions must have a clear and documented process for decision-making and authorisation relating to requests for access to collections. In most cases the curator of a particular collection or the collection manager would make the recommendation and the manager of that individual would authorise the access / denial of access.
- Each application for access to an institution's collections must be assessed based on whether the requester is at a recognised institution (e.g., university, museum, herbarium), the track record of the requester/s and the purpose of the request.
- In the case where there are no concerns about the request for access (i.e., the requester is at a recognised institution which holds relevant collections and has a solid research track record in a field relevant to the taxon for which material has been requested), the decision will be straightforward. In some cases (e.g., the request is from someone not based at a recognised institution or without a track record in a relevant field; restrictions or limitations as mentioned in the NSCF Policy on Access are of concern) the reason for the request and the nature of the request will need to be more carefully considered and there may need to be an internal process for making a decision. This process should involve one or more scientists, the collection manager and an institutional manager.
- The response to the request for access must be made in writing to the requester within a reasonable time frame.

6.2.1 Guidelines for decision-making relating to access to collections by different categories of requester

🟢 = approve request; 😐 = consider specific details of the request; may be approved with some restrictions / limitations; ☹️ = access requests not generally approved

Category of User	Visit	Loan	Access to Material for DNA Analysis or Other Forms of Destructive Sampling	Data	Images
Bona fide researchers at recognised institutions, with a track record in the field	🟢	🟢 Ideally on request from manager responsible for collections, loan made in name of manager.	😐 Dependent on number of samples requested; availability of appropriate materials; permits for	🟢 Restrictions on sensitive species data: may provide QDS; permission required to pass on to third party or publish data.	🟢 But dependent on feasibility.
Postgraduate students / postdoctoral fellows	😐 With support letter from supervisor.	😐 On request from supervisor / manager responsible for collections; loan made in name of supervisor / collection manager.	😐 On request from supervisor; subject to same conditions as for researchers.	🟢 Restrictions on sensitive species data: may provide QDS; permission required to pass on to third party and to publish data.	🟢 But dependent on feasibility.

Independent researcher, not affiliated to an institution	😐 Dependent on project proposal / reason for visit.	☹ No loans to private residences, non-research institutions.	😐 Dependent on project proposal and access to resources for analysis.	🙂 Restrictions on sensitive species data: may provide QDS; permission required to pass on to third party and to publish data.	🙂 But dependent on feasibility.
Conservation authorities	🙂	☹	😐 Dependent on project proposal and access to resources for analysis.	🙂	🙂 But dependent on feasibility.
EIA consultants	🙂	☹	☹	🙂 Restrictions on sensitive species data: may provide QDS; permission required to pass on to third party and to publish data.	🙂 But dependent on feasibility.
Other users outside of the categories above	😐 Dependent on project proposal.	☹	😐 Dependent on project proposal and access to resources for analysis.	😐 Dependent on project proposal. Restrictions on sensitive species data: may provide QDS; permission required to pass on to third party and to publish data.	😐 Dependent on project proposal.

6.2.2 Reasons for declining a request for access

- For bona fide researchers, the default decision will be to provide access according to the table above. Valid reasons for declining a request to researchers could be:
- Outstanding loans held by the requester that are overdue without reasonable explanation being provided.
- Other researchers (including postgraduate students / postdoc. fellows), whether internal or external, known to be actively and currently working on the same group. In this case the details of the other researcher should be provided to the requester, and the other researcher can be contacted to seek clarity on progress / make the researcher aware of the request.
- Request not in line with policy / legislation (e.g., request for loan or destructive sampling of holotypes), or no benefit sharing or export permit for sending DNA material outside of South Africa.
- Requester does not have appropriate facilities to store the material while on loan.
- Data requested is for a species / taxon that is threatened by illegal collecting (e.g., Colophon beetles, cycads), with the species / taxon listed on the SANBI Sensitive Species List.
- A request for destructive sampling will have a significant negative impact on rare specimens (e.g., <3 specimens of the species in the collection).

- In the case where the quantity of collection objects / material / images requested is too high, the curator / collection manager should not decline the request but can negotiate breaking a loan into batches. In the case of a request for a large amount of material for DNA analysis, collaboration or other forms of benefit can be negotiated. In the case of requests for images where these will be used commercially, institutions may consider charging a service fee to cover the time required to do the imaging. In some cases, it may be acceptable for collection objects to be loaned to a researcher to work on at their home, although this should not be permitted under normal circumstances. In such cases, the researcher will need to ensure that there is a secure and safe storage place for the objects and commit to caring for these for the duration of the loan (see Appendix 6.4).

6.3 Access Appeals Process

6.3.1 Internal process for appeals

- Should an institution decline a request for access to the collection in any form, the reasons for this must be explicitly stated in the written response.
- Each institution should have their own documented internal process for appeals from requesters who have been denied access. This process must be explicitly stated on the response to the requester in the case where a request for access has been declined.
- A timeframe for considering the appeal must be included in the details of the appeals process. Ideally this should be within one month of receipt of the appeal.
- The outcome of the internal appeals process must be communicated to the requester within the stated timeframes, with an explicit explanation for the decision. If the original decision to deny access is upheld, the rationale for this must be explained.
- Appeals that remain unresolved can be referred to the NSCF Access Appeals Panel, either by the requester or by the institution, but this should only be once all internal processes have been exhausted (see Appendix 6.1 for details of the NSCF Appeals Panel).

6.3.2 Institutional Access Panel

- An internal Institutional Access Panel should be established by the institution. This may serve to assess requests for access where these are not straightforward, and to consider appeals in the case where access has been declined.
- Membership of the Institutional Access Panel: at least three individuals should be included, and none of the members of the Panel should be conflicted in any way (e.g., if a curator / scientist is a specialist in the same field as the requester and was responsible for declining the request, this would be considered as a conflict of interest). This may mean that at least five members should be appointed since one or two may not be eligible to consider a particular request. The members involved in a decision could include a senior manager associated with the collections (i.e., not an administrative manager), a scientist and a collection management / curation staff member (i.e., not a researcher).

- In some institutions the Board of Trustees or Council may consider appeals if these are not resolved by a panel of staff members. This would, however, need to be formalised in the Terms of Reference for the Board or Council.

6.3.3 NSCF Access Appeals Committee

- A NSCF Access Appeals Committee may be established to consider appeals from requesters where these have not been resolved by internal appeals processes, or in the case where an institution may not have an internal appeals process. The working document for the NSCF Access Appeals Committee is shown in Appendix A6.2 at the end of this Chapter.

6.4 Visitors to Collections

6.4.1 Processes for requesting and providing access to collections for research visits

- All requests to visit a collection must be made in writing, including e-mails from an institutional address, to the delegated staff member (e.g., Collection Manager / Officer). The standard form requesting access must be completed and submitted (see Appendix A6.3 for an example of such a form).
- Requests for students to visit a collection must be made in writing by the supervisor, or if made by the student, must be accompanied by a letter / email from the supervisor/s supporting the visit.

Visitors to the collection at Amathole Museum with collection managers - *image provided by Amathole Museum.*

- In the case where a request is to visit collections that fall under different departments in the institution, each relevant department's visitor contact / Collection Manager /Officer must be notified.
- All visitors must get a visitor access card / biometrics security pass, granting them access to where they are allowed to go (so that they are free to go where necessary e.g., bathroom, restaurant, exit in case of an emergency, etc.). This visitor card must remain visible throughout the visit and must be returned at the end of the visit.

Example of a visitors' book that must be signed by all collection visitors - *image provided by ARC.*

- Upon arrival, visitors must sign a visitor's register, provide a copy of their identity document, passport or student card (whichever is applicable), and sign an indemnity form.
- Visitors must be given a copy of the visitor rules, and the collection objects access and handling protocols, and these must be strictly adhered to.
- Specific guidelines on how to make changes to the identification of a collection object must be provided to visitors. This is likely to be dependent on the type of collection object (see Appendix A6.4 for an example concerning herbarium specimens from SANBI's policy).
- Visitors must acknowledge in writing (e-mail is acceptable), that they have read and understood the institution's access and collection object handling protocols.
- In cases where visitors do not abide by the visitor rules, a decision may be taken to deny future access to the visitor, but a transparent process must be followed, and the decision must be communicated to the visitor, in writing and signed by the Director or authorised manager of the institution.
- The institution must provide visitors using the collection with an appropriate working area (sufficient bench space and chair of appropriate height, Wi-Fi or network access) with functional equipment relevant to the collection object/s being studied and requested (e.g., a high-quality microscope with camera attachment or drawing tube depending on requested equipment, and a good quality light source), as well as consumables (e.g., label paper, topping up chemical, pins, petri dishes etc.). If visitors are required to provide their own dissecting kit or other tools, this must be communicated to them prior to the visit.
- Visitors must be advised on waste disposal, especially for chemicals such as ethanol.
- Relevant health and safety information must be provided to visitors (e.g., evacuation routes and hazards that the visitor might be exposed to).
- Where required, appropriate Personal Protective Equipment (PPE) must be supplied to visitors for wearing at all times when handling collection objects. The institution should provide handling gloves and any other equipment required by its Health and Safety Policy / guidelines for handling materials / working in the collections.

- Institutions should state the times during which the collection will be accessible to visitors (official business hours), and it should be clear that these times will be adhered to by both the institution and visitors. Special arrangements for access after-hours (e.g., on weekends, public holidays, etc.) should be agreed with the visitor in advance and will depend on the institution's own policies and capacity.
- Visitors bringing external collection object/s into the collection area must notify the collection staff in advance, so that any decontamination processes required can be followed, and to ensure that there is no confusion between the visitor's own collection object/s and that of the institution.
- No bench fees may be charged to visitors (according to the NSCF policy), and reasonable costs associated with the visit such as photocopying, scanning or use of phones should be absorbed by the institution. If these costs are considered excessive, the visitor may be asked to cover them.

6.4.2 Guidelines for visitor rules (to be signed by the visitor)

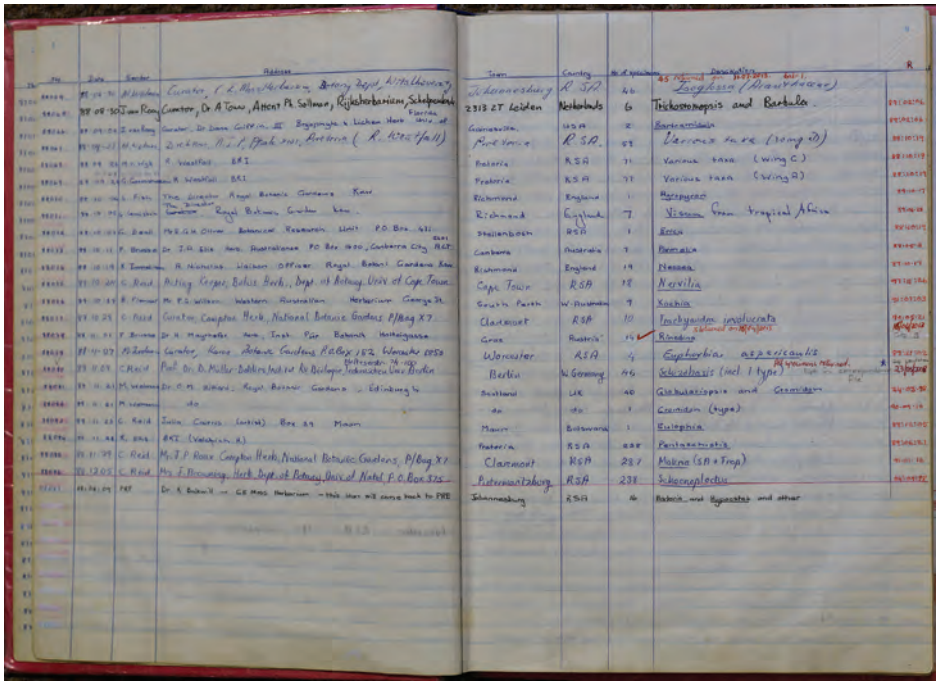
- Visitors must agree to follow collection objects access and handling protocols provided by the institution at all times.
- No collection object/s are to be removed from the collection storage area unless given approval by the collection staff who are assisting during the visit.
- Updates to identifications of collection object/s examined are a valuable contribution to the collection. However, implementation must follow the institution's guidelines for this action.
- Collection object/s may not be modified in any way without permission.
- Visitors are to dispose of hazardous substance waste as per posted signage in the work area or as per instructions of the collection staff assisting them during the visit.
- Health and safety instructions indicated or provided by the collection staff must be adhered to. This includes wearing of protective clothing items where this is considered to be relevant by the collection staff.
- No food or liquid of any kind should be allowed in the collection areas (i.e., collection work room, collection storeroom.) or galleries.
- Smoking is not allowed in the collection building.
- The opening and closing times of the institution will be complied with unless prior arrangements have been made to access the collection outside these times.
- Any external collection object/s being brought into the institution by visitors must be declared in advance and on arrival, so that the institution's staff can action any decontamination procedures required and ensure that external collection object/s are not confused with those of the institution.

6.5 Loans

- The highest risk for providing access to collections is through loans because there is no direct control over the conditions under which the collection objects will be stored or handled, and shipping poses an additional risk. The infrastructure available for storing the material while it is out on loan will need to be considered and it may be necessary to request the borrowing institution to provide written evidence that it can secure and look after the loaned collection object/s properly. In cases where numerous collection objects are requested, it might be advisable

for institutions to only send half of the requested collection objects and the remaining half once the initial loan has been returned.

- Collection object/s on loan should be subject to the standards set out below, as well as any additional provisions detailed in loan agreements. All outgoing loans will be packed according to these procedures, whether hand collected, sent via post office or by courier, to minimise damage to the collection object/s.



Example of a loan book reflecting records of outgoing loans.

6.5.1 Requests for loan of collection object/s

- Requests for the loan of collection object/s should be made in writing using the access request form (see Appendix 6.2). The request should specify the collection object/s needed, the purpose for which they are requested and how the requester wishes to have samples sent (some need samples urgently and will offer to pay for a courier service).
- Following a request for a loan, the borrower will be provided with a copy of the institution's access policy.
- The borrower should be advised of the likely time frames for considering their request and finalising the arrangements before dispatch of the loan. This is likely to vary, depending on the size of the loan.
- Requests for extensions to the loan period must be made in writing at least 30 days prior to the original termination date. Such requests must be approved by the appropriate authority in the lending institution.

6.5.2 Authorisation and selection of loan material

- A check of the collection data is required to determine if the requested collection object/s are in the collection and whether there are any restrictions (e.g., embargos) on the material.
- A person with the appropriate level of authority should authorise the loan request. The loan approver should check the status of the borrower in terms of existing and past loans and the extent and nature of the loan. This is to ensure

that not more than 50% of the collection object/s in a taxon are being requested, as well as to assess whether types and/or destructive sampling have been requested.

- When the loan has been authorised, selection of the collection object/s should be done by the Collection Manager / Officer and any restrictions / limitations should be communicated in writing to the person/s responsible for removing the collection object/s from the collection and packing up the loan.
- The institution will supply the minimum number of collection object/s requested by the borrower, or fewer in cases where collection objects are limited.
- If necessary, feedback should be provided to the borrowing researcher at this stage, perhaps involving the choice of alternative samples if necessary.
- In some instances, there may be irregularities with collection objects that have been requested (e.g., collection object/s incorrectly labelled, more than one species in a sample, catalogue number missing, etc.). These must be sorted out immediately and where necessary, records should be updated in the Specify or Brahms database and labels reprinted.
- The packer must work with one lot at a time so that collection object/s or catalogue numbers do not get mixed up.
- The packer must check the condition and count the collection object/s to be sent on loan and record their condition in the collection object database (e.g., Specify or Brahms). This information should also be provided on the loan inventory provided to the borrower.
- Two or three images of each collection object should be captured or if there is a large number of collection objects, collection object lots could be imaged (e.g., a tray of insects). These pictures should allow verification of what has been sent and the condition of the collection objects when sent out. The pictures must be linked with the loan in Specify or Brahms (and/or create an electronic record of the pictures that can be linked to the collection object/s).
- A separate verifier should check the collection object/s against the collection object list before the loan material is packed up and an approver should sign off on the final loan document. This is in line with accounting standards and is an audit requirement.
- A collection object movement record slip must be completed for all collection objects on loan. Place this in the location from where the collection object has been removed. This slip should state who the loan was made to, loan number/ reference, the date of loan issued as well as the return due date of the loan. In the case of collection object/s that have been removed from containers, the container must be placed back in the correct position with the collection object movement slip inside the container. The collection object movement slip should be completed and filed, even for internal loans.

6.5.3 Roles and responsibilities of Collection Manager / Officer for outgoing loans

The Collection Manager / Officer is responsible for:

- Ensuring that the borrower has all the information needed to finalise their request for collection object/s, and that the institution has all the information necessary to evaluate and give proper consideration to the request. This includes obtaining sufficient information to assess each loan request against the criteria set by the institution.

- Assessing the credibility of the requester in terms of their status (are they a researcher in the field? Are they at a recognised institution?) and assessing the collection object/s requested in terms of the number, type status, condition and any limitations on use.
- Tracking all outgoing loans as well as keeping up-to-date loan agreements for all outgoing loans.
- Sending loan reminders to borrowers with outstanding loans. For long term loans, loan reminders must be sent annually and for regular loans, they must be sent three months prior to the end of the loan duration.

6.5.4 Conditions for outgoing loans

- All outgoing loans are subject to the signing of a loan agreement. This should be made available on the institution's website, along with a copy of the institution's Access Policy, the collection access request form as well as handling protocols.
- Special terms or conditions may need to be negotiated/motivated for the loan that are different from, or additional to, the standard agreement, particularly in the case of very valuable collection objects, or large quantities of collection objects.
- The period of the loan will depend on the collection object/s being lent, the purpose of the loan, the request made by the borrowing institution and the institution's own requirements.
- Time frames for the period of the loan must be adhered to and extensions to the loan must be requested in writing before the end of the agreed upon loan period.
- Once the terms have been agreed on, the loan agreement can be finalised and must be signed by both parties.
- The borrower must provide contact details of another person in their institution who can be contacted in case they themselves are unreachable.

6.5.5 Packing loan material

- **General**
  - Care with handling and packing is essential. Collection object/s must not be bent or forced into boxes or bags.

- **Fluid preserved collections**
  - If handling / packing fluid preserved collection object/s, wrap the collection object/s in a soft cloth / tissue soaked in the preservative (e.g., ethanol). If the loan material comprises more than one collection object as part of the same lot (from the same container with the same label), they can be packed as a group by carefully arranging them in the same cloth. Place the label and catalogue number with the wrapped collection object/s in a plastic bag, with a small amount of the preservative liquid (not exceeding 30ml), and heat seal the bag closed.
  - The sealed collection object/s are placed in a second plastic bag, with suitable absorbent material (like tissue, polyester fibre) and with the plastic having a minimum thickness of 0.2mm. Heat seal this bag closed.
  - Several bags can be placed in a larger third bag that is then heat sealed.

Collection object being wrapped in moistened tissue for packing - *images provided by SAIAB.*

- Any free liquid in the inner package must not exceed 30g/30ml with the total quantity of flammable liquid per parcel not exceeding 1litre, as per IATA regulations (Special Provision A180).
- If collection objects are very small and/or delicate, they may be packed in small plastic vials, provided that the amount of preservative is less than 30ml. Each vial should be wrapped in absorbent material before being sealed in three bags as described above. The lids of vials may be sealed with tape or parafilm.

Heat sealing of a collection object in a plastic bag - image *provided by SAIAB.*

- Excess air must be removed from bags before carefully heat sealing these so that there are no leaks. Note that heat sealing is mandatory according to IATA regulations for postage of fluid preserved collection object/s.

Heat sealed collection object - *image provided by SAIAB*

- **Dry unpinned collection (bones, skeletons, skins, skulls, fossils)**
  - If packing a dry-unpinned collection, individually wrap each collection object in bubble wrap or tissue paper with the collection object/s' information label/s and catalogue number, then place in a box or container appropriate for its size.
  - For mammal or bird skins wrap each skin separately in tissue paper, taking care not to bend the collection object (in particular tails or wings) or the label. For large numbers of skins pack in layers; each layer (one skin deep) being separated by insulation material. Pack similar sized skins together. Ensure a firm fit between wrapped skins and within the insulation material so that the skins will not move about unnecessarily in transit, but the skins should not be buckled or bent by being too tightly packed.
  - For small to medium sized skulls, wrap skull and/or mandible in tissue paper to avoid them being in direct contact with one another during transit. For skulls and skeletons pack additional tissue paper into the vial or box to stop unnecessary movement of the bones during transit.
  - To protect small fossils with protruding, delicate parts, a small cavity mount made out of foam or rings can be used to protect the collection object during transport. Use the shape of the fossil collection object as a guide to carve a cavity of material out of the foam just slightly larger than the collection object itself.
  - For larger samples wrap elements in packaging material and place packaging material within a box so as to keep the elements separated from one another. Take care that there is sufficient cushioning for collection object/s, and that more fragile parts (e.g., premaxilla and paraoccipital processes) are well protected.
  - If the loan includes several small collection objects, each collection object is placed in an appropriately sized box/container lined with bubble wrap, with

more bubble wrap placed over and around the collection objects, with the lid secured.

- The collection object box/container/s should be packed within a larger shipping box and then covered with more insulation. Bubble wrap can be used to make sure that the smaller boxes don't move around in the bigger box/container.
- The outer shipping box must be strong enough to prevent collapse or distortion of shape. The following test is recommended: the outer box must pass the drop test before filling: a free drop on top, bottom, long and short side and the junction of three sides of the package from 1.8m onto a solid unyielding surface, should not result in any damage to the box.
- As per IATA Regulations, packages should not exceed 29kg in weight. To be on the safe side, it is recommended that one does not pack more than 27.5kg (to leave room for scale uncertainty).

- **Dry pinned collection**
  - If handling / packing a dry pinned insect collection, carefully select an appropriately sized acid-free box, lined with a polyethylene foam at the bottom for pinning. Do not select a large collection object box for only a few collection object/s or pack too many collection object/s tightly in too small a box. The collection object box should have a tight-fitting lid that can be set firmly in place.
  - Check the thickness of the pinning foam in the collection object box to ensure it doesn't push the labels up against each other, as this may break the collection object parts (antennae, legs, wings, etc.) and necessitate additional labour to reset the labels.
  - Pin the collection object/s into the box, making sure that the pins are set completely through the foam and taking care not to over-pack the collection object/s within the collection object box too tightly (body parts, especially antennae and tarsi, should never overlap) which could result in damage to them or adjacent collection object/s, during removal.

Example of box of pinned insects showing arrangement for shipping.

- For large collection objects use extra pins for cross pinning to keep the insects from rotating on their pins and damaging neighbouring collection objects.

Bracing or cross pinning of larger insects. Note the stabilising cross pins used to hold the insect during shipping.

- The collection object box should have a tight-fitting inner lid that can be set firmly in place. It lies on top of the collection object/s and underneath the outer collection object box lid and keeps the collection object/s securely seated in the foam, preventing them from working their way out of the foam into which they have been pinned. If the inner lid does not fit tightly against the outer lid use padding between the inner and outer lids.

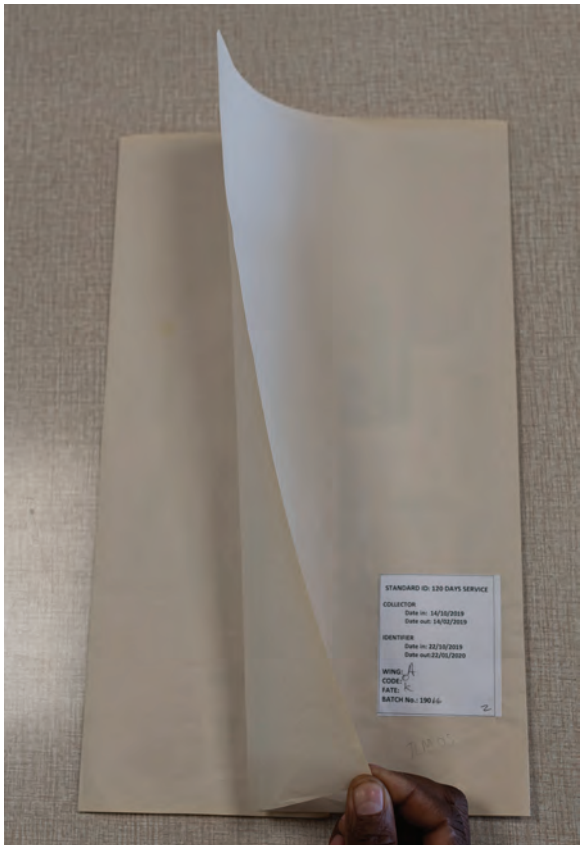
Example of padding in inner lid to ensure that it fits snugly into outer lid.

- Pack collection object box/es inside an oversized shipping box.

Collection objects placed inside boxes, with lids secured, and these placed in a larger box, with foam chips to cushion the inner boxes.

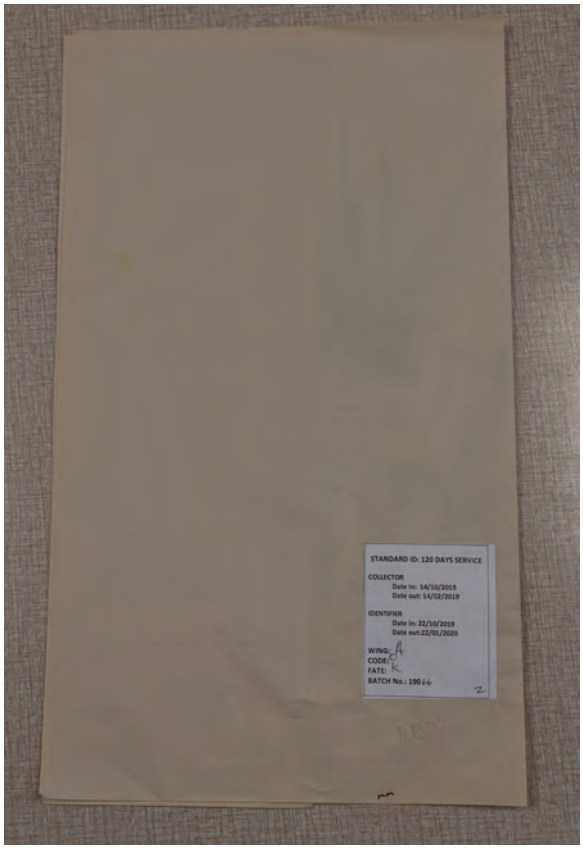
- The packaging material needs to provide a cushion to protect contents from direct damage and provide shock absorption to protect the collection objects from impact damage. The collection object box/es should be able to move slightly within the closed shipping box, so the packaging material must not be too tightly packed. Packaging materials that should be avoided are biodegradable foam chips made of wheat or corn starch, as these could act as potential attractants to insect pests.
- The packed box should be filled up with foam chips to protect the inner box/es containing the collection objects.

- **Herbarium collection objects**
  - Choose a box with length and width slightly larger than herbarium collection object/s.
  - Place an acid-free flimsy (a single-fold sheet of paper) on the cover sheet that covers both sides of the entire collection object. It is advisable to stamp the flimsy with the institutional acronym to avoid a mix-up with other collections. This also provides an easy method of sorting when preparing to return the collection objects to their respective institutions after study.
  - The fold in the flimsy should be on the left, for ease of separating flimsy from the collection object later on. It is good practice to place a flimsy on every cover sheet; this practice saves time and affords some cushioning.



A flimsy used when packing herbarium collection objects. Note the fold is on the left.

- A single collection object in its flimsy should be centred on a corrugated cardboard sheet and then a stack built up, keeping each sheet directly over the sheet below and within the boundaries of the bottom, corrugated cardboard.



An example of a flimsy, with a single collection object, on a corrugated cardboard sheet.

- Use corrugated cardboard on the top and bottom of a stack. Loosely stack collection objects no more than 12-15cm high (usually 25-40 sheets, depending on bulkiness). When the stack is tied or heat sealed, it will compress to about 6cm high.
- If bundling the collection object/s in genus folders, or in one or two layers of paper, the stack should be only about 2.5 to 5cm high (i.e., much smaller).
- All collection objects in the bundle must lie face up.
- It is useful to write a brief description of the contents (e.g., loan number, number of sheets and destination herbarium, borrowing researcher, etc.) on the upper side—this not only keeps track of what is inside but also avoids bundles from being boxed upside down. Alternatively, include a note stating, 'this side up'.
- Finish the stack with a second corrugated cardboard sheet on top and secure the bundle with narrow cotton cloth tape (or soft cotton string) that will not cut into the corrugated cardboard and/or sheets.

A bundle of packed herbarium collection objects.

- Place the bundle in an appropriate plastic bag, then heat seal it. If you do not have a heat sealer, wrap the string crosswise around the bundle, bring the end of the string through the loop, leaving a "tail" which can be pulled for a quick-release knot. Alternatively, flat tape can be tied in a bow. Using two ties equally spaced around the bundle is favoured.
- Tie bundles securely, in order to keep the collection object/s from bumping against one another during transit but not so tightly that the corrugated cardboard creases.

Bundle of herbarium collection objects placed in an appropriate plastic bag in preparation for heat sealing of the bundle.

- If a heat sealer is not available, wrap brown paper around the string tied bundle, keeping track of which side faces up. Put the parcel in plastic, then use tape to seal.
- After heat sealing the plastic containing the bundle, wrap it up in bubble wrap to increase the layers of protection against being bumped and/or potential contamination during transit.

Plastic-sealed bundle of herbarium collection objects being wrapped in bubble wrap for further protection.

- Place a sheet of corrugated cardboard on the floor of the shipping box.
- Additional packaging material can be used to fill in the space around walls of the box for a snug and protective fit if needed.
- Place bundles right side up, with the loan invoice (and other loan documents) and enough corrugated cardboard, shredded paper, bubble wrap, etc. to fill up the box.

Packed herbarium collection objects with loan invoice (and other loan documents).

Packaging material used to fill around the inside of the box for a protective fit.

- Close and seal shipping box, then cover with waterproof brown paper or bituminised paper and secure this with any good quality white tape. Weigh the parcel and attach all loan documents and stickers.

Image of a sealed parcel wrapped in bituminised paper and secured with white tape.

6.5.6 Loan invoice and other dispatch documents

- **Loan documents**
  - Collection objects and/or samples should not be dispatched for loan without all relevant documents being finalised.
  - There should be three loan documents that are sent with the loan, and that must be signed by the borrower and returned to the sending institution:
    i. The loan invoice, that includes the details of the borrower, and the institution providing the loan, the relevant dates (sent and due back), the type of collection object/s, the number of items included of each type (e.g., pinned insects, fluid preserved arthropods, skulls etc.), and instructions for the return of copies of documents.
    ii. A copy of the loan agreement form detailing what can and what cannot be done with the material, storage requirements, packing requirements for the return of the loan, request for extension procedure.
    iii. A loan inventory that includes a list of each collection object / lot, with details (see 6.11 below).
  - One copy of each document must be retained by the sending institution following dispatch.
  - Two copies should accompany the loan. One of these copies should be signed by the borrower on receipt of the loan and returned to the institution that sent the loan.
  - The other copies should be signed by the borrower and returned with the collection object/s to the institution at the end of the term of the loan.

- **Dispatch / postage documents**
  - For international packages, the borrower must be asked if there are customs requirements in their country or special forms that must accompany the loan parcel, so that these can be compiled or obtained by the borrower. The country to which the loan is being sent must also be checked on the Post Office country list to see which forms need to be filled in.
  - One of these forms (obtainable from the Post Office) could be required: 701310 (old PP4), CP71 and CN23. In addition, for foreign parcels, a letter from the sending institution for Postal Inspectors and the loan invoice are required.
  - Weigh the parcel and fill in the weight on the forms.
  - Make three copies of all documents; one entire set must be placed inside the shipping box and another set placed in a clear plastic envelope attached to the outside of the shipping box and the remaining set must be filed.
  - Dispatch documentation should be linked or integrated into collection management systems (e.g., Specify or Brahms).
  - The method of dispatch or transportation of the loan is at the discretion of the institution and is dependent on the availability of resources at the time of dispatch. Alternatively, the borrower can agree to pay shipping costs.

- **Documentation and labelling for the parcel**
  - Clearly label the packed parcel with the sender's and receiver's names, addresses and telephone numbers (print the label in bold) and add fragile stickers on the outside of the box.

- The parcel should be sent in such a way that it can be tracked. The norm is that followed by the Post Office tracking service, but couriers can also be used, depending on the budget available (this may be for the borrowing scientist's expense).
- The completed package must be marked "scientific research specimens, not restricted Special Provision A180 applies" where this is appropriate (e.g., an international courier where a waybill is issued).
- It is a good idea to obtain a rubber stamp with a standard disclaimer such as "preserved specimens for scientific study, no commercial value, no endangered or CITES species enclosed," for use on international shipments.
- When the parcel is posted you will receive a tracking number from the Post Office (e.g., CN 013 847 205 ZA) or a waybill number from the courier service provider.

Image of a completely sealed and wrapped parcel that is fully addressed, showing a set of paperwork for office use by postal services.

- **Notification that the loan has been sent**
  - Compile an inventory of all the data for the collection object/s that were sent. It is possible to extract this from Specify into a spreadsheet.
  - Send an e-mail to the borrower and attach the loan invoice, loan agreement with conditions of loan, and loan inventory, and include the tracking or waybill number, and if possible, an estimate of the expected delivery date.
  - Ask the recipient to confirm receipt in writing as soon as the parcel is received.
  - Keep tracking the whereabouts of the sent item until it reaches its destination, and you have confirmation from the borrower that they have received it. Note that it is possible to track Post Office parcels beyond national boundaries.

6.5.7 The process for incoming or returned loans

- Record the incoming or returned loan in the acquisitions register.
- Ensure that there is a storage space to exclusively store incoming collection object/s associated with loans received, where they will not be incorporated

into the institution's main collection if they have been borrowed from external institutions.

- All packing materials should be stored during the loan period in a place at the same temperature and relative humidity levels as those under which the loan itself is stored or displayed. This will ensure that the packing material does not become infested with pests or mould.
- Carefully open the parcel and take out the collection object/s within three days of receiving the parcel.
- Check that all collection object/s listed on the loan invoice are present, check their condition, and the number of individuals. An independent verifier must also check the collection object/s and must sign off on the return / receipt of loan document.
- Place the collection objects into their original containers if they are a returned loan.
- If the collection object/s are a loan from another institution and need to be transferred into storage containers of the borrowing institution, retain separate samples in the same order they were originally packed in and place respective labels in the correct container with the objects.
- For returned loans record the details in Specify or Brahms and close the loan.
- Sign and send confirmation that the loan has been closed, with a statement about the collection object/s having been checked, all being accounted for (or missing), and in acceptable condition to the returning institution (see Appendix 6.5).
- Plant collection object/s, skins, bones and pinned insects, be they returned or incoming collection object/s, must be quarantined for the recommended period and/or decontaminated.
- For returned loans, place the collection object/s back in the collection in the correct position, removing the temporary label/slip from any collection containers that had information about the outgoing loan.
- For loans to the institution (incoming loans), scan the invoice then file in the appropriate location in Specify or Brahms and save the scanned page. Ask the scientist who requested the loan to sign as well as the institution head/ relevant authority, then email or post the copy of the invoice to the sender to acknowledge receipt.

6.5.8 Returning borrowed material

- Collection object/s should be returned via the same method of shipping as they were sent unless other arrangements are agreed to in writing. The loan must be packed the same way as it was received. If this cannot be achieved, the lender must be contacted for guidance.
- Before the loan is packaged, check the collection object/s' condition and cross check the number of collection objects / lots and individual numbers / details against the loan invoice. Record the collection object/s' condition in Specify or Brahms. This step should be checked and signed off by an independent verifier.
- Plant collection object/s should be returned with the same covers as initially received in, and all other collection object/s, returned in the same or improved containers.
- All loaned collection object/s should be returned in their entirety before the staff member who requested and used the collection object/s retires or leaves the institution.

6.5.9 Loan documentation

- **Documents for outgoing loans for filing**

The following documents should be retained on file (hard copy and electronic) for each loan sent out:

  - The original loan request form / correspondence, with any subsequent correspondence regarding the loan.
  - The loan agreement with the conditions of loan (signed by the relevant authorities at both the sending and the receiving institutions).
  - The loan inventory or invoice (signed by the relevant authorities at both the sending and the receiving institutions).
  - Documents relating to an extension of the loan.
  - A copy of all postage / shipping documents.
  - All related permitting documents.
  - Confirmation of receipt of loan material.
  - The receipt of the returned loan form / closing of the loan document from the sending to the receiving institution.
  - If destructive sampling will be carried out, a Material Transfer Agreement must be signed by both parties in advance.

All documents should be signed by the delegated authority at the institution providing the loan, by the recipient, as well as the recipient institution's delegated authority.

- **Process of recording outgoing or incoming loans**

  - All collection object/s being sent out or received must be entered into the relevant loans database by the relevant official.
  - The loan number/reference as well as the loan duration with start and end dates must be recorded in Specify or Brahms.
  - Each collection object / lot must be documented with the following details recorded:
    - catalogue number and / or accession number;
    - family, genus and species name (if available);
    - number of collection object/s;
    - condition of collection object/s;
    - borrower's / lender's institution name;
    - borrowing researcher's name; and
    - lending collection contact details as well as those of one other person from the borrower's/lender's institution.
  - Complete a collection object movement record slip for all collection objects on loan. Place this in the collection object location in the main collection. This slip should state who the loan was made to, loan number/reference, the date of loan issue as well as the due date for return of the loan.
  - If a loan has been extended, the details must be updated on the Specify or Brahms database and on the collection object movement slip.

- **Process of documenting an incoming loan**

  - Upon receiving an incoming loan, all collection object/s must be checked for damage (i.e., broken body parts, visible pest infestation, etc.), and the condition of each collection object must be recorded. Any damage must be reported in writing to the lending institution (photos must be taken).

- Contact the borrowing institution regarding institutional decontamination procedures when necessary.
- Check the following details on the collection object labels against the loan form to ensure that the details have been accurately recorded on the loan form: catalogue number, family, genus and species name (whichever is applicable). Also check that the number of collection object/s received is correct, and that the sending institution name and the contact person's details are recorded, as well as the borrowing researcher's name and contact details. Ensure that all these details are recorded in the appropriate file in Specify or Brahms.
- Once checked and recorded by the Collection Manager / Officer or other relevant official, the collection object/s and all paperwork (loan agreement) will be handed over to the requesting researcher.
- After recording the received loan material, file parcel acknowledgement forms (See Appendix A6.6 for an example of such a form) and all related documents. This will include the duplicate form that stayed with the collection object/s at all times - for returning institution material.
- Attach the incoming loan agreement to the loan record (e.g., staple or clip together paper forms; electronically link the agreement to the loan record in Specify or Brahms collection management system) and return the signed versions of the documents required by the sending institution.

6.5.10 Transfer of loans

Transfer of loans from one institution to another is only allowed if the following process is followed:

- The institution that originally requested the loan must send a formal request to the lending institution for approval to transfer the loan to a third party.
- The third party (receiving institution) should send a letter (signed by its Collection Manager or Director) to the initial lending institution, acknowledging acceptance of the loan.
- The third-party institution agrees to adhere to the loan conditions. A signed acknowledgment of receipt form must be sent to both institutions (the original lender and the transferring institution), upon receipt of the transferred loan.

6.6 Digital Access to Collections

The provision of images of collection objects is increasingly replacing the loan of material, as the risks associated with sending material increase.

Requests for collection object data for use in research, threat assessments, impact assessments and spatial planning is an important service that natural science collections provide and should be treated as a form of digital access.

- Requests for photographs of collection object/s or data sets must be made in writing (e-mail accepted) and an Access Request Form completed.
- Institutions may have their own policies on use of images and data, including acknowledgement requirements, copyright or commercial use requirements, distribution to a third party - and this information should be provided in writing to the requester.

- Institutions should keep records of the images taken and sent; as well as copies of these images in case some of them have already been taken and for reporting purposes.
- Institutions should keep records of data sets provided, including details of the requester, number of records, scope or description of the data set, fields included, format (software) of the data set, purpose of the request, restrictions on use, whether any sensitive species data was provided and restrictions on this.

6.7 Guidelines for Destructive use of Samples / Collection Objects

6.7.1 General points about destructive sampling

- While the purpose of the collections is primarily for research purposes, institutions have an obligation to ensure that the collections are not excessively degraded or lost through use. This means that some requests for destructive sampling may be denied in order to maintain a balance between use and availability for use by future generations of researchers.
- Institutions should have a policy on destructive sampling of collection objects, which provides guidance: including which collections and collection objects can be subsampled and which ones cannot, the type of subsampling permitted, the permissible purposes for subsampling, the maximum number of samples that can be provided to an individual requester, who is permitted to do the subsampling and any conditions required of the requester.
- The decision to approve a destructive sampling request should be based on several factors (see table earlier in this chapter), including the scientific value or uniqueness of the collection object/s in question, the proposed sampling technique, the degree of destruction, the potential of the sampling to yield significant scientific benefit, and any legal and ethical issues regarding these collection objects.

6.7.2 How to request material for destructive sampling

- All requests for destructive sampling must be in writing (including by email from an institutional address); requests from students must be co-signed by the supervisor.
- Requests for destructive sampling should include the following:
  - A brief summary of the research, including the following details:
    - The objectives of the project and its potential scientific value.
    - The time frames of the study.
    - Where applicable, the availability of material other than that in the collection, including the researcher's own efforts to collect samples for the project.
    - Method/s of analysis, including a statement about why this analysis has been selected over others, and evidence of requester's competency in carrying out the analysis.
    - Details of funding available to complete the project.
  - The nature and amount of material needed (e.g., section of herbarium collection object, part of toe pad, etc.), taxon, number of samples or specific institution catalogue numbers (if known), geographic location if relevant, and desired method of transport (e.g., frozen, 95% ethanol).
  - A rationale for the type and quantity of material requested.

- Researchers not directly employed or affiliated with a university, museum, herbarium or research facility must provide a supporting letter from the host laboratory.
- Requests for material for student projects must be supported in writing by the academic supervisor/s, to confirm that the student possesses the expertise (or will receive supervision) to conduct the research and deposit sequences (if generated) in a publicly accessible database.

6.7.3 Destructive sampling request review

- Requests will be processed in the order that they are received by collection staff.
- Requests should be submitted at least four weeks in advance of the time when they will be needed.
- In deciding whether to approve a request to carry out destructive sampling, the Collection Manager / Officer / authorised delegated collection staff should consider the institutional policy and may also request the opinion of other institution staff and / or colleagues from the NSCF network.
- Requests should take the following criteria into consideration:
  - The type and extent of the request, including whether it duplicates previous efforts.
  - Whether there are compelling reasons why the project cannot be completed without the use of the collection object/s in question. This includes consideration of whether:
    - The research question being addressed is explicitly historical and thus requires the use of this collection object, or,
    - The taxa of interest cannot be sampled directly from the field.
    - Efforts by the requester to obtain material from the field (i.e., distribution and abundance of the taxon relative to the location of the user).
  - The amount of material in the institution's collection.
  - The rarity and replaceability of the samples.
  - Demonstrated ability of the requester/s to perform the work (e.g., PCR amplification, sequencing of DNA, drilling of a tooth, etc.), and complete the project.
  - The extent of the requester's experience with analytical procedures associated with the proposed studies and whether such procedures are likely to generate data that would be useful to other researchers, applications or decision-makers.
  - The level of invasiveness or impact of the destructive sampling on collection objects considering the following levels:
    - Benign methods – these include sampling procedures such as removal of fragments of soft tissue on bones, moult, dead cells, etc.
    - Minor or invisible damage – these include sampling procedures such as picking of breast feathers, hair, fish scales, slight incision in toe pads for removal of small amount of internal tissue, removal of parasites from a host, etc.
    - Moderate damage – these include sampling procedures such as removal of small clips of skin, fin, claws, sample of an ear punch, permanent clearing and staining, removal of a loose tooth for a subsample, dissections, etc.

- Severe damage – these include sampling procedures such as destruction of unique collection object features such as canines, removal of a toe, sectioning postcranial bones, etc.
- Terminal damage – this is destruction of an entire collection object or loss of scientific integrity.

6.7.4 Conditions for destructive sampling approval/disapproval

The following conditions should be applied to any collection object/s or materials supplied for destructive sampling, and must be communicated in writing to the requester, as part of the documentation:

- Usable samples and unused portions of collection object/s should be returned to the institution, unless otherwise agreed upon in writing.
- Only one sample from each collection object for the same study is permitted.
- Extraction or removal of a sample should always be the smallest amount possible in order to minimise any potential damage, and it should be taken from areas or tissues on the collection object that contain no characters of taxonomic or morphological interest.
- Any part/s of sample/s that are removed from the collection object for study (e.g., the dissection of reproductive organs and or digestive tract), must be appropriately labelled, including the original catalogue or accession number / barcode of the collection object/s from which the parts were removed, packaged and returned to the donor institution. Slides produced for study should be deposited with the donor institution, and they must clearly show the catalogue or accession number / barcode of the collection object they are associated with.
- Where it is necessary to obtain transport and import permits for rare and/or endangered species across national and international borders, the requester is responsible for legal compliance and for obtaining all the necessary permits.
- If material is to be DNA sequenced, the sequence must be lodged in a publicly accessible database (e.g., GenBank, BOLD, etc.) and the lending institution must be informed of the accession number so that this can be recorded in the collection database.
- The requester / borrower agrees to the following:
  - To fully acknowledge the institution and its collections in any publication using data collected from the institution collections.
  - To supply reprints or copies of other publications (hard copy or electronic) containing data, or any other information derived from institution collection objects.
  - Where experimental protocols used differ from published methods, copies must be provided to the institution.

APPENDICES

A6.1 Summary of documentation related to access

POLICIES

- Access Policy. The NSCF has developed an Access Policy and institutions can chose whether to adopt this fully, or to develop their own policy that aligns with the principles in the NSCF Policy.

PROCEDURES

- Process document for decision-making related to access. This could be integrated / appended into the Access Policy, or other documents, but there should a clear documentation of who receives requests, who recommends whether access is granted or not, who verifies the materials to be provided (specifically in the case of loan objects, data and images) and who signs off on the decision on the request.
- Internal appeals process document. This could be combined with the decision-making process document. The document should state the steps, who would be involved, the timeframes for the steps and how the outcome is to be communicated.
- Visitor procedures document. This should cover the steps to be followed once a visit by a researcher / by a tour group is approved, who is responsible and what the rules are that need to be followed by visitors and staff assigned to the visitor / tour group.
- Workflow document for loans, from the point at which an access request is received, to the point that the request is fulfilled and the record closed. The workflow must end with the return of the loaned materials and their re-incorporation into the collection. Timeframes for each step, roles and responsibilities must be stated. There may be specific process documents for some activities included in the workflow, such as decontamination of returned materials, or checking of outgoing or incoming materials and packing of the materials.
- Workflow document for considering and servicing requests for images.
- Workflow document for considering and servicing requests for data associated with collection objects.

STANDARDS

- Standard documents for packaging materials and packing of loans.
- Standard document that covers what facilities / equipment / consumables should be made available to a visiting researcher.
- An institutional list of rules for visitors using the collection, which is provided to visitors prior to their visit, which they should be required to sign, and which should be developed and used.
- Limitations / restrictions / requirements for use of data or images.
- Limitations / restrictions / requirements for provision of materials for destructive sampling / DNA analysis.

BOOKS / REGISTERS

- Loans book or register, which records details of all loans sent out. In some cases, this could be digital, but a regular print out should be filed and dated.
- Register (could be digital) for data and digital images supplied.

FORMS / AGREEMENTS

- Access request form, which covers all different types of requests for access, and that includes details about the requester, what they are requesting and why they need it.
- Loan form / agreement, that includes details of the borrower and the material, the conditions under which the loan is provided, and the signatures of the recommender, packer, verifier and approver.

- Receipt of retuned loan form.
- A collection object movement record slip must be completed for all collection objects on loan.
- Material Transfer Agreement for use when material is supplied for destructive sampling or if DNA extracts are supplied. This document could include the benefit sharing aspects of the transfer, or a separate Benefit Sharing Agreement document could be developed.

A6.2 The NSCF Access Appeals Committee

Composition of the Committee

NSCF Co-ordinating Hub representatives:

- The NSCF Lead, Collection Management & Conservation Co-ordinator (in the case of loans, visits and destructive sampling / DNA samples) or Data Co-ordinator (in the case of data or images).
- The incumbents of these positions are automatically appointed to the Committee.
- The NSCF Lead will serve as the Chair of the Committee. A Deputy Chair may be appointed by the Committee.

Co-ordinating Committee representatives:

- Three representatives, one with a background in zoology, one from botany (including fungi since there is only one preserved fungal collection), and one from palaeontology, with alternates for each of these representatives.
- Criteria: management level.
- Elected by the Co-ordinating Committee members.

Scientist representatives:

- Three representatives, one with a background in zoology, one from botany (including fungi since there is only one preserved fungal collection) and one from palaeontology, with alternates for each of these representatives.
- Criteria: knowledge of collections-based research and environmental decision-making, as evidenced by publications, membership of professional societies, conference attendance, and contribution to conservation / decision-making projects.
- Elected by the scientists of participating institutions.

Collection management / curation representatives:

- Three representatives, one with a background in zoology, one from botany (including fungi since there is only one preserved fungal collection), one from palaeontology, with alternates for each of these representatives.
- Criteria: knowledge of collection management and curation best practice, as evidenced by minimum of five years relevant experience and membership of the Collection Management and Conservation Working Group.
- Elected by the Collection Management and Conservation Working Group members.

Term of office for members

- There is no set term of office for members to serve on the NSCF Access Appeals Committee. If members resign from the institution or from the Committee, they must be replaced in an election. If members are not responsive to requests for input, they could be asked to resign from the Committee.

Terms of Reference and process to be followed for the NSCF Access Appeals Committee

- The NSCF Access Appeals Committee will consider appeals from individuals whose request for access to the collections through loans, visits, provision of material for DNA analysis, data or images has been denied. These appeals must first have been submitted to the institution's internal Access Panel, and only if this Panel has denied the appeal can the user approach the NSCF Access Appeals Committee.
- In cases where an institution is not able to establish an internal Access Panel, they may refer the appeal to the NSCF Access Appeals Committee.
- In a case where a user's appeal to the institution has not received a response within the specified time frame, the user can approach the NSCF Access Appeals Committee.
- A template form for appeals must be provided on the NSCF website, and institutions should also be able to provide this form.
- Appeals to the NSCF Access Appeals Committee must be submitted to the NSCF Project Manager, who will then set up the meeting of the Committee.
- Meetings should be held virtually – either by input recorded on the appeal document through e-mail, or through a virtual meeting (e.g., Zoom or Skype).
- The Appeals meetings will be chaired by the NSCF Lead (Chair), or by the Deputy Chair.
- At least 80% of the members of the Committee must participate in the process for the outcome to be valid. This includes alternates.
- The Committee must obtain input from the institution that has declined access on the reasons for this decision, and the internal appeals process that was followed.
- The Committee must deliberate on the merits of the appeal and consider the input from the institution.
- The Committee should attempt to reach a consensus on the decision, but if this is not possible, a vote should be taken.
- If necessary, additional information or input may be requested from the appellant, or from researchers or collection managers outside the Committee.
- A decision must be made in writing, upholding the decision of the institution, or over-ruling it, with full explanation of the decision.
- The decision must be communicated to the institution for their response. The institution can accept the decision of the Committee or they can challenge it. In the case of the latter, the challenge must be motivated in writing and taken back to the Committee for further deliberation.
- In a case where the institution and the Committee fail to reach an agreement on access, the Committee Chair must prepare a submission to the CEO, Dean, Board or Council describing the appeal, process and decision, and request action from a high level governance structure. The governance structure can choose to instruct the institution to implement the decision of the NSCF Access Appeals Committee,

or support the decision of the institution or do nothing. A deadline for a response to the Chair of the NSCF Access Appeals Committee must be specified.
- The outcome of the appeals process must be communicated to the appellant as soon as the process has been finalised.
- The appeal process must be concluded within 12 weeks of receipt of the appeal.
- The appeal process will be considered to be confidential to avoid the spread of inaccurate information or pre-empting of decisions.

Should an institution repeatedly decline requests for access and refuse to accept the decision of the NSCF Access Appeals Committee, future participation in the NSCF may be reconsidered.

A6.3 Access request form

REQUEST FOR ACCESS TO COLLECTIONS	INSTITUTION LOGO HERE
Please complete all sections of this form (as far as possible) so that your request for access to collection object/s for research and or photography can be processed as promptly as possible. This form must be submitted to the Collection Manager / Officer at least **four weeks** prior to the requested date for access. This form must always be accompanied by the Access Policy and the Visitor guidelines and rules. Submission date: _____	
DETAILS OF THE REQUESTOR:	
Name:	
Name and address of institution researcher is associated with (including department, year of study and letter from supervisor if a tertiary student):	
Position:	
Background of the requestor:	
Recent relevant publications or works by the requestor:	
DESCRIPTION OF REQUEST:	
Type of request:	
Please tick the relevant box/es to request access to collection object/s ☐ Photographs of collection object/s ☐ Obtain collection object/s data ☐ Visit collection ☐ Loan of collection object/s ☐ Destructive sampling request	
In the space below or as an attached document, please provide your specific interest in our collection. If the visit is for research, please include a brief overview research design.	
Give an outline of the research project/study. (Continue on a separate sheet if necessary):	
List or description of collection object/s to be accessed: (Continue on a separate sheet if necessary):	

If any, provide the name and institutional or organisational affiliation of your project partner(s):
If any, provide the source/s of funding for the research project/study:
Provide expected outcomes of research (include working title and publication venue if relevant):
If any, note potential for collaboration and joint publication with lending institution's staff:
Preferred date (please suggest a range of dates if possible) and expected duration of visit (if applicable):
Please indicate any deadlines you have for receipt of images or information (if applicable):
List institution resources requested (e.g., lights, photography equipment, measuring equipment): (Please note that the institution can only provide resources they already have):

AGREEMENT

I/We accept and understand that:

Permission to access any collection item/s is granted at the discretion of the (institution name).

Any time limits agreed upon prior to approval for access being granted will be strictly adhered to.

I have read, understand, and agree to the terms of the Access Policy (see http://nscfinstitutionname.org/collections-accesspolicy/ and Visitor guidelines and rules, http://nscfinstitutionname.org/collections-visitorguidelinesandrules/). If for some reason the link provided isn't working, it is my responsibility to request the documents and read them.

Any other requirements communicated by ***(institution name)*** staff during the visit will be adhered to as these will be in line with the care and preservation of the collection.

As custodians of the items in its collection and the data associated with them, the institution is to be acknowledged in any publications as: ***"How Your Institution Name Should Appear, South Africa"***

Please fill in your contact details below:

NAME: _____

INSTITUTION: _____

EMAIL: _____

I hereby grant / do not grant permission to the 'institution name' to release my name, associated institution address, and research questions to others with similar research interests.

SIGNED: _____ DATE: _____

Discretion of the institution – this means that visits will be scheduled according to the institution's availability of visitor workspace, specialised equipment and collection staff to assist, availability of the collection object/s, etc.

A6.4 Example of guidelines for annotating / changing information on herbarium collection objects (from SANBI's policy)

1.1. Annotations by visiting researchers are greatly appreciated.

1.2 Annotations should be written in permanent ink (not ball point pen), pencil or printed on annotation labels, available from herbarium staff members, who should also be consulted for printing larger quantities of annotation labels.

1.3 Annotation labels for mounted collection objects should indicate the name of the investigator, affiliation and date of annotation, and should be glued to the sheets or packets.

1.4 Annotation slips for unmounted collection object/s should also include the collector and number.

1.5 Annotated collection objects should not be re-filed but should be brought to the attention of herbarium staff.

Further recommendations for annotating labels

1.6 In the case of loaned collection objects, the borrower should consult the lending institution for their guidelines on attaching annotation labels/ sheets, if none have been provided. Note that under no circumstances should this information be added to the original label, previous annotation slips, or the sheet. A new annotation slip is required for every annotation.

1.7 The title of the study for which the collection objects were used can also be included on the annotation label as a header or below the annotator's name and date of annotation.

1.8 Annotations should include the accepted name of the taxon with the corresponding author/s of the species, the full name of the investigator, his/ her institution, and the date of identification.

1.9 Typically, the annotation label should be placed without obscuring any part of the collection object. For herbarium collection objects, this would be as close to the original label as possible (above it).

1.10 All type collection objects should be annotated with the basio-nym (previously published name on which a new combination or name at new rank is based) and citation of its place of publication.

1.11 Lectotype or neotype annotations should include citation of both the original publication and the lecto - or neotypification.

1.12 Any publications resulting from the use of the collection objects on loan should also be sent to the lending institution(s).

A6.5 Loan form for exceptional circumstances

LOAN FORM – EXCEPTIONAL CIRCUMSTANCES **INSTITUTION LOGO**

Loan from: _____ Loan No.: _____
Loaning institution address: _____
Telephone: _____ Email: _____
Loan to: _____ Telephone No.: _____
Address where loan will be housed: _____
_____

Description of the storage facilities / space that will be provided for the collection objects and steps to be taken to ensure their safety while on loan:
_____
_____

Motivation for the loan to be sent to a private residence: _____
_____
_____

No. of collection objects loaned: _____
Description of loan: _____
Condition of CO: _____
Verified by (name, designation and signature): _____
Date: _____
Approved by (name, designation and signature): _____
Date: _____
Sent via: _____ Date sent: _____
Brief description of the research project/study: _____
_____

Collection consumables required: _____
_____

The borrower commits that they will keep the collection in a room that can be locked when not in use and that no other person will handle the collection while it is in their care.

The borrower agrees to keep the borrowed collection object/s insulated against pests, fungus and humidity, and preserved appropriately, as per the nature of the collection object/s while in their temporary custody. They should take all necessary steps to protect the collection from all agents of deterioration (e.g., cover the collections and put them out of reach, on a sturdy surface).

The borrower agrees and understands that they cannot have a blowing fan or any type of heater going in the room where the collection is kept.

The borrower agrees and understands that they will not move the collection from one room to another unless it is absolutely necessary. When they do move the collection, they will handle it with care.
The borrower agrees and understands that the collection will be stored in a dry safe place where other people's entry can be restricted as much as possible.

The researcher / staff member agrees and understands that upon returning collection material, it must be isolated and observed for any pest activity before being incorporated into the main collection.

I have read, and I understand the above and agree to adhere to all the requirements.

Loan No.: _____ Borrower: _____
Signature: _____ Date: _____

Authorised by: _____
Signature:_____ Date: _____

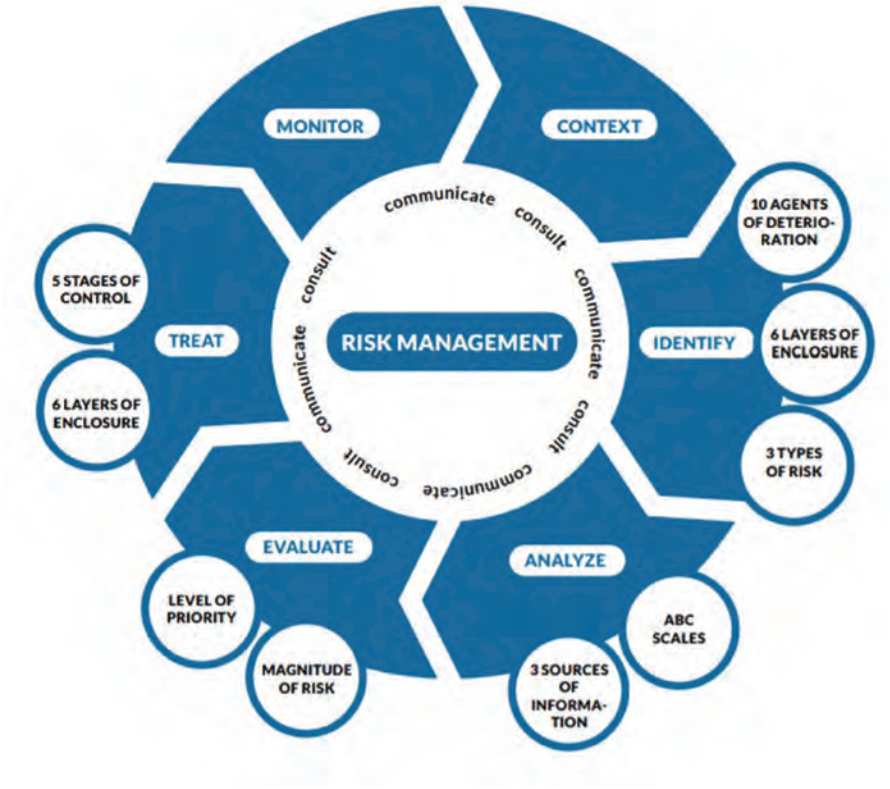
A6.6 Acknowledgement of loan return form

This form is to acknowledge receipt of returned loan material, highlight outstanding material, as well as confirm closure of a loan that has been returned.

RECEIPT OF LOAN MATERIAL RETURNED FORM	INSTITUTION LOGO
Received from: _____ Institution Address: _____	
Email address: _____ Telephone: _____ Shipped via: _____	
Returned collection object: Catalogue No.: _____ Condition received in: _____	
Outstanding collection object/s from this loan (if any): _____ _____	
Person receiving and processing loan: _____	Date received: _____
Checker verifying returning loan contents: _____	Date checked and verified: _____
Date when the returned loan was closed: _____	

NOTES:

CHAPTER 7: RISK AND DISASTER MANAGEMENT



Summary of the main steps (inner circle) and concepts and tools (outer circle) involved in risk management for heritage resources, starting with context in the inner circle, and moving clockwise. ***With permission. © Copyright is owned by ICCROM and the Government of Canada, Canadian Conservation Institute, 2016, as published originally in https://www.iccrom.org/wp-content/uploads/Guide-to-Risk-Managment_English.pdf***

7.1 Background

Apart from the deterioration of collection objects as a result of poor storage conditions, the lack of monitoring and maintenance, and inappropriate use, collections are at risk from disasters such as flooding or fire and from security threats such as riots, vandalism and theft. The condition of the buildings in which the collections are housed can contribute to these risks and pose additional risks (e.g., collapsing roofs or walls, the building being a government building making it a target during service delivery protests). Staff often believe that disasters are events that only other institutions suffer but they can happen to any institution, usually with devastating effects for the collections and potentially for staff as well. Each institution must have a good understanding of the hazards associated with the collections, the risk presented by these hazards, how these are mitigated, and how they would deal with any event that impacted the collections. Each institution should also have professional assessments of the state of the buildings so that problems can be addressed.

Hazards are anything that has the potential to cause harm, and can be broadly divided into physical, chemical and biological.

Risk is the likelihood of such harm being realised plus the severity of the consequences.

The 10 agents that can cause deterioration and loss to collection objects. ***With permission. © Copyright is owned by ICCROM and the Government of Canada, Canadian Conservation Institute, 2016, as published originally in https://www.iccrom.org/wp-content/uploads/Guide-to-Risk-Managment_English.pdf.***

7.2 Risk Assessment, Controls and Monitoring

- It is not possible to completely prevent all disasters, but the impacts on human life and property can be reduced by **understanding hazards and risks and having an emergency preparedness and response plan in place.**
- Institutions must conduct regular **risk assessments for the natural science collections** in order to identify potential hazards and assess the risk these pose (how likely is a disaster related to the hazard, and what would the severity of the impacts of such a disaster be).
- Risk assessments must be used to develop **mitigation or control measures** for each risk (see Appendix A7.2 for an example), and **monitoring plans** to check implementation of the mitigation measures. A record should be kept of all monitoring activities and outcomes. An example of a monitoring checklist for fire protection is presented in Appendix A7.3. Similar checks for other critical hazards should be developed, used regularly, with issues addressed, and documents retained on file.
- **Risk assessments must also be used to develop detailed emergency response plans that include:**
  - **response in the case of each type of disaster,**
  - **salvage plans for each type of disaster** which should include the options for treatment of different types of damage to different types of collections, and advice for deciding which type of treatment to apply, as well as details of how to apply different types of treatments,
  - **staff roles and responsibilities** in the case of disaster.

- Creating an emergency response plan requires a coordinated planning effort. **It is critical that all staff are involved in the risk assessment and the development of the response plan** because this will ensure understanding and support from the people who will need to implement the plan.
- The emergency response plan will need to be maintained and updated once it is written, and one of the best ways to do this is by testing it. **Regular training exercises** help this process and ensure that the people using the plan are familiar with it.
- The Emergency Response Plan must include the **date of last revision** / review.
- After each disaster, the damage should be assessed using a **damage assessment form** such as that shown in Appendix A7.4.

7.2.1 Guidelines for carrying out a risk assessment for collections

Collections are subject to risks that can seriously affect the lifetime and value of a collection. Risk assessments can be adapted to evaluate risks at a very broad and comprehensive level, across an entire institution or department, or down to a narrow range of materials or specific conditions (e.g., risk evaluation prior to a collection move). The results of these evaluations can inform procedures to plan for and reduce the effects of unavoidable disasters.

Approaching a collections risk assessment independently is a set up for failure; it must be **approached as a team effort** to be credible, transparent and fair. Internal partnerships are critical to its success and these should be between institutional management, operations and scientific departments. Participation of management is essential to provide support and guidance. The operations staff can provide vital data concerning collections security, engineering control systems, and Integrated Pest Management procedures. Having staff involved who have historic knowledge of the building and its infrastructure (critical variables concerning collection care), is important and the involvement of scientific staff (conservators, collection managers, preparators, technicians, curators, researchers) will provide the information needed to determine the extent to which specific threats could impact collection objects.

A risk assessment, whether formal or informal, extensive or just on a representative portion of a collection, is generally an administrative tool to **prioritise the implementation of measures to preserve the collection.** The goal is to prevent damage or at least to limit the extent of the damage by determining:
- What percentage of the collection is susceptible to a specific risk?
- What could be the resulting loss in value?
- What is the probability of the event happening?
- What would be the extent of the event?

First, a**ll the risks that threaten the collection or building should be identified.** It is important that significant risks are not missed. When identifying risks, the main question to ask is: What can go wrong and cause damage and loss of value to the collection? The most common risks to museum / herbarium collections, often called the "10 Agents of Deterioration", should all be considered when carrying out the risk assessment (see Appendix A7.2 for an example of an assessment of these

Agents of Deterioration). The risk assessment should include inspection of the collections as well as the building and should be updated as changes to staff and facilities occur.

The risk assessment is particularly relevant in situations where resources are limited, and activities have to be prioritised. The assessment should provide administrators with information crucial to making decisions about resource allocations for reducing and mitigating risks to collections.

- **Methodology for risk assessment**

It is important to develop a methodology document outlining the evaluation process, which is then established as a guideline for maintaining consistency and limiting biases as in the future. A useful approach for a complete identification of risks is to consider the three **different types of risk occurrence** (i.e., rare events, common events and cumulative processes).

- **Rare events** occur less often than about once every 100 years. As a result, rare events are not part of the direct experience of most institution staff. Some examples are floods, damaging winds, large fires, grand theft, and a visitor knocking over a special item.
- **Common events** occur many times per century. These are events that are part of the direct experience of many collection institution staff or of people in the vicinity of the institution. Some examples are water leaks, small fires, collapse of overloaded storage furniture, many handling "accidents" and petty theft.
- **Cumulative processes** can occur continuously or intermittently. Over the years, most institution staff will have observed the cumulative effect of one or two such processes on some collection objects, that is to say, they will have seen the item "age." Very frequent events can also be considered as cumulative processes for risk analysis. Examples are yellowing of paper, fading of some collection object colours, corrosion of metals, erosion of stone and wear and tear from daily handling.

  Dividing both the risks and the collections into smaller components ensures that both are understood in a clear, comprehensive way. Collection staff may want to view data not only by collection type, but also by department or by division/unit. Collection units could be created based upon the hierarchy that already exists within the institution, divisions, departments, and collections. In addition to following the structure of the institution's holdings, the collection units could be further defined by location (building, floor and room).

- **Analysing risks**

Identifying the risks that threaten our heritage is necessary, but an understanding of the **extent of these risks** is essential. Which ones are unacceptable? How can we prioritise them? These questions must be answered in order to make effective decisions.

Each risk must be understood in detail. Estimate the **chance of occurrence** and the **expected impact.**

When the risks are of the 'event' type try to e**stimate how often it occurs.** For example, 'a large earthquake damaging the heritage asset is expected to occur

about once every 300 years, the theft of heritage items is expected to occur about once every 30 years, rainwater infiltration through the roof affecting the institution's collections is expected to occur about once every three years. Once the likely frequency of a risk has been determined, **evaluate the potential impact of the risk** on the collection, and **the extent of the damage** that is likely.

For example, imagine that the collection objects are in a historic house institution whose building is made of wooden floors. A large fire will most likely cause a total loss of value to this collection. Theft of 'treasure objects' from the collection in this institution would imply a large (but not total) loss of value to the entire collection. Small or moderate water damage to a few books of average importance in this collection, on the other hand, would represent a very small loss of value to the collection as a whole. Some dust accumulation on the collection objects and interior surfaces of the building would also mean a small or very small loss of value to the collection.

A system or a tool should be created to help calculate, compare, and communicate the **magnitude of risks to collections.** In risk management it is important to recognize that uncertainty always exists, and to show it explicitly. Whatever system or tool is used, it should factor in **how often a risk will happen, what the loss in value would be for each affected collection object, and what percentage of the value of the collection is affected per event, to be able to work out the size of the risk.**

- **Communicating risks: The Reports**

A very important part of risk management is the communication of risks in a clear and meaningful way, particularly to decision-makers. Failure to communicate effectively could result in a lower level of interest and involvement of stakeholders, as well as poor decisions and ineffective actions concerning risk treatment.
A useful way to communicate risks is through **risk summary sentences.** The risk summary sentence is a complete and meaningful sentence that **refers to the future, identifies the danger or agent of deterioration, specifies the expected adverse effect, and indicates which part(s) of the heritage asset will (most likely) be affected.**

The ability to generate reports is critical when presenting the results of a risk assessment. Risk management must involve engagement, collection of information, earning the trust of others, and receiving authorisation from superiors. This means that communication with different people and audiences is an essential part of risk management.

The use of images to illustrate dangerous situations and their expected impact on collections can be very helpful when communicating risks. It also helps to use maps or floor plans to locate the sources of danger, and to locate the parts of the collection object that will be affected by each danger.

Examples of risk summary sentences:

- Red highlights the danger, blue the affected part of the collection, brown highlights the expected adverse effect,

- "Failure in the digital storage system where the only existing copy of the museum collection inventory is kept will cause irreversible loss of information and will compromise intellectual access."
- "Bursting of the water pipe that runs over the collection storage room will cause damage to water-sensitive materials, such as stains, deformation, and mould growth if left wet for too long."

- **Collection specific reports**

These reports document the storage and use of the collections at a particular time, the breakdown of collection size by department, division and/or institution wide, and the distribution of collections throughout the institution. In addition to being useful for collections and conservation staff, these documents also have the potential to inform annual reporting and planning.

- **Location specific reports**

These reports show the breakdown of collections by specific security and environmental conditions. They provide summary data concerning the physical conditions of the collections' storage and the percentage of collections stored under the given parameters. One example of how these reports can be used might be in highlighting the breakdown of collections housed in storage conditions with sprinklers versus those housed without sprinklers.

7.2.2 Components of an Emergency Response Plan for collections

- **Contact List.** This includes the names of the Emergency Response Team with their phone numbers and e-mail addresses. An accompanying document should outline roles and define responsibilities (see example in Appendix A7.5).
- **Inventory and list of prioritised collections,** a collections inventory (complete with locations) and a priority list will identify and locate rare or vulnerable items (such as type collection objects, material borrowed from other institutions, field notes, as well as potentially hazardous collection objects treated with heavy metals or other pesticides, radioactive minerals, etc.) (see example of a priority list in Appendix A7.7).
- **List of materials and supplies for an emergency** supply cart for protecting collections in an emergency. The cart carries supplies and tools needed in an emergency; these will be collection specific. It is a first line of defence and relies heavily on the preparedness and training around the use of the cart contents. The contents depend on the size of the collection, the method of collection storage and the type of collection objects stored. An example of a supply cart contents list is provided in Appendix A7.6.
- **List of service providers for assistance in an emergency.** This should include companies that would be able to assist with temporary storage, freezing, cleaning up and salvage efforts.
- **Identification of backup storage and/or triage areas.** These areas must be identified prior to any emergency and should be kept prepared for whatever emergency they have been identified for. If the area is sometimes used for other purposes, staff must ensure that it is left prepared for use as a triage area after each use.
- **Procedures for evacuation,** responding to various types of emergencies, and salvaging collection objects. More details regarding the various options

for evacuation and salvage are provided in this chapter. The specifics of the collection and accompanying risks will need to be taken into consideration.
- **Training schedule.** Regularly scheduled training workshops help to ensure continuity of information in the case of staff changes, as well as ensuring that everyone remembers what their role is during an emergency event.

Note that while a full Emergency Response Plan is important, it is equally important that the Emergency Response Plan, or at least components of it are portable, easy to handle and within which one can find relevant information in a hurry: and simple but explicit. One suggestion is a "Pocket Response Plan", which is a simple template printed on both sides of a sheet of paper and folded into a wallet size, which can be carried by staff at all times. Examples of pocket-sized plans are provided in Appendix A7.7.

7.2.3 Some best practices for emergency response planning

- **Good communication, training, collaboration and development of strategic partnerships** within various departments in large institutions, as well as with local first responders (fire department, police, security companies), neighbouring institutions, and other organisations nationally and internationally, are essential in establishing a framework for support and assistance, in the aftermath of an emergency.
- **Emergency contact numbers** should be posted in prominent locations in the institution and should be saved on cellular phones of staff members who are on duty. The contact information should be reviewed regularly, to ensure that the information contained therein is current.
- **Key individuals should be identified who will serve as being "on call"** or who will be able to respond to an emergency at the institution. Leave and vacation schedules should be monitored to ensure that coverage of essential responsibilities is in place should key individuals be unavailable.
- **Institutions should have a checklist of activities for on call staff to follow during an emergency.** On call staff should be familiar with the location and operation of certain key equipment and controls (e.g., circuit boards), that may need to be checked during an emergency.
- **Telephone numbers for professional assistance should be clearly posted in the institution** and accompanying administrative areas (e.g., engineering or facilities personnel, municipal service departments, fire and rescue services, security company).
- Each institution must **keep records of assessments and of any disasters;** make these accessible once investigations have been concluded and share the information for the purpose of sharing lessons learnt.
- If critical risks are identified and it is beyond the budget or responsibility of the institution to address or mitigate these, they should be submitted to the governance structures that are responsible for the building or budget allocation.

7.2.4 The Emergency Response Team (ERT)

- The emergency plan must include details of the Emergency Response Team (ERT) structure, including names, contact details and well-defined roles. The roles give staff specific duties in the event of an emergency.

- Leadership and decision-making processes during disasters, including in relation to the allocation of emergency funds and procurement of expert services and goods must be included in plans. In the event of an emergency, an institution should have an established reporting structure.
- The composition of the ERT will vary according to numbers of institution personnel and other contributing factors like skills and relevancy to carrying out expected activities.
- With the duties of each role predetermined and practised, when there is an emergency, staff can work efficiently with each other and avoid duplication of effort and critical actions being forgotten, right from the beginning of the event.
- The ERT should include at least the following two structures: **The Emergency Committee and the Collection Managers Group.**
- **The Emergency Committee (EC)** comprises:
  - The Security Manager (who acts as the Emergency Preparedness Manager - EPM).
  - Collection HODs or Chief Curators.
  - Health and Safety Officer/s.
- The EC is responsible for:
  - Limiting access to an area if necessary.
  - Ensuring that the area is safe and free from danger after the disaster and making the decision about re-entry.
  - Overseeing the cleaning of the affected area.
  - Ensuring any infrastructural issues have been resolved.
  - Maintaining contact up and down the command chain (especially above the chain to institution administrations and managers).
- **Collection Managers Group (CMG)** comprises:
  - The staff who are most familiar with the collections. In cases where there is no collection manager, any person with the responsibility of one should be involved at this level.
- The CMG is responsible for:
  - Working closely with the Recovery Team Leader (RTL) to prioritise the salvage effort and identify what supplies / duties the effort will require.
  - Contacting the appropriate companies (movers, or institutions identified as triage area) (this action may require approval from the Supply Chain Management staff).
- **A Recovery Team Leader (RTL)** is part of the CMG and works closely with the EC and reports to the EPM regarding planning/response and salvage efforts. The RTL will also work with the appropriate curators and the technical and support staff on the planning, documenting and salvage phases of the effort. Depending on the size of the institution and collection composition there could be an RTL for each collection type (as per staff availability), or one for each section. The RTL has an overall responsibility for the execution of the emergency response plan during an emergency event, and to work to keep the team focused and clearly explain the tasks at hand. During an emergency event, the RTL is responsible for:
  - The welfare of the team members and communicating the needs of the team to the Emergency Preparedness Manager (EPM).
  - Acting as liaison between curators and the ERT, as well as the security unit.
  - Guiding the collection risk assessment and salvage efforts.

Staff from the CMG should be assigned as:

- **Emergency Event Recorders (EER)** who ensure that the emergency event is properly documented, including tracking and recording where objects are moved to, producing an inventory of what has been moved, what has been damaged and the type of damage, and for photographing storerooms, and objects and salvage and treatment efforts.
- **A Triage person (TP)** who will act on orders from the CMG who will have determined whether the collection objects can be salvaged (i.e., the order in which they must be saved, the method of salvage, as well as the drying protocol if appropriate).
- **Emergency Event Transporter/s (EET) –** who will carry the collection objects, whether damaged or not, to the predetermined salvage area. Ideally these should be people who are very experienced and familiar with handling collections.
- **Dryer or packer/s -** should be people who are familiar with handling collection objects; particularly because in an emergency event they will be more delicate and fragile. If other people can be identified who possess the skills and experience required, even if not from the CMG and DG, they should conduct this task. The dryer/packers will work in the salvage area and either lay out collection objects to air dry or pack them up for removal from the site for storage or for transport to a freeze-drying facility.

7.2.5 Training

- All staff must understand their role and responsibilities in the case of a disaster.
- Staff must be trained in order to understand how to respond in the case of different types of disaster.
- Managers and incident recorders should be trained on how to properly document and investigate incidents before being assigned such tasks.
- All training given must be recorded and officialised by both the trainer's and the trainees' signatures.
- Plans must be tested and staff training reenforced by holding regular emergency response exercises.

7.3 Emergency Planning for Collection Hazards

7.3.1 Fire

Fire is probably the highest risk to natural science collections because there are many potential causes of fire in collections and therefore a high probability that fire will occur (highly flammable chemicals and large amounts of flammable objects, old buildings with poor infrastructure); and the impacts of fire are likely to be devastating in terms of both the collections (total loss of part or entire collection in a very short time), and staff safety.

The following infrastructure and actions are required to prevent and reduce the impacts of fire in collections:

- **Detection and suppression**
  - Collection storage areas must have fire detection and suppression systems that are appropriate to the nature of collections and the structures housing them.
  - The institution must ensure that fire detection and suppression systems, including fire extinguishers, are checked and maintained according to the supplier's requirements, and that checks are documented and signed off.
  - Institutions must clearly communicate the location of fire extinguishers, fire detection equipment and fire suppression systems and train staff in the use of these.
  - The procedures of how to notify the fire department and other emergency response personnel must be visibly posted in all collection areas.
  - Fireproof or fire-retardant collection cabinets should be used.
  - In very high-risk storerooms, fire doors should be used to limit the spread of fire.

- **Fire Prevention**
  - All flammable materials must be stored in approved containers outside spaces housing collections.
  - Maintain good housekeeping, remove waste often and avoid accumulation of packaging materials near the collections.
  - Prevent smoking in the building and remove any other ignition sources.
  - Maintain electrical systems to the required standards.
  - Cooking in the building should only be allowed in dedicated kitchen areas and these should have fire prevention and suppression mechanisms.

- **What fire vulnerabilities are in the collections?**
  - Old wooden structures housing collections present a high risk for fire. Wood burns easily. Wooden floors and stairways in collection storage areas, wooden cabinets and shelves all present a fire hazard.
  - Composition of the collections influences the vulnerability. Dry collections can easily burn to ashes. Fluid-preserved collections are preserved with flammable chemicals; botanical collection objects are dried and would promote fire.
  - Stored paper materials such as documents and packaging materials such as boxes pose a risk.

- **What are the fire damage risks to collections?**
  - Collection objects could be completely destroyed by fire.
  - Building structural integrity could be severely damaged or even destroyed by fire.

- Institution records, archives and manuscript collections could be destroyed or damaged by fire.
- During fire suppression water, chemical, and physical damage may all occur.
- Mould may result from the use of water for fire suppression.
- Heat and smoke from fire causes accelerated deterioration of collection objects not consumed by the fire.
- Embrittlement of organic material and oxidation of metals may be caused by fire or excessive heat from fire.
- Plastic-ware will melt, and glass will explode as a result of very high temperatures or fire.
- Smoke and soot damage collection objects. Sometimes soot can be acidic and cause extensive corrosion, etching and discoloration.

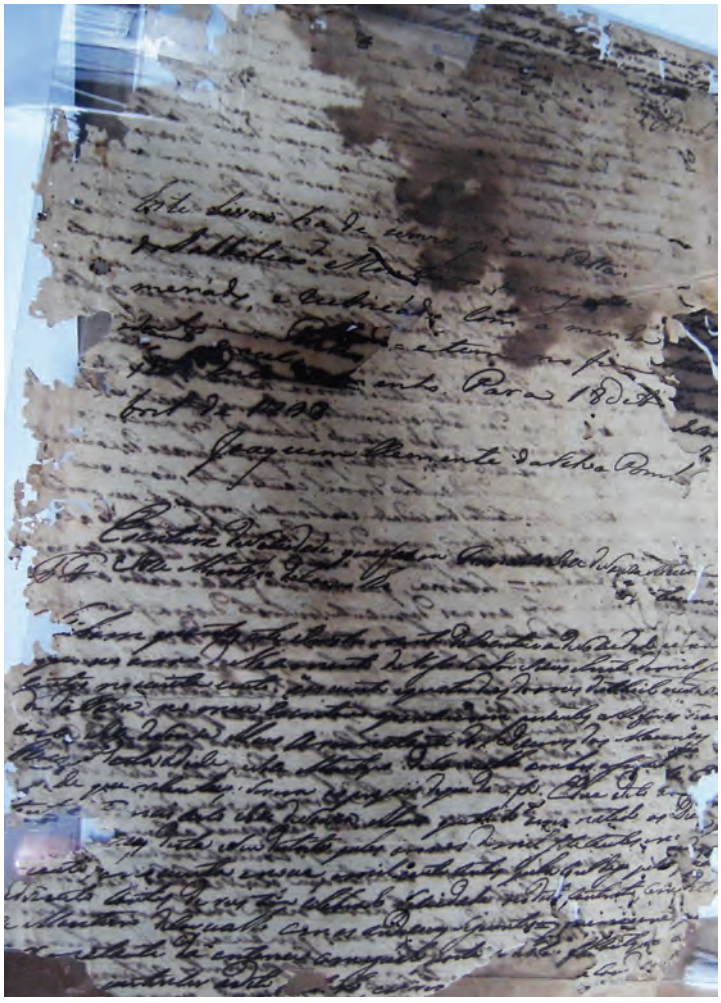
• **Fire survival points**

All institutions should provide evacuation and fire safety training for all staff and the roles and responsibilities for staff in the case of fire should be clearly understood. The following are some points that serve to guide staff in the event of a fire.

- If present during a fire, activate the fire alarm immediately.
- If safe to, check the elevator for trapped individuals.
- Help disabled or injured people evacuate safely without using elevators (use evacuation chair).
- As you evacuate, close all doors behind you.
- During evacuation keep close to the ground.
- If smoke is bad, place a wet cloth over your face.
- Don't open windows.
- Never allow fire to get between you and the door.
- Never jeopardise your safety by trying to put out a fire unless it is safe to do so.
- If possible, take the visitor log and staff register with you to help account for everyone in the building.

7.3.2 Water damage or flood hazard

Water damage can be the result of fire-fighting activities, storms, and structural damage, but may also be due to flash floods or burst pipes in the building.



Staining and corrosion of an archival document affected by a water - *image by José Luiz Pedersoli Jr., ICCROM (2016). With permission.*

- **Water damage and flood vulnerabilities**

Some of the materials most vulnerable to water damage are:

  - Papers, including archival materials, backup documents, institution records, catalogue books, field notes and photographs.
  - All dry collections, including skins, pinned insects, bone and ivory due to being hygroscopic, and water sensitive geological and paleontological collection objects.
  - Previously mouldy collection objects in the collections including animal and botanical collection objects, books, furniture, paper, parchment, photographs.

- **Water damage**

  - Development of mould and rotting of animal and botanical collection objects, books, furniture, paper, parchment and photographs.
  - The structural integrity is lost for wet paper, and pigment and dye loss occur on books, paper and photographs.
  - Staining and deposition of contaminants on bone, ivory, paper and shells.
  - Electronic equipment may be damaged.

- **Preventing flooding and water damage**
  - Collection storage buildings must be maintained so that flooding is avoided.
  - Any leaks or other potential sources of flooding must be reported to the relevant authorities as soon as these are noticed.
  - Only use spaces for the storage of vulnerable collections that will not flood if pipes break or drains back up.
  - All collection objects must be stored at least 15cm off the floor.
  - Ensure that all drainage and water removal systems are functioning well.
  - Know where water and utility shut-off valves are and how to operate them.
  - If you are in a flood prone area, know the area flood stage water table level so that you can avoid storing items below this level.
  - Avoid using wooden storage equipment as it floats, and it may swell, and crush materials housed inside. Wood also holds water and weighs a great deal when wet, potentially leading to excessive floor loading and structural collapse.

An example of mould damage to old documents - ***image by Pemba.mpimaji - Own work, CC BY-SA 3.0 (https://commons.wikimedia.org/w/index.php?curid=18543283).***

7.3.3 Power and water cuts

Power outages and water cuts are common in South Africa and present various risks to collections, especially if outages are protracted.

The most significant risk associated with loss of power and water is after an emergency such as fire or flooding. Emergency recovery will be impossible without back-up power. The temporary lack of light and clean water can incapacitate an institution during the vital first 48 hours of collections' emergency recovery, regardless of the original type of emergency. Staff may be injured or collection objects physically damaged while trying to find doors, emergency equipment lights and telephones.

- **Risks associated with loss of power in collections**
  - Personal safety of staff. Accidents and crime are likely to take place when it's dark.
  - Collections lacking good alarm systems with alternative sources of power are vulnerable to theft during power outages.
  - Collections housed in buildings with inadequate emergency lighting are vulnerable to theft and damage.
  - Collections housed incorrectly, maintained improperly in research room areas, or kept in spaces with inadequate walkways are vulnerable to damage or loss in the dark.
  - Collections easily destroyed by mishandling, such as bone, ivory, paper, and fluid-preserved collection objects in glass bottles can be lost or damaged.
  - Cold storage systems can fail leading to deterioration of frozen collection objects samples or materials.
  - Accelerated ageing of most organic collections occurs due to environmental instability.

- **Limiting the impact of power and water outages**
  - Scheduled electricity outages cannot be prevented. Institutions must have relations with regional utility authorities to ensure that they are alerted when an outage is planned or likely. The municipality usually keeps proposed schedules of outage.
  - Institutions must be prepared for power and water outages. There should be a plan for how this will be dealt with in the short, medium and long term.
  - Institutions should have a back-up power source for essential services, such as emergency exit lights, the ventilation system and security lighting.
  - All back-up power sources must be tested regularly, and a regular schedule must be set up for changing and checking batteries for backup systems.
  - Battery powered emergency lights must be installed near electrical, fire, and security panels and along the evacuation route.
  - All staff must be trained on how to evacuate in case of a power failure.
  - Where possible, solar powered exterior lights should be considered.

- **Power utility and water cut survival**

Each institution should have a plan to deal with the specific risks associated with power and water outages in their buildings. Some buildings or areas may be completely dark in the event of power loss, while this may not be the case in other buildings or areas. Some points that should be considered include:

- If you are in the building during a power failure, stay calm and find your flashlight (often available on cell phones).
- If you are leaving the building, the first person in line opens all window blinds / shades / curtains along the evacuation route to increase illumination. Don't open the windows themselves.
- The last person in line closes the blinds / shades / curtains and doors as she/he departs.
- The evacuation monitor must check to see if anyone was caught by the outage in the elevator.
- Disabled or injured people must be helped to safety.
- Once safely in the designated assembly point, check to see if anyone is missing.
- Be prepared to search visitor bags, coats, and parcels if the evacuation involves entering normally restricted spaces.

7.3.4 Hazardous materials



Hazardous materials (hazmat) include various chemicals used in the collections or associated laboratories, and some of these are toxic or pose some other health risk and / or they are flammable. Oil and fuels for generators and vehicles are also considered as hazmat. Hazmat accidents mostly involve spillage of materials, which, apart from health risks to staff, can cause damage to collections or other infrastructure and make it impossible for staff and other collection users to access collections. The disturbance depends on the size of the accident (a minor spillage can be cleaned up faster than a complex one) and the nature of the hazmat involved in the accident. The information presented here focuses on risks to a collection posed by hazmats, while the risks to staff health and safety are provided in Chapter 8.

- **Hazardous material vulnerabilities**
  The following risks to the collections are posed by hazmat accidents:
  - Collection objects might weaken or lose structural integrity when exposed to chemicals such as acids.
  - Staining and deposition of contaminants on collection objects may occur.
  - Archival documents may stain or discolour after coming into contact with a hazmat.
  - Equipment such as computers, or other electronic items, including microscopes, may be damaged.
  - Structural integrity may be lost for infrastructure such as plaster, flooring, shelves or cabinets.

- **Hazardous material accident prevention**
  - To avoid hazmat accidents, house collections far from chemical storage areas, construction sites, fuel storage areas, garages and laboratories.
  - Ensure that expired or unused chemicals are legally disposed of and do not accumulate these in collection storage areas.
  - Maintain an inventory of all hazmat maintained in the institution, including locations, quantities, date of purchase and expiry.
  - Provide collection staff with necessary preventive equipment for handling hazmats, including fume hoods, nitrile gloves and rated breathing apparatus.
  - Maintain a file of how to handle exposures to hazmats, including details of service providers to contact for cleaning up of selected hazmat spills, where this is required.
  - Facilities with hazmats should have eyewash and shower stations; the location of these must be noted on the building plans in the emergency plan.
  - Check seals on all fluid-preserved collections regularly.

- **Hazardous material accident survival**

The steps taken when there has been a hazmat incident will depend on the extent and nature of the incident. The following points should be considered if there has been a substantial or serious incident involving hazmat:

  - Evacuate the area immediately, using the stairs instead of elevators.
  - Assess risks as you evacuate (spills, power cut, fires), so you can alert authorities.
  - Contact authorities immediately.
  - Avoid re-entering the area until officially informed that the area is safe to enter.

7.3.5 Theft

- **Theft prevention plans and monitoring**
  - A regular audit programme is an essential security mechanism to deter and detect theft of collection objects. Institutions must have a full inventory of the collections for use in audits.
  - Institutions must have crime prevention and physical security plans which include procedures for various staff (outreach guides, reception desk personnel and cashiers) to call for help in an emergency, when a visitor becomes unruly or during a robbery.
  - The institution must evaluate the physical security of spaces housing collections, with attention paid to barriers, display cases, locks, doors and windows.

- Institutions must have operational procedures and practices for security, such as key control, access control, and opening and closing procedures.
- Institutions must immediately report and document any damage, loss, or possible theft of collections in the institution's custody and on loan.

- **Theft prevention mechanisms**
  - There must be burglar proofing or controlled access to all collection areas, strict control of keys, well maintained locks, well maintained security devices and surveillance of public areas. All portable items must be kept in locked cases or under surveillance.
  - Barriers and locks are the most common tools used to accomplish the objectives of access control. The fewer keys there are, the better. Designate, by name, those authorised to have keys to collection storage spaces and display cases.
  - Institutions have a responsibility to measure the effectiveness of a security system and evaluate the effectiveness of the countermeasures intended to reduce the risk.
  - Theft, mishandling, and vandalism increase with collection room visitation and use therefore additional efforts will be required to protect collections that are frequently visited.

- **General crime prevention**
  - Keep your personal and company valuables locked and secured at all times.
  - Report suspicious persons, vehicles, and activities to institutional security control as soon as you are able.
  - Don't leave keys, ID cards, access cards, or other issued equipment unsecured at any time.
  - Keep offices locked when not in use.
  - Be aware of your surroundings at all times.

7.4 Emergency Response Team Actions when an Emergency Event Strikes

Note that contact details, roles of emergency staff, and the evacuation plan must be displayed prominently in the workplace.

7.4.1 Immediate actions

- Isolate the affected area.
- Retrieve the emergency supply cart.
- Contact appropriate emergency organisations (e.g., fire department, hazmat rescue, ambulances, police), area support institutions (e.g., institutions that may be used as triage, institutions that can lend a hand during the emergency).
- If safe to do so, assess damage.
- Initiate relocation, evacuation, and possibly salvage measures for the collection.
- Document (record and take photographs) all response activities (a crucial function).

7.4.2 Evacuation procedures for employees and the public

- There should be documented evacuation routes and care should be taken when choosing an evacuation route to ensure that people should not have to pass through the risk area to evacuate.
- When the evacuation alarm is sounded or flashes, or an instruction is given to evacuate the building by the health and safety officer:
  - Immediately shut down all hazardous operations. Seal chemicals, turn off equipment, shut all doors and windows behind you, if safe to do so, but do not lock.
  - Leave quickly by the nearest safe exit.
  - Go directly to the nearest safe designated evacuation assembly point.

Example of a designated emergency assembly point, where everyone should report to during an evacuation.

  - The health and safety officer (where applicable) will ensure that occupants evacuate the area. All employees should help each other to leave as instructed. The evacuation monitor checks nearby restrooms, copier rooms and all other areas that may have people and closes all doors.
  - Accompany and help any people with disabilities, co-workers who appear to need calm direction or assistance. Only take car keys, purse and / or wallet if it is safe to do so. Do not attempt to take large or heavy objects.
  - Proceed as quickly as possible, in an orderly manner. Do not push or shove. Remove high heels if necessary.
  - Once outside the building, move away from the structure and do no not block streets or driveways.
  - Group with other members of your department / unit in the assembly area. Assist the relevant person with a head count and staff register.

7.5 Collection Salvage and Recovery

7.5.1 Guidelines for a salvage plan

Taking the correct steps in salvaging collections immediately after a disaster will maximise the impact of recovery efforts. Salvage plans should include an ordered list of priorities for collections and collection objects. This may be based on the importance of the collections (e.g., type collections checked first), immediate risk to objects (e.g., those not yet damaged but that will be unless they are removed, followed by those that are most severely damaged), and accessibility (e.g., those most accessible to be moved first). The plans should also include the options for treatment of different types of damage to different types of collections, and advice for deciding what type of treatment to apply, as well as details on how to apply different types of treatments. Some of the points for consideration in the salvage plan are provided below.

- **Affected and triage areas**
  - Personal safety is the first consideration in all emergencies. Even after being given permission by first responders to re-enter, personal safety equipment may be needed.
  - After an emergency event, re-entry into storage areas may be delayed by dangers in the building such as structural instability, electrical hazards, and the presence of hazardous materials or by external hazards such as downed electrical wires and debris in the roads preventing access to the institution.
  - With all emergency preparedness plans there should be a map or floor plan, showing places to note. The salvage plan should also show the triage areas.
  - In an emergency event (e.g., fire, flood), if the identified triage area has not been affected, the area must continue to be used and signage should be placed to show its direction.
  - If an identified triage area is affected by the emergency event, another area should be identified, even if in another institution within the network. In a case where a triage area is identified outside the institution, transportation should be planned at the soonest convenient time, including people who will travel with the collection. Taking the correct steps in salvaging collections immediately after an emergency will maximise recovery efforts.
  - Places that have not yet been salvaged should be cordoned off.

- **Documentation**
  - Details of the salvage are recorded by specifically assigned recorder/s in each Emergency Response Team. The recorder/s work closely with the person in charge of triage. The job of recording the collections is often the slowest step in the process and it may be necessary to delegate more than one or two people, depending on the nature and extent of the emergency.
  - During the salvage, it is important to record and take photographs of the collection objects involved, showing their present condition (see Appendix A7.4 for an example of a damage assessment form), how they will be treated in the short term, and where they are stored / moved to, after the salvage. This will ensure that records essential to the ongoing preservation of collections are kept and are available.

- In preparation for documenting the salvage procedure, pre-printed salvage forms (see example in Appendix A7.9) should be available for each collection type to record the collection objects, the salvage method used (freeze, air dry, etc.), and the new location where they are moved, after the disaster. If collections are moved, packing and tracking records must be kept (i.e., an inventory of objects moving out of the incident site (box or tray lists if they are in boxes / trays), and destination).
- It is essential to keep track of all collection objects (see Appendix A7.8 for an example) and to ensure that they remain secure. Documentation is therefore important but should not delay removal or 'first aid' treatment of collection objects.

- **Priority collection objects list**
  - The collection objects on the priority list should be salvaged first if this is possible in terms of accessing the area.

- **Remaining collection objects**
  - After removal and documentation of priority collection objects, only the salvage form will be used to record what other collection objects have been removed and whether they have been stored or sent for further treatment. This is because there is no record to cross check with, besides the register and the electronic inventory.

- **Labelling collection objects**
  - Identification labels with the accession or catalogue number should be attached to large collection objects or, in the case of collection objects boxed, the number of collection objects in the box, their unique identifying numbers and the room, shelf or cabinet they were salvaged from. These details should be entered onto the salvage form. Labels should be attached to collection objects by tying them on with cotton tape; adhesive stickers should NEVER be stuck directly onto an object.

- **Security**
  - Decide what security measures are needed at the earliest opportunity. The immediate salvage scene is likely to be chaotic and is the most vulnerable to opportunist theft. Wherever possible, choose a salvage area that has the following features:
    - Easily accessible from the scene.
    - Has naturally occurring boundaries (e.g., fences or walls), and is protected.
    - Is easily overlooked and doesn't look like it may have valuables.
    - Is away from footpaths, and not many people pass there.
    - Is away from planting or other features that might allow a thief to approach unseen.
  - Taping off a secure area with only one entry point, to deposit removed objects, will help identify trespassers. Anybody not known or easily identifiable and any suspicious activity should be challenged.
  - The further movement of objects to a triage and treatment / packing area can be more easily controlled and all persons working in these areas should be reminded of their security responsibility by the Emergency Preparedness Manager (EPM).

- If there are sufficient people, one should be appointed to supervise the secure salvage area and help ensure security.

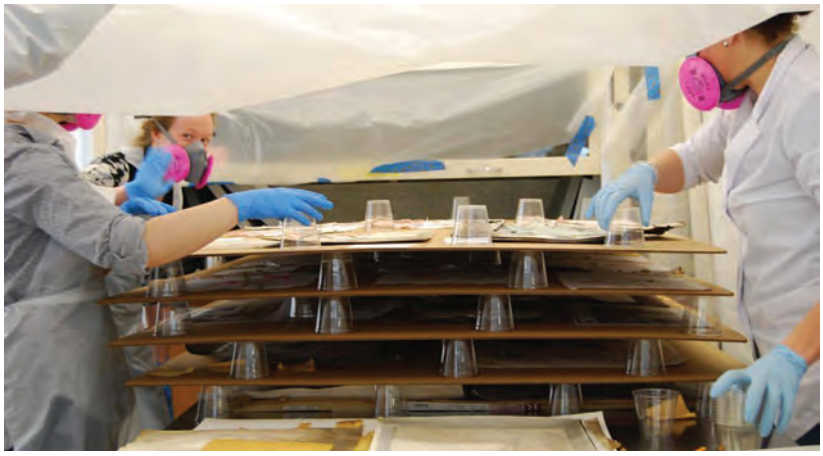
- **Security when transporting collection objects**
  - If collection objects are to be transported, they need to be recorded at the salvage site and recorded (checked against a list) at their destination by another employee.
  - High value priority objects may need to be accompanied during transporting and the security of the storage facility should be assessed before entrusting the collection objects to a third party.

7.5.2 Guidelines for dealing with residues after salvage

After an emergency event involving fire and/or water, different types of residues may be present on the collection and in the building. Possible residues include mould, soot, smoke odours, chemical residues and mud. Dealing with these residues safely and appropriately is essential for both the health of the responders and the collections.

- **Mould**

To minimise the danger of mould developing after a water emergency event:
  - Remove any objects that are not yet wet but are at risk of getting wet if left in their current position.
  - Ensure that there is no standing water on the floor or on top of cabinets or on shelving.
  - Remove wet collections and other wet materials from the space if possible.
  - Lower the temperature in the affected space to below 18°C. Most species of mould favour a higher temperature.
  - Ensure that the relative humidity in the space is below 60%. Most species of mould prefer more humid conditions.
  - Note that materials that retain large quantities of water will keep the relative humidity level in the space high, slowing down the drying process and they may carry mould within them or beneath them. If possible, move the collections out of areas where there are such materials or remove wet materials from the area where the collections are being treated.



Conservation staff drying mould-damaged materials - ***image from Benjamincarpenter - Own work, CC BY-SA 4.0 (https://commons.wikimedia.org/w/index.php?curid=63198099).***

- **Treating mould**
  - Consider freezing suitable collection objects that cannot be dried within 2–3 days; this will delay deterioration (but first find out whether this is appropriate for the specific type of material being dealt with – see points about freezing).
  - If mould does occur, physically separate affected collection objects into another space and isolate them. Keep them in a dry environment. If possible, have a sample of the mould identified by a mycologist, then take precautions as advised, based on the identification.
  - There are chemicals that may prevent the development of mould. For example, Thymol was tested by the Natural History Museum on wet pinned insects in drawers and found to be effective against mould. Such chemicals must be handled with appropriate care.
  - To treat collection objects infected with mould, soak the cotton swab in ethanol (70% or higher), then remove the excess ethanol by blotting it over tissue / paper towels, so as to not add too much moisture to the collection object. If working with feathers or other layered surfaces, it's recommended to cut tissue or paper towels or blotter paper into small strips and put them under the feathers to avoid more feathers getting wet. This can be done with mammal skins too as long as the hair is long enough. After applying the ethanol, go over the skin with some delicate tissue to absorb any remaining moisture.

Preventing mould from developing on wet bird specimens by placing paper towel cut into a small strip under feathers to avoid more feathers getting wet - *image by Mariana Di Giacomo, Natural History Conservator (with permission).*

- **Soot and fire residue**
  - If there is a fire, the ventilation systems should be shut down and internal doors closed to prevent the spread of smoke and soot, if this can be done without putting staff in any danger.

- Different processes create the mix of fire residue, but research is clear that most of the contaminants come from incomplete combustion of materials in the structures. Residue is easily disturbed and can spread through a building, even into areas that were not originally impacted by fire or smoke. It is very important to correctly and timeously remove soot and fire residue.

- **Working in the area with soot and fire residues**
  - Soot may contain hazardous substances, according to what burned and should not be treated simply as “dirt”. The deposited soot must be analysed, then precautions as advised by an industrial hygienist should be taken before any salvage can take place.
  - During any activity involving fire and soot residues, including initial cleaning, personal protective equipment (PPE) should be worn. It is recommended that the following are used by all staff involved in salvage activities: nitrile or rubber gloves, a properly fitted respirator or mask, safety goggles and disposable coveralls.
  - From a respiratory protection standpoint, disturbance of large quantities of soot can result in exposure to airborne toxic Polychlorinated Biphenyls (PCBs). It is recommended in such situations that supplied air or a powered air-purifying respirator should be used.
  - If highly toxic substances are present, it may be a requirement that qualified Hazmat professionals carry out the cleaning operation under the guidance of collections staff.
  - When clean-up operations have advanced to a point where airborne polychlorinated biphenyls (PCBs) can no longer be detected, air-purifying full face-piece respirators equipped with a high efficiency particulate air filter and organic vapour cartridge should be used as a precaution, until final decontamination is completed.
  - Once access to the space is permitted, external doors and windows should be opened to exhaust smoke (if there is still any). Use extractor fans and consider turning the HVAC system to 100% fresh air intake.

- **Salvaging collections exposed to soot and smoke**
  - Collections that have been exposed to a fire may be highly compromised. Damage caused by extremely high temperatures is irreversible and the appearance of collection objects may be altered, and they may be very fragile, especially if they are also wet.

- **Recommendations for soot removal**
  - Soot is so fine that it will get into every crack and onto every surface. Be prepared to clean everything that was exposed.
  - Get started as soon as possible; the longer soot stays on the surface, the harder it is to remove.
  - Some soot is acidic and can degrade collection objects and surfaces. If left on surfaces for even relatively short periods, soot can cause extensive corrosion, etching and discoloration. Prioritise cleaning sooty objects.
  - Work from most to less sooty collection objects, remembering not to touch them directly - handle as little as possible because handling ingrains the soot particles into the pores of the handler as well as the collection object, where applicable.

- Dry methods of soot removal are preferred to anything involving water or solvents.
- First, vacuum on site with a HEPA (High-Efficiency Particulate Air) vacuum cleaner using micro attachments and soft brushes.
- Follow the vacuuming with dry brushing, soot removal sponges, or kneaded erasers.

- **Odours**
  - Smoky odours will dissipate over time but can be reduced during the early stages of the recovery by the removal of the damaged collection objects and building materials. Using drying techniques also reduces the smoky odours.
  - The odour of mould can be prevented by quickly freezing the damaged (suitable) collections to prevent mould growth.
  - Plenty of fresh air circulation will help remove odours.

- **Mud**

Mud is a residue often associated with receding flood waters; as layers of residue dry, they will be deposited over the surface of storage equipment and possibly also collection objects. The composition of this water-borne sediment will vary according to its origins, and may contain toxic substances such as sewage, pathogens, pesticides, and other chemicals. Have a sample tested, before the clean-up begins. If the mud is toxic, take the precautions recommended by an industrial hygienist.

When mud is allowed to dry on collection objects, it becomes hard, and may be very difficult to remove without damaging the objects. Therefore, if you have time and resources immediately after an event, the following is recommended:

- If objects are wet and muddy and will tolerate the flow of water to remove mud, items may be gently rinsed. Use a series of three or four tubs of cool rinse water.
- Mud can be rinsed off wet books (journals, field notes, catalogue books) and fossils. Care should be taken to hold books closed so that the mud will not infiltrate the text block.
- If mud has dried, it may be possible to use a brush or vacuum cleaner to gently remove it. Use the vacuum cleaner with a plastic screen between the nozzle and the object to protect the object.

7.5.3 Drying a collection left wet by an emergency event

There are various ways in which a collection can be dried. In deciding which method to choose in a particular situation, there are some factors to be considered. Sometimes the wet collection can be frozen to buy time to respond and take a proper, well considered decision. This kind of freezing is not a drying method and does not kill bacteria or mould spores; however fungal and bacterial activity will be dormant when a collection is frozen, so there is no longer a need to rush into decisions. Once a wet collection is frozen, there is time to take advice, weigh options, and make thorough preparations for the drying and recovery stage. Some of the factors to consider when choosing a drying method are listed below:

- **Which method will yield the best results?** Some kinds of collection objects may be damaged if frozen or be thoroughly soaked such that they are impossible to air dry successfully.

- **What is the volume of collection objects to dry?** For an example, air drying requires a huge amount of space, a large supply of absorbent materials, and requires quite a lot of time and attention. This can be unrealistic if a large number of collection objects are involved. On the other hand, if the collection objects can be frozen, small numbers can be removed from the freezer and dried over time.
- Is there a **need for access to the collections during drying?** Some drying methods will necessitate restricting access for weeks or months on end.
  There are different collection drying techniques that can be used for collections.

- **Air drying**

Air drying is the most obvious and immediate way to dry almost any wet collection object. Air drying requires little or no special equipment, but it is space and labour-intensive because the used space should be outfitted with fans and dehumidifiers and wet objects are laid out on absorbent surfaces.

Air drying is therefore a suitable choice to dry small numbers of damp or slightly wet materials (fossils, books, bone and skulls, etc.), or for smaller objects. Skins, stuffed collection objects, and very large or very wet collection objects cannot be successfully air dried and are likely to become mouldy before drying out.

- **General procedures for air drying**
  - Set up a drying space of appropriate size with tables covered with absorbent materials – blotting paper, newsprint, towelling, etc.
  - Aim to have temperature and relative humidity as close as possible to "normal" room conditions. Introduce dehumidifiers and heaters as needed to achieve these conditions.
  - Ensure good air circulation. Try to pull dry air into the room with fans and push humid air out. Ensure that air currents are gentle so that they do not damage the collection objects or blow their labels off.
  - Spread wet items on tables with absorbent coverings. Gently blot off as much water as possible from the object's surface.
  - Change absorbent materials whenever they become significantly dampened.
  - For stuffed collection objects, remove stuffing materials that will slow air drying. If not feasible, consider another drying method.
  - Robust items such as documents and records (rather than collection objects) can be hung with clips on a laundry line or string to save space.

- Pros of air drying
  - The method is gentle and has no risk of over-drying.
  - It has low "out-of-pocket" cost as it uses an already existing space and requires simple equipment.
  - It is easy to monitor as collections stay at the institution.

- Cons of air drying
  - There is risk of mould developing.
  - This method is labour intensive.
  - It requires large spaces.
  - Rebinding of very wet books should be expected and expanded shelf-space will be needed.
  - Some materials cannot be successfully air dried.

- **Freezing a wet collection to buy time to respond**

For a dry preserved collection, the longer it stays wet after an emergency event, the more deformation and damage it will experience and the more likely it is to develop mould. This is true of all types of natural history collections, including bird and mammal skins, photographs and documents.

Mould develops in as little as 48-72 hours, depending on temperature. If a large number of collection objects become wet, it is unlikely that there will be time and space available to dry everything before there is a risk of mould developing. In this situation, it is recommended that freezing be considered in order to "buy time."

Small scale freezing can be carried out in a walk-in freezer or in an ordinary chest freezer. For larger quantities, freezer containers can be used to separate the collection objects, and space can be shared between institutions. For this, mobile cold rooms could be rented and used to freeze a collection and then take it, frozen, to another institution where it can be dried by various methods.

It is ideal for the freezing equipment to have the capacity to freeze very quickly. Fast freezing and low temperatures keep the ice crystals that form small, thereby reducing stress on the wet collection material. In practice, this means that items should be frozen with space around them rather than in a dense stack and that a blast freezer, if one is available, is the ideal choice.

There has been little well-documented research on the effect of freezing collections that have been wet, because almost all of our experience of freezing collection objects and artefacts either concerns dry objects which are being frozen for purposes of pest control or waterlogged archaeological materials. Natural science collection objects that have become wet in an emergency event are different from either of these. Risks and benefits should always be weighed when considering freezing any wet collection. A major mould outbreak in a collection is so serious that in some situations freezing these materials may be the better option and should be considered. As always, consult other people before making these decisions when in doubt.

- **General procedures for freezing**
  - Wet materials are fragile and easily damaged. They should be handled as little as possible.
  - In some cases, it may make sense to freeze whole storage drawers with collection objects left in situ. This method maintains order and identification, as well as minimising handling.
  - If objects are to be shipped in storage drawers, some sort of filler or padding can be placed in these to keep objects from slipping, and the entire drawer can be secured with bubble-wrap and then shrink-wrapped.
  - Since fast freezing promotes formation of smaller ice crystals, items should be frozen with space around them rather than in a dense stack.
  - Take care in upright or chest freezers to leave room around collection objects. Walk-in freezers may be equipped with shelving units, which make spacing easy.
  - It is not necessary to seal wet objects in plastic bags unless bagging will help to pad and protect them physically during their time in the freezer.

- Freezing should not be at a temperature below-40° C because this could damage the objects.

- **Benefits of freezing to buy time**
- Fungal and bacterial activity will become dormant when frozen.
- The necessity to dry objects before mould becomes established is relieved.
- Decisions on drying methods can be made with deliberation.
- Time must be allocated to prepare for the drying and recovery stages.

7.5.4 Documenting treatment and repairs to collection objects

Once collection objects have been secured, all treatments must be recorded with details of the specific objects treated. All repairs carried out must be documented with details of the specific objects' repairs. The outcomes or effects of the treatments or repairs should also be documented. For example, record how collection objects were dried and for how long, record any mould infections and how long after drying these were noted, and how they were treated. Ideally, this information should be included in the collection object inventory / database, as part of the information associated with each collection object. All records associated with salvage efforts must be retained permanently.

An assessment of collection objects will need to be carried out at some point during the salvage, treatment and repair process, in terms of whether any objects have been damaged beyond the point where they have any value. The decision-making process for this should be documented for future records and audits, and the de-accessioning processes detailed in Chapter 3 should be followed.

Further details on documentation relating to disasters and salvage are provided in Chapter 3.

APPENDICES

A7.1 Summary of documents related to Risk and Disaster Management

POLICY

- **Risk and disaster management policy,** which includes statements about managing and reducing risks to collections, assessing risks to collections, the frequency of assessments, monitoring these, mitigating where necessary and responsibilities. The policy should also include the approach to communicating the risks to the relevance governance structures, so that they are aware of the main risks, the status of these and the potential impact on the collections and the institution.

PROCEDURES

- **Procedure document for risk assessments, monitoring of risks, mitigation measures and monitoring of these.** This should include a check list of all the risks to be assessed, as well as details of what aspects to assess and how the assessment should be done (methodology), what mitigation measures to put in place in response to priority risks (e.g., standards for fire detection and suppression systems, security systems, hazardous materials storage, audits

of collection objects to check whether there has been loss through theft or misplacement), the roles and responsibilities, and the signatories for assessment outcomes, as well as the monitoring of the risk; including frequency of checks of the functioning and effectiveness of mitigation measures (servicing and checks of fire suppression systems, security systems, status of hazardous materials), roles and responsibilities. The procedure document should state that all records of mitigation measures and their monitoring must be recorded and filed. This would include inspections and servicing of fire detection and suppression systems, evacuation drills, emergency response training sessions etc.

- **Risk assessment document for collections.** Most institutions are required by their auditors to have a risk assessment that considers the likelihood of a risk actually happening and the severity of the impact if it did happen. This would be the output from implementing the risk assessment procedure.
- **Emergency response plans for the main risks,** that include response to a disaster, salvage actions, roles and responsibilities. There are several elements to such a plan, including a list of contacts for emergencies, a list of who will be involved in the emergency response and what their roles will be, a list of prioritised collections, a list of items that are needed for the emergency response cart, a list of service providers for assistance in an emergency, identification of temporary storage or triage areas, emergency evacuation procedures for various types of disaster, as well as routes for salvaging collection objects, and a training schedule. The plan should also include the steps to be taken in the case of objects lost through theft (see Chapter 7).
- **A pocket-sized version / summary of the critical points for dealing with an emergency** (see Chapter 7 of the manual for examples).
- **Workflows, procedures and standards for salvage of collection objects damaged by different types of disaster** (e.g., fire, flooding, building or shelving collapse). What should be done to different types of collection objects and by whom?

REGISTERS

- **Register for recording all disasters / emergency events** where collection objects were lost or damaged (may be hard copy or digital).
- **An inventory of all hazardous materials maintained in the institution,** including locations, quantities, date of purchase and expiry. Associated with the inventory, manufacturers sheet documenting all relevant information about the material, details of how to handle exposures to the hazardous materials, including details of service providers to contact for cleaning up of selected hazmat spills where this is required.
- **List of prioritised collections.**
- **List of items for the emergency response cart** (potentially one for each collection or area).

FORMS

- **Damage assessment and salvage form** for use when a collection or collection object is damaged.

A7.2 Example of a risk evaluation and control plan

Hazard / agent of deterioration	Common sources	Risk / typical effect	Existing controls	Suggested additional controls
Physical force	Incorrect handling. Incorrect or difficult storage equipment to work with. Transportation of CO and being in collision. Wind erosion of geological sites, excavations, construction works, armed conflict, overload, etc.	Collapse storage equipment. Deformation or breakage of CO. Abrasion, wear and tearing. Accumulation of ethanol vapours from poorly sealed containers. Loss of institutional knowledge.	Use of correct storage equipment, trained drivers involved in transporting collection objects, use of correct excavation tools, studying the field work area in advance and planning accordingly, conducting air monitoring.	Training on proper collection object handling, moving collections to stable buildings that are safe.
Criminals (thieves and vandals)	Political, ideological, economic motivation as most institutions are in Government buildings, collection visitors, etc.	Disappearance, destruction and disfiguration of collection objects.	Burglar guards. Security cameras. Biometric system. Security guards patrolling.	N/A
Fire	Lightning, veld fires, gas leaks, faulty electrical installations or equipment, smoking, candles, arson, construction and renovation works, etc.	Total or partial burning of wooden structures with collection objects. Collapse or deformation of structures. Partial or total damage of collection objects by heating. Soot deposition on collection objects reducing their scientific value. Smoke altering CO appearance. Building structural integrity could be severely damaged.	Have fire detection systems. Have a fire suppression system in place. Conduct regular training on fire prevention and response. Conduct regular evacuation procedures. Regular service and maintenance of firefighting equipment. First aid training. Store collections furthest from electrical pipes.	Conduct annual fire inspections. Regular fire inspections.
Water	Flash floods, heavy rain, ground water, burst water pipes, cleaning procedures, firefighting, etc.	Staining, weakening, and deformation of collection objects or structures. Dissolution of collection objects info. Corrosion of storage equipment. Weathering. Salt efflorescence.	Keep collections 30cm above ground. Use correct medium for firefighting. Follow correct cleaning procedures. Store collections furthest from water pipes.	Use waterproof material. Cover collection shelves / cabinets with waterproof material.
Pests	Local fauna (insects, rodents, birds, bats, etc.). Sources of food and nesting materials attract pests.	Staining of collection objects. Weakening and perforation of collection objects and structures, especially wooden. Loss of parts or whole collection objects. Destruction of collection objects. Pests can damage or destroy collection objects and even entire collections.	Use of appropriate pest management programme. Monitoring environmental conditions. Decontamination and isolation of incoming material. Good housekeeping. Conducting visual inspection. Maintenance of the building interior and exterior areas.	Exclusive use of collection storage area.

Hazard / agent of deterioration	Common sources	Risk / typical effect	Existing controls	Suggested additional controls
Pollutants	Industries, vehicles, construction and renovation works. Storage and display materials that emit gases. Restoration materials that contaminate the object, etc.	Discoloration, weakening, staining and or darkening. Corrosion. Obscuring delicate and important collection object features or information. Abrasive. Can attract pests. Removing dust can cause damage to fragile fossils and other collection objects.	Fume cabinets are used. Air monitoring equipment. Good housekeeping. Sealed cabinets. Use of appropriate PPEs (e.g., a dust mask, safety goggles).	Cabinet and shelf covers. Dust extraction units.
Light	Sun, electrical light sources (lamps).	Colour fading (primary effect of light). Yellowing and weakening of collection objects. Disintegration (primary effects of UV). Affects preservation adhesives. Discoloration of mounting boards impact on integrity of collection object.	Keep collections in dark storage areas. No collection objects left in direct sunlight or under any strong illumination. Block or cover windows with light-blocking curtains. Seal cabinets, and store collections as far as possible from windows.	New collection buildings to be built without windows. Seal off windows where possible.
Incorrect temperature (too high, too low, fluctuations).	Local climate. Sunlight entering through windows. Incandescent lamps used. Heaters used near collections.	Faster deterioration by chemical reactions. Deformation, dehydration, embrittlement, and / or softening of collection objects. Warm and damp environments are conducive to pest infestations.	Storage areas kept sealed off from external exposure. Cover windows to avoid fluctuations. Maintain recommended temperatures.	Data loggers in collection storage areas will enable better monitoring. Seal off windows where possible.
Incorrect relative humidity (too high, too low, fluctuations).	Local climate. Ground water. Inadequate air conditioning. micro-climates, etc.	Deformation, cracking, flaking, delamination and or weakening of collection objects. Corrosion. Mould growth. Staining. Accelerated failure of seals. Swelling and contracting of collection objects. Fire risk caused by increased static electric as RH decreases. Pyrite disease.	Conducting air monitoring. Maintain recommended temperatures.	Data-loggers (temp. and RH) in collection storage areas will enable better monitoring. Maintain RH between 45 and 55%.
Custodial neglect / dissociation	Lack of inventory. Poor documentation or identification. Misplacing collection objects. Hardware and software oldness. Staff resignation or retirement.	Loss of information about collection. Temporary loss or inability to access collection object or their data. Mixing up of samples.	Following best practices.	Development of workflows. Documenting all collection activities. Development of collection overviews. Keeping collection inventories.

A7.3 Example of a monitoring checklist for fire protection.

Similar checklists should be developed and used for checking on hazardous materials, building structures and any other hazards identified.

Fire protection checklist	Date of check	Name and designation of person responsible for check
		Yes / No/ Details
Fire Extinguishers	Number of fire extinguishers checked:	
	Are all mounted on metal hangers or contained in properly marked case?	
	Pressure gauge needle in the green and there are no signs of leakage around upper seals?	
	Inspection tag showing inspection within past twelve months	
Fire Exit Signs	There are a variety of signs to include reflective, lighted, or other technology that causes sign to be visible in low light conditions.	
	Signs should designate fire exit route and be posted in conspicuous manner, either above the door, or at side of door.	
Fire Exit Routes	Route should be clear of any obstructions, including furniture, empty boxes, or other material.	
	Temporary storage along fire exit routes is not acceptable.	
	Signs should be posted along exit routes, clearly showing direction to nearest fire exit.	
	Check to ensure signage is readable, not faded or otherwise damaged or neglected, thus becoming useless in an emergency.	
Smoke Detectors	Not all detectors are visible, some have blinking LCDs, and others do not.	
	Regularly observe detectors to determine if there is an accumulation of visible dirt, dust, sawdust, or other airborne elements. Pay special attention to detectors in workshop or construction areas.	
	It is recommended that detectors should display a blinking red light.	
Sprinkler System Main Valves	Control valves for water suppression systems should be identified and tagged with a current inspection tag.	
	Sprinkler valves should not be obstructed in any way.	
	The area should never be locked, it should be accessible at all times, with instructions on how to turn on or turn off the valves attached at eye level.	
Small Appliances	Coffee pots, floor heaters, fans, microwave, or any other small appliance should be unplugged after hours.	
	Timers on electrical appliances are not always reliable. appliances should be manually turned off.	
	Electrical appliances are the cause of many commercial fires.	

Fire protection checklist	Date of check	Name and designation of person responsible for check
Overloaded Outlets	Use of extension cords and multi-plug sockets to connect tools, office equipment, or other electrical appliances should be discouraged.	
	If sockets are hot, they should be unplugged immediately.	
Flammables	Fuel, cleaning products, paint, or anything marked “flammable” should be stored in a properly ventilated exclusive storage area and in a properly identified “flammable substance” storage container.	
	Small amounts of flammables for use, can be kept outside the exclusive storage.	
	Lawn mowers, generators, or other fuel-operated equipment should not be stored indoors unless in a remote area away from other storage, and with proper ventilation.	

A7.4. Examples of Pocket-sized Emergency Response and Salvage Plans

1. The Foundation for Advancement in Conservation’s Emergency Response and Salvage Wheel (reproduced with permission).

2. Example of a Pocket Response Plan, based on the original design by the Council of State Archivists (USA) and accessed through the WESTPAS (Western States and Territories Preservation Assistance Service) website (http://www.connectingtocollections.org/wp-content/uploads/2019/09/PReP-Samples.zip).

This example shows how all relevant information that will need to be accessed immediately after an emergency can be condensed into two sheets to allow

quick and easy access. It includes (1) channels of communication – immediate notification, (2) how to assess collection damage, (3) collection salvage priorities, and (4) how to handle water damage to objects. It can also have a plan of the buildings showing the location of collections and the priorities, the emergency cart and the temporary storage / triage areas.

Placer County (California) Museums Archives & Collections Facility

Archives and Collections Management Facility

Pocket Response Plan for Collections

Date revised: 10/24/2011

INSTITUTIONAL CONTACTS

Museums Administrator
Melanie Barton
Office -530-889-6504
Home phone
Cell-
email- mbarton@placer.ca.gov

Museums Program Manager
Ralph Gibson
Office - 889-6502
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Cell-
e-mail- rgibson@placer.ca.giv

Emergency Manager
Scott Mulic
Office
Work
After Hours

Financial Services / Accountant
Valerie Bayne
Office
e-mail

Facilities / Building Manager
Todd Pisarek
Office

Security
Sonitrol
Office

Environmental Health & Safety
Virginia Lineberry
Office

Janitorial Services
Jim Miller
Office

INSTITUTIONAL CONTACTS (con't)

Risk Manager
Maryellen Peters
Office

Insurance Contact / Agent
Jennifer Ludford
Office

Public Relations Officer
Robert Miller
Office

Information Technology Officer / IT
Dennis Christmon
Office

Curator of Collections
Kasia Woroniecka
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DISASTER TEAM

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home phone-
e-mail- dpoulsen@placer.ca.gov

Member 3
Jason Adair
Office - 889-7702 / home phone
/cell –
jadair@placer.ca.gov

BUILDING UTILTIES

Water – Fire Sprinklers
Placer Co. Water Agency
530-823-4850

Plumber
886-4966 day
886-6201 night

Electricity
PG&E 530-889-3190

Gas
PG&E 530-889-3190

Telephone
530-745-7735

Security System
Sonitrol 877-771-5407

FIRST RESPONDERS

Fire Department
9-911
(530) 889-0111

Emergency Medical / Ambulance
9-911

Police Department / Law Enforcement
9-911
530/889-7800

County Emergency Management
530/ 886-5300

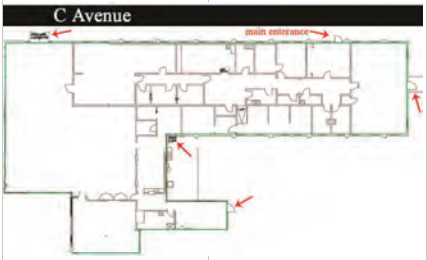
State Office of Emergency Services
916/845-8510 CalEMA

Health Department
530/ 886-1870

Red Cross
530/885-9392

FEMA
Disaster Assistance
800-621-FEMA
Environment & Historic Preservation-Region IX 510-627-7027

WESTPAS - 888-905-7737



EMERGENCY RECOVERY SERVICES

American Institute for Conservation
AIC-CERT:202-661-8068 24hr
AIC "Find a Conservator"
http://www.conservation-us.org
"Resource Center"
202-452-9545

Conservator Textiles
Margaret Geiss-Mooney
707/763-8694
meg@textileconservator.com

Conservator Photography/ Disaster Recovery
Thomas Portue
925/938-3900
tportue@yahoo.com

Conservator **Ethnographic/Decorative**
Jane Williams
510/643-1192x1
j.williams@berkeley.edu

Refrigerated Trucking Service
Ryder Truck Rental/ Rocklin
916/543-0835

Mobile Freezer Rental
1-800-379-4626

Commercial Recovery Service
There –to –Repair Auburn Water Damage
1-866-871-6839

Data Recovery Service
Dennis Christmon
889-4959

Industrial Hygienist / Mold Testing Lab
Environmental Services/Carmichael
916/993-1001

Exterminator / Fumigation Service
PCM Office: Mary Jane Coon 889-6500

Structural Architect
Building Maintenance
Service Desk – 886-4966

REGIONAL CONTACTS

California Preservation Program
Julie Page/Barclay Ogden
888-905-7737 (emergencies)
info@calpreservation.org
www.calpreservation.org

Balboa Art Conservation Center
WRFSO Kara West
619-236-9702
wrfso@bacc.org, www.bacc.org

CA Office of Historic Preservation
General Information 916-653-6624

California Association of Museums
831-471-9970

California State Library
State Librarian's Office 916-654-0174

California State Archives
General Information 916-653-7715

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Office – 889-7705, Home and cell
Tom Reinke
Office – 889-7702, Home -
cell –
Karen Mattson
Office – 889-6506, Home –
, cell-
Leith Sorenson
Office – 889-7716, Home
, cell:
Debbie Poulsen
Office- , Home

SIDE A. All relevant contact details and the floor plan.

Placer County (California) Museums Archives & Collections Facility

Immediate Response and Checklist for Collections Recovery

IMMEDIATE RESPONSE

Notification (as appropriate):

- First Responders
  - Ensure that all staff and visitors are safe and accounted for
  - Maintain security of building and collections
- Institutional Contacts
- Building Utilities
- If shared facility, make contact
- Activate the Disaster Plan's emergency response actions
- Activate the Disaster Team if collection damage
- Follow other Communication steps

WATER RESPONSE

- Stop the source, remove standing water
- Cover collections with plastic sheeting
- Remove materials from water path. Move collections higher on shelves or onto tables/book trucks

ASSESSMENT

Ensure through proper authorities that all hazards are cleared before entering building

- Health & safety first; protect staff
- Document with photos, videos, notes
- Assess damage to collections, building, information systems
  - What type of an emergency was it (fire, smoke, chemical, clean water, dirty water, heat, humidity)?
  - What areas are affected?
  - How much of the collection is damaged?
  - What types of materials are damaged?
  - Are critical information systems functional / safe?

WATER RESPONSE

- Identify materials needing immediate salvage action (coated paper, leather bindings, unstable inks, artwork, film, etc.)
- Stabilize the environment (cool, dry, circulating air optimal)

COMMUNICATION

Establish and maintain channels of communication

- Establish communication with appropriate local & regional emergency management
- Communicate with staff using the Phone Tree
- Contact risk manager and insurance agent
- Contact the public relations officer
- Contact CPP, Regional Contacts, conservators
- Contact outside Emergency Recovery Services
- Confirm funding sources for emergency services as needed
- Contact regional libraries to ensure continued services to constituents
- Report status to administration and public
- Post emergency information and instructions on the institutional website
- Obtain appropriate permissions to begin salvage (public safety, public health, structural engineer)

WATER RESPONSE

- Quick response is essential to prevent mold growth and irreversible damage to collections
- Obtain refrigerated trucks, freezer storage

COLLECTION SALVAGE

Salvage collections using pre-established Collection Priorities, taking into account access & extent of damage

- Identify and gather emergency supplies
- Identify secure, dry location for pack-out and air-drying
- Recruit staff / volunteers
- Wear appropriate safety protection
- Start collection salvage guided by Disaster Plan and collection response protocols, including Collection Priorities

WATER RESPONSE

- Organize staff / volunteers to load priority materials into freezer based on material type
- Organize staff / volunteers to air-dry materials that should not be frozen

DON'T PANIC!

COLLECTION PRIORITIES

First Priority Collections:

CMF :

Pate Collection (Room C and cabinets AA, BB, CC, DD, EE, GG and HH)

Archives:

Bins 411, 410, 399.
Lapp Collection Bins 387A and 386A,

Second Priority Collections:

CMF:

Chinese collection (cabinet RR)

Archives:

Assessor's Maps
Maps in rear map room

Files/Equipment:

CMF:

Accession Registers (7)

Donor files (metal cabinets)

Archives:

Accession registers

Other:

CMF: Object and donor index cards (next to cabinet MM)

MAJOR DISASTERS: INCIDENT COMMAND SYSTEM

ICS authority structure:

- Incident Commander: Responsible for overall management of the incident
- Public Information Officer: Responsible for communication with media/public
- Safety Officer: Monitors safety of the incident in regards to both the facility and the responders
- Liaison Officer: Coordinates with representatives of cooperating agencies
- Planning Section Chief: Prepares Incident Action Plan (IAP) to respond to the event
- Operations Section Chief: Ensures that the IAP is enacted
- Logistics Section Chief: Responsible for all support needs to enact the IAP
- Finance/Administration Section Chief: Manages all financial aspects of the incident

SITUATION REPORT

Know these answers when speaking with insurance and Emergency Response
–Who is in charge?
–What is the safety status?
–What has happened and the cause?
–What are the hazards?
–Who discovered and reported the damage?
–What has been done so far?
–Can the staff handle the situation initially?
–Is relocation of some/all of the collection required?
–Who is handling the media?

Side B: This side is used to provide step-by-step instructions for staff who will respond to an emergency affecting their institution.

Note that this document is not intended to replace the comprehensive emergency plan, but it can be developed quickly and relatively simply. This approach is widely used in collections in the USA.

A7.5. Example of a contact list for the emergency response team, as well as other professional assistance and maintenance services.

These contact lists should always be visibly displayed in institutions. All staff should know where they are located. They should be verified every six months to make sure that the institution has the latest numbers, or as often as emergency event drills or maintenance are held.

INSTITUTION NAME		INSTITUTION LOGO
CONTACT LIST FOR EMERGENCY RESPONSE TEAM		DATE COMPILED
Name and Last Name	Emergency Response Role	Contact Information
Usisipho Madinda	Preparedness Manager (EPM)	Cell: 082 100 3000 Office: (012) 843 1000 u.madinda@nscf.co.za
Zama Mwelase		Cell: 081 100 3000 Office: (012) 843 1002 z.mwelase@nscf.co.za
Mkhipheni Ngwenya		Cell: 083 100 3000 Office: (012) 843 1007 m.ngwenya@nscf.co.za
Zwai Dwani		Cell: 084 100 3007 Office: (012) 843 1080 z.dwani@nscf.co.za
Aisha Mayekiso		Cell: 089 100 3000 Office: (012) 843 1008 a.mayekiso@nscf.co.za
Velaphi Bellingan		Cell: 088 100 3002 Office: (012) 843 1005 v.bellingan@nscf.co.za
Christina Curry		Cell: 082 100 9009 Office: (012) 843 100 1020 c.curry@nscf.co.za
Jurie du Plessis		Cell: 084 200 1000 Office: (012) 843 1021 j.duplessis@nscf.co.za
Sifiso Bews	Recovery Team Leaders (RTLs)	Cell: 089 900 1212 Office: (012) 843 1018 s.bews@nscf.co.za
Roger Bills		Cell: 074 990 1201 Office: (012) 843 1500 r.bills@nscf.co.za
Laz Kgasi		Cell: 055 800 4000 Office: (012) 843 1234 l.kgasi@nscf.co.za
OTIS Elevator	Maintenance Manager Justin Cook	(012) 1610021 0860 123 6007/8/9 help@otis.co.za
Contractor Unit Fans	Luft Industries Joseph Muller	(031) 579 3999 082 962 0087 service@luft.co.za

Smoke Detection	Falcon Fire Sharon Smith	072 972 4704 060 756 9789 smoke@falconfire.co.za
Name and Last Name	**Emergency Response Role**	**Contact Information**
Fire Alarm Monitoring	Falcon Fire Sharon Smith	072 972 4704 060 756 9789 smoke@falconfire.co.za
Suppression System	Falcon Fire Sanele Ngidi	072 972 4704 060 756 9789 suppression@falconfire.co.za
Fire Sprinklers	Falcon Fire Jabulani Nkosi	072 972 4704 060 756 9789 sprinkler@falconfire.co.za
Fire Extinguishers	Falcon Fire Faith Smith	072 972 4704 060 756 9789 extinguisher@falconfire.co.za
Tshwane (Toll-free)	All services	080 111 1556 info@tshwane.gov.za
Emergency Services	Fire and Ambulance	(012) 358 6300/6400 or 107
Environmental Health Services		(012) 358 4656 (012) 358 2111 after hours

A7.6 Example of a list of emergency supply cart contents

Note that this is only an example and the contents will be specific for each collection, based on the collection type and the risk assessment. The information supplied for the emergency cart below is for a flood emergency.
The number of supplies to keep will depend on the size of collection as well as other factors that are institution specific. It is recommended that the emergency carts are filled with contents for use by two people. For very large collections it may be necessary to have additional carts, rather than having a single cart with materials for a large number of people.

INSTITUTION NAME		**INSTITUTION LOGO**
EMERGENCY CART CONTENTS		
COMPILED BY:	**DATE COMPILED:**	
CATEGORY	**SPECIFIC ITEMS**	**QUANTITY**
• **Personal protection equipment (PPE) for Response Team**	Tyvek protection hooded suits (in different sizes) Goggles for dust and liquids Hi-visibility vests (you may work well into hours of reduced visibility) Disposable aprons (a pack) Dust masks for fine toxic dust and aqueous mists Tough rubber / neoprene gloves (in different sizes)	
• **Clean-up items**	Mop with high water absorption capability Broom with handle Bucket with wringer Heavy duty rubbish bin or refuse bags (plenty) High absorbing sponges Dust and brush Smoke sponges Absorbent cloths (pack) Cloths (micro fibre)	

• **Preparing emergency survey**	Clipboard with lined pad Waterproof notebook Permanent marker pens, pencils Waterproof labels (pack as available in the market) Accident camera kit	
CATEGORY	**SPECIFIC ITEMS**	**QUANTITY**
• **Illumination**	Torch Head lamp (leaves your hands free) Spare batteries for torch and head lamp Electrical extension cord	
• **Deflecting and absorbing water**	Absorbent sheet Absorbent strips Absorbent water barricade cushions	
• **Other useful items**	Instructions for use of the emergency cart and a copy of the collection emergency plan if one exists Laminated / waterproof institution phonebook with important numbers Red and white barrier tape Utility knife String to tie up electrical cords, keeping them out of water Duct-tape Pair of scissors Plastic bags and flattened easy-to-assemble boxes Collection object tags (various sizes)	

A7.7 Example of a list of prioritised collections

Which collections are prioritised will depend on what collection objects an institution keeps. The inventory list is very useful in the exercise of compiling a priority list. If none exists, going through the collection itself will be the only other way of prioritising your collection.

INSTITUTION NAME			**INSTITUTION LOGO**
LIST OF PRIORITITISED COLLECTIONS FOR USE IN CASE OF DISASTER			
COMPILED BY:		**DATE COMPILED:**	
Priority No.	**Priority collection / specimens**	**Location**	**Reason for prioritisation**
1	*Loxodonta africana;* Cabinet 2, has type material (2 x tusks)	Main building, Mammal Collection Store 7; Cabinet 2	Holotype collection object stored here
2	TMSA000080, Mrs Ples – 1 x skull	Main building, Broom room, D8, Cabinet 4, Drawer 2	Hominid fossil skull, globally significant
3	PRE102 *Encephalartos altensteinii;* Cabinet 2 (1 x herbarium sheet)	Herbarium building, Second floor, Wing D. Row E	Rare cycad collection object. One of 5 known in Africa
4	NMSA0002310 Salticidae spiders, marked KZN Museum (24 vials)	Collection building, Arachnida storeroom, Shelf unit AC, Shelf number 6, Last shelf of Salticidae	Loaned material from another institution
CAUTION	Collection objects tested positive for arsenic and haven't yet been treated.	GE collection storeroom C4, Cabinet 20, Rows 1 – 4	Contains hazardous chemical and not safe to handle.

A7.8 Damage assessment and salvage form

This form is to be used during/after an emergency event to assess damage caused to the collections, track objects during salvage efforts and record treatment method.

DAMAGE ASSESSMENT AND SALVAGE FORM **INSTITUTION LOGO**

Collection type: _____
Collection location: _____
Floor No.: _____ Room No.: _____
Cabinet and row No.: _____ Shelf / drawer No.: _____
Accession No.: _____ Catalogue No.: _____
If missing/unreadable, assign alternate number for tracking purposes: _____
Explain how alternate number/s is assigned: _____
_____
Condition of collection object: _____
_____
Describe damage: _____
_____
_____
Details of images of damage (note whether objects were imaged, who did this, with which camera, and whether images have been lodged / downloaded and if so, where): _____
_____
_____
_____
If collection object is broken (but usable), number of pieces:_____
Person conducting damage assessment: _____
Position held: _____ Signature: _____
Date of incident: _____ Date of damage assessment: _____
Salvage method used: ☐ Freeze ☐ Air Dry ☐ Other
_____
Triage destination: _____
Floor No.: _____ Room No.: _____
Packed in: ☐ Box ☐ Crate ☐ Tray ☐ Other
_____
Packer: _____ Signature: _____
Date of incident: _____

Details of images of damage (note whether objects were imaged, who did this, with which camera, and whether images have been lodged / downloaded and if so, where): _____
_____
_____
_____
If collection object is broken (but usable), number of pieces:_____
Person conducting damage assessment: _____
Position held: _____ Signature: _____
Date of incident: _____ Date of damage assessment: _____
Salvage method used: ☐ Freeze ☐ Air Dry ☐ Other
_____
Triage destination: _____
Floor No.: _____ Room No.: _____
Packed in: ☐ Box ☐ Crate ☐ Tray ☐ Other
_____
Packer: _____ Signature: _____
Date of incident: _____

A7.9 Example of a document recording salvaged collection objects.

Unique identifying No.	CO Description/s	Floor and room recovered from?	Treatment required? Where?	Returned from treatment?	Packed?	Crate? Box? Ref No.	Where Stored?
TM9224	One lion skull	Ground Floor Room 2	No	NA	Yes	Crate 1	Technical Department Storeroom
Box 14	Drawer of pinned collection – cicadas. All cat numbers intact.	Ground Floor Room 4	No	NA	Yes	Box 14	Old boardroom
Box 36	Mammal skulls	First Floor Room 12	Yes, CO are wet, and labels need fastening	Yes	Yes, all skulls wiped and individually wrapped.	Box 36, has 9 mammal skulls	East wing lab for air drying
PRE564	Lichen in two separate boxes	Basement Room 9	Yes, lichen broken into fragments	Yes	Yes, CO boxes put in blue crate	Blue crate number 2	Registrar's office

CHAPTER 8: HEALTH AND SAFETY IN THE COLLECTIONS

8.1 Background

This chapter focuses on specific issues related to health and safety risks to staff / users of the collections. **The Occupational Health and Safety Act (OHSA) 1993** and associated regulations are legal requirements for institutions, and non-compliance can result in the shutdown of the institution by the Department of Labour, or if there is an injury or fatality and the legal requirements have not been met, the Chief Executive Officer may be liable for prosecution. However, the main purpose of this chapter is not simply compliance, but to ensure that staff and visitors to collections are protected from injury and ill health, resulting from their work.

The Occupational Health and Safety Act (OHSA) of 1993 and its Regulations visibly displayed in an institution as required by the Act - *image provided by ARC.*

As a minimum, the basic steps that are essential for all institutions are:

- Decide who will be responsible for Health and Safety (if there is no specific appointment for this role) and make sure that health and safety officers and a health and safety committee are established and carry out their duties.
- Prepare a health and safety policy.
- Do a risk assessment to identify hazards in the workplace and assess their likelihood and potential impact.
- Consult and involve staff in all processes.
- Provide information, including signage and training.
- Make sure that the right facilities for health and safety are available.
- Ensure that there are first aid kits, staff trained in first aid and appointed as first aid officers.
- Report accidents and illness related to work activities.

8.2. What the OHSA says

(Note that not all sections of the Act have been repeated below):

Section 7: A written **health and safety policy** must be prominently displayed in the workplace. This policy must describe the organisation; convey how the health and safety policy will be carried out and reviewed and contain guidelines concerning the contents of the health and safety policy concerned.

Section 8 includes the following requirements:

1. Every employer shall provide and maintain, as far as is reasonably practicable, a working environment that is safe and without risk to the health of his employees.
2. Without derogating from the generality of an employer's duties under subsection (1), the matters to which those duties refer include in particular:

(a) the provision and maintenance of **systems of work**, plant and machinery that, as far as is reasonably practicable, **are safe and without risks to health**;

(b) taking such steps as may be reasonably practicable to **eliminate or mitigate any hazard or potential hazard to the safety or health of employees, before resorting to personal protective equipment;**

(c) making arrangements for ensuring, as far as is reasonably practicable, the safety and absence of risks to health in connection with the production, processing, use, handling, storage or transport of articles or substances;

(d) establishing, as far as is reasonably practicable, **what hazards to the health or safety of persons are attached to any work** which is performed, any article or substance which is produced, processed, used, handled, stored or transported and any plant or machinery which is used in his business, and he shall, as far as is reasonably practicable, further **establish what precautionary measures should be taken** with respect to such work, article, substance, plant or machinery, in order to protect the health and safety of persons, and he shall **provide the necessary means to apply such precautionary measures;**

(e) **providing such information, instructions, training and supervision** as may be necessary to ensure, as far as is reasonably practicable, the health and safety at work of his employees;

(f) as far as is reasonably practicable, not permitting any employee to do any work or to produce, process, use, handle, store or transport any article or substance or to operate any plant or machinery, unless the precautionary measures contemplated in paragraphs (b) and (d), or any other precautionary measures which may be prescribed, have been taken;

(g) enforcing such measures as may be necessary in the interest of health and safety.

Health and safety devices for working with formalin preserved collections. The green and orange devices worn by the technician and shown separately are for monitoring chemical vapours in the collections at SAIAB, while the exhaust unit extracts odours and fumes - *images provided by SAIAB.*

Section 12 requires the following:

1. Subject to such arrangements as may be prescribed, every employer whose employees undertake listed work or are liable to be exposed to the hazards emanating from listed work, shall, after consultation with the health and safety committee established for that workplace:

   (a) **identify the hazards and evaluate the risks** associated with such work constituting a hazard to the health of such employees, **and the steps that need to be taken to comply with the provisions of this Act;**

   (b) as far as is reasonably practicable, **prevent the exposure of such employees to the hazards concerned or, where prevention is not reasonably practicable, minimize such exposure;** and

(c) having regard to the nature of the risks associated with such work and the level of exposure of such employees to the hazards, **carry out an occupational hygiene programme and biological monitoring, and subject such employees to medical surveillance.**

2. Every employer contemplated in subsection (1) shall **keep the health and safety representatives designated for their workplaces or sections of the workplaces, informed of the actions** taken under subsection (1) in their respective workplaces or sections thereof and of the results of such actions; provided that individual results of biological monitoring and medical surveillance relating to the work of the employee, shall only be with the written consent of such employee be made available to any person other than an inspector, the employer or the employee concerned.

Section 13. Duty to inform (1) Without derogating from any specific duty imposed on an employer by this Act, every employer shall:

(a) as far as is reasonably practicable, **cause every employee to be made conversant with the hazards to his health and safety attached to any work** which he has to perform, any article or substance which he has to produce, process, use, handle, store or transport and any plant or machinery which he is required or permitted to use, as well as with the precautionary measures which should be taken and observed with respect to those hazards; and

(b) **inform a health and safety representative as soon as reasonably practicable of the occurrence of an incident in the workplace** or section of the workplace for which such representative has been designated.

Section 14: General duties of employees at work (1) Every employee shall at work:

(a) take reasonable care for the health and safety of himself and of other persons who may be affected by his acts or omissions;

(b) as regards any duty or requirement imposed on his employer or any other person by this Act, co-operate with such employer or person to enable that duty or requirement to be performed or complied with;

(c) carry out any lawful order given to him and obey the health and safety rules and procedures laid down by his employer or by anyone authorized thereto by his employer, in the interest of health or safety;

(d) if any situation which is unsafe or unhealthy comes to his attention, as soon as practicable report such situation to his employer or to the health and safety representative for his workplace or section thereof, as the case may be, who shall report it to the employer; and

(e) if he is involved in any incident which may affect his health or which has caused an injury to himself, report such incident to his employer or to anyone authorized thereto by the employer, or to his health and safety representative, as soon as practicable but not later than the end of the particular shift during which the incident occurred, unless the circumstances were such that the reporting of the incident was not possible, in which case he shall report the incident as soon as practicable thereafter.

Section 16. Chief executive officer charged with certain duties

1. Every chief executive officer shall as far as is reasonably practicable ensure that the duties of his employer as contemplated in this Act, are properly discharged.
2. Without derogating from his responsibility or liability in terms of subsection (1), a chief executive officer may assign any duty contemplated in the said subsection, to any person under his control, which person shall act subject to the control and directions of the chief executive officer.

Section 17. Health and safety representatives

Subject to the provisions of subsection (2) every employer who has more than 20 employees in his employment at any workplace, shall, within four months after the commencement of this Act or after commencing business, or from such time as the number of employees exceeds 20, as the case may be, **designate in writing for a specified period health and safety representatives for such workplace, or for different sections thereof.**

Section 18. Functions of health and safety representatives

1. A health and safety representative may perform the following functions in respect of the workplace or section of the workplace for which he has been designated, namely:
   (a) review the effectiveness of health and safety measures;
   (b) identify potential hazards and potential major incidents at the workplace;
   (c) in collaboration with his employer, examine the causes of incidents at the workplace;
   (d) investigate complaints by any employee relating to that employee's health or safety at work;
   (e) make representations to the employer or a health and safety committee on matters arising from paragraphs (a), (b), (c) or (d), or where such representations are unsuccessful, to an inspector;
   (f) make representations to the employer on general matters affecting the health or safety of the employees at the workplace;
   (g) inspect the workplace, including any article, substance, plant, machinery or health and safety equipment at that workplace with a view to, the health and safety of employees, at such intervals as may be agreed upon with the employer: Provided that the health and safety representative shall give reasonable notice of his intention to carry out such an inspection to the employer, who may be present during the inspection;
   (h) participate in consultations with inspectors at the workplace and accompany inspectors on inspections of the workplace;
   (i) receive information from inspectors as contemplated in section 36; and
   (j) in his capacity as a health and safety representative attend meetings of the health and safety committee of which he is a member, in connection with any of the above functions.

Section 19. Health and safety committees

1. An employer shall in respect of each workplace where two or more health and safety representatives have been designated, **establish one or more health and safety committees and, at every meeting of such a committee as contemplated in subsection (4), consult with the committee with a view to**

initiating, developing, promoting, maintaining and reviewing measures to ensure the health and safety of his employees at work.

2. The persons nominated by an employer on a health and safety committee shall be designated in writing by the employer for such period as may be determined by him, while the health and safety representatives shall be members of the committee for the period of their designation, in terms of section 17 (1).
3. A health and safety committee shall hold meetings as often as may be necessary, but at least **once every three months**, at a time and place determined by the committee; provided that an inspector may by notice in writing direct the members of a health and safety committee to hold a meeting at a time and place determined by him: Provided further that, if more than 10 percent of the employees at a specific workplace has handed a written request to an inspector, the inspector may by written notice direct that such a meeting be held.

Section 20. Functions of health and safety committees

1. A health and safety committee-
   (a) may make recommendations to the employer or, where the recommendations fail to resolve the matter, to an inspector regarding any matter affecting the health or safety of persons at the workplace or any section thereof, for which such committee has been established;
   (b) shall discuss any incident at the workplace or section thereof in which or in consequence of which any person was injured, became ill or died, and may in writing report on the incident to an inspector; and
   (c) shall perform such other functions as may be prescribed.
2. A health and safety committee shall keep record of each recommendation made to an employer in terms of subsection (1) (a) and of any report made to an inspector in terms of subsection (1) (b).

Section 24. Report to inspector regarding certain incidents

1. Each incident occurring at work or arising out of or in connection with the activities of persons at work, or in connection with the use of plant or machinery, in which, or in consequence of which-
   (a) any person dies, becomes unconscious, suffers the loss of a limb or part of a limb or is otherwise injured or becomes ill to such a degree that he is likely either to die or to suffer a permanent physical defect or likely to be unable for a period of at least 14 days either to work or to continue with the activity for which he was employed or is usually employed:
   (b) a major incident occurred; or
   (c) the health or safety of any person was endangered and where-
      (i) a dangerous substance was spilled;
      (ii) the uncontrolled release of any substance under pressure took place;
      (iii) machinery or any part thereof fractured or failed resulting in flying, falling or uncontrolled moving objects; or
      (iv) machinery ran out of control, shall, within the prescribed period and in the prescribed manner, be reported to an inspector by the employer or the user of the plant or machinery concerned, as the case may be.

In the event of an incident in which a person died or was injured to such an extent that he is likely to die or suffered the loss of a limb or part of a limb, no person shall without the consent of an inspector disturb the site at which the incident occurred or remove any article or substance involved in the incident therefrom: Provided that such action may be taken as is necessary to prevent a further incident, to remove the injured or dead, or to rescue persons from danger.

8.2.1 The Department of Labour

Note that the OHS Act is enforced by the Department of Labour, whose inspectors may:

- Enter any workplace without prior notice.
- Request any document.
- Inspect any condition, process, plant or article.
- Take samples or seize any article.
- Question or summon any person within the workplace.

8.2.2 OHS Regulations relevant to collections

Relevant OHS Regulations that should be consulted include:

- General Administrative Regulations, 2003.
- Environmental Regulations for Workplaces, 1987.
- Diving Regulations, 2010 (relevant if diving is required to collect collection objects).
- General Safety Regulations, 1986.
- Hazardous Biological Materials Regulations, 2001.
- Hazardous Chemical Substances Regulations, 1995, amended 2003.

8.3 General Health and Safety Guideline Statements

In order to comply with the Occupational Health and Safety Act (1993), the following are required (this may not include every requirement, and managers are advised to read the entire Act, or consult with OHS specialists):

- Institutions must have a carefully thought-out Health and Safety Policy which is displayed in a readily accessible area in the workplace. This must be reviewed and updated regularly.
- Institutions must conduct assessments of the risks in order to identify those specific to their environment and decide what precautions are needed to mitigate and manage all such risks.
- Institutions are required by law to take all reasonable actions required to prevent or limit the chances of accidents happening or staff health being negatively impacted by their working conditions and activities.
- Monitoring and surveillance of risks and impacts on health must be carried out according to legal requirements, particularly for listed activities, which include working with hazardous substances.
- Staff must be informed and updated on a regular basis of the risks, monitoring and mitigation actions and outcomes (as far as is accepted by the Act), and of all incidents that have occurred.
- Staff must be appropriately trained to work with hazardous materials and to deal with the risks identified in their workplace. Visitors, students and volunteers

working in the collections must be briefed on all relevant risks and mitigation measures required.

- Employees must take responsibility for ensuring that they are aware of and understand the risks and mitigation measures relevant to their work, for their own health and safety, and for those whose health and safety may be compromised by their actions, for complying with any instructions relating to health and safety, for reporting any situation which they consider to be unhealthy or unsafe, and for reporting any incidents related to their health or safety.
- A Health and Safety Committee must be established and must meet at least every three months, and the meeting must be documented. There must be a Health and Safety Officer for every 20 staff members, and these Officers must be members of the H & S Committee.
- The H & S Committee and the Health and Safety Officers must carry out their duties as specified by the Act.
- All qualifying incidents must be reported to the Department of Labour, as required by the Act.
- All incidents must be investigated and reviewed, and measures put in place to avoid the same type of incident reoccurring.
- All health and safety related assessments, plans, training and incidents must be documented and kept on file (see Appendix A8.2 for an example of an incident report template), with medical surveillance records being retained for at least 30 years, and other monitoring results for at least three years.

Additional points:

- Assessments are required on a regular basis to monitor control measures and any change in status of risks. New equipment and processes will need to be considered, accident records reviewed, and the suitability of previously selected PPE re-evaluated.
- Every institution should have an emergency preparedness plan. This is a written document which sets out the procedures to be followed in an emergency event. Its general contents will be known to all staff through prior discussion and through regular training sessions and emergency exercises. Information on emergency response plans is provided in Chapter 7.
- Staff and visitor awareness and understanding of risks and mitigation measures, as well as emergency roles, responsibilities and actions are critical for effective health and safety implementation in the institution. Institutions must mark potentially dangerous chemicals and display appropriate signage relating to risks and emergency procedures.

8.4 Health and Safety Risks to Staff Working in Collections

Safety risks:

- Flammable liquids / chemicals / other materials
- Fire
- Breaking of bottles / containers and glass injuries
- Slipping and falling on floors which may be created by slippery surfaces or liquid spills
- Falling from ladders when accessing high shelving
- Injury from collapsing structures or heavy collection objects falling
- Injury from lifting and moving heavy objects

- Armed robberies / violent crime in the workplace or during collecting trips
- Vehicle accidents or incidents during collecting trips
- Various weather-related risks associated with field work

Health risks:
- Exposure to toxins used for pest control
- Exposure to toxic preservatives
- Exposure to toxic plants
- Working in storage / preparation areas where there may be large amounts of dust and/or vapours
- Exposure to disease from animals and associated parasites and micro-organisms during collection / handling or to toxins from plants
- Health related risks associated with field work.

8.5 Health and Safety Risk Assessment (identification of hazards and risks)

- Each institution must carry out a thorough assessment of health and safety risks associated with their collections, with all relevant details documented. Staff must be involved in this process.
- A risk assessment specifically related to field work carried out to collect collection objects / material for the collections should also be carried out.
- The following section includes an overview of the main health and safety risks that may be present in collections or while doing field work that should be considered in an assessment.

8.5.1 Chemical preservatives and pesticides

- Collections themselves can be a hazard when they have been treated with a hazardous substance (preservative or pesticide). Acquired hazards result from the application of a wide variety of chemical pesticides and preservatives for pest control and conservative treatment. Past cleaning and pest control methods were rarely documented; therefore, the assumption must be that some chemicals have been used on most collection objects. In addition to the risk of poisoning from handling collection objects, pesticides and other chemicals used on collections during fumigation or treatment can increase flammability and combustibility, and release vapours. Appendix A8.3 provides details of the health and safety risks associated with chemicals commonly used in natural science collections (ethanol, propanol, formalin and sulphuric acid).
- Exposure to chemical agents previously used as pesticides or preservatives on natural history collections may have included arsenic, DDT, methyl bromide, mercuric chloride and naphthalene. Many of the substances previously used left behind known residual contaminants that are poisonous and possibly carcinogenic (see Appendix A8.4).
- Several chemicals commonly used for research or during collection (e.g., ethyl acetate, cyanide) are suspected carcinogens or toxins.
- The composition of dust in the collections or generated while preparing fossils may not always be known and may pose health risks.
- There may also be unknown chemical interactions between the chemical agents used with the collection object itself that produces hazardous contaminants.

- Exposure can occur by inhalation, ingestion or absorption through the skin, but inhalation is usually the main route of entry into the body.
- Inhalation is likely to occur by breathing in fumes of fluid preservatives or gases from off-gassing minerals.
- In addition to handling collection objects, handling and/or using objects made from hazardous materials is an additional risk (e.g., thermometers have mercury compounds; if they break exposure to mercury salts is harmful).

8.5.2. Overexposure

- Over a period of time, a person may be exposed to extreme heat or cold or hazardous substances such as ethanol or formalin vapours, silica gel or dust.
- Heat stroke and dehydration are major risks during field work in summer, but exposure to extreme cold is also a potential risk in some areas and during some months.

8.5.3. Physical injury

- Fall-to-surface injury, which happens when a person slips or trips and falls to the surface he/she is standing or walking on, or when falling from a ladder while trying to reach collections located on the top shelves of the cabinets can cause severe injuries.
- Physical hazards ranging from sharp edges, heavy weights, unstable storage structures and pointy ends in the collections are a risk to collection staff.

8.5.4. Fire risk

- Fire in the collection storage area is a high risk to the staff who work in the collection or nearby offices. Fire can result in the death or injury of staff or visitors.
- Fire suppression systems may release materials that have a negative impact on the health of staff.
- Fire may also be a risk during field work in some areas and habitats.

8.5.5. Crime including violent robberies and assault

- Poorly secured buildings or collection areas expose staff working in these areas to potential crime, including armed robbery or other forms of violence.
- Field work to collect material for collections is a risk in terms of violent robbery such as vehicle hijacking, armed robbery, and assault.
- Service delivery protests can become violent and travellers passing through such areas could be at risk of injury.

8.5.6 Disease, poisoning and injury from plants, animals or other organisms

- Field work exposes staff to potential injury and illness from plants and animals, depending on the specific habitat/s being surveyed. In terrestrial habitats, snake, scorpion, spider and tick bites, bites from mammals, bee and wasp stings, reactions to plants, scratches from thorns, reactions to toxins produced by plants

all pose a risk to staff. In marine habitats stings from jellyfish or blue bottles, sea urchin spines, bristle worms, or bites from various fish pose a risk.
- Infections can be contracted from a wide range of vectors (mosquitoes, ticks, mammals) or directly (e.g., bilharzia, intestinal helminths), or through exposure to bacteria or viruses, including through food poisoning or injury from certain objects (e.g., tetanus).

8.5.7 Accidents and incidents during field work

- Vehicle accidents, vehicle break downs, punctures, getting stuck in mud or sand and losing vehicle keys are relatively common incidents associated with doing field work and can be serious, especially in remote areas and high crime areas.
- All activities involving water pose a drowning risk, including crossing rivers or streams, collecting in or along the banks of dams or rivers, along the seashore or use of any type of boat or SCUBA diving. Getting lost while hiking to sites may be a risk, especially when the weather changes suddenly and visibility is lost through mist or storms.
- Extreme weather such as storms can result in flooding, which is a risk in terms of rivers that need to be crossed on foot or in vehicles, flooded or muddy roads or lightning strikes.
- Covering uneven terrain, where vegetation may mask holes or depressions, can result in injury.

8.6 General Mitigation Measures

Once all risks have been identified, comprehensive mitigation measures must be identified and implemented. Some measures may address several risks, while others will be specific to a particular risk. Some of the general principles regarding mitigation include the following activities.

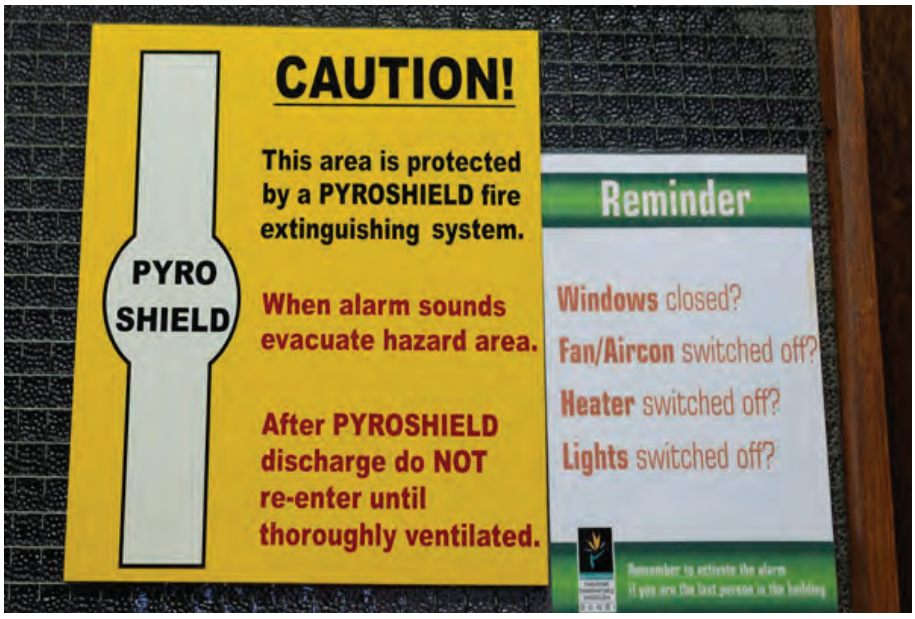
8.6.1 Awareness and training

- **Signage**
  - The institutions must communicate identified hazards and risks to collection staff and visitors, for awareness and precautionary measure, in written fact sheets, and/or information labels or signs on collection storerooms or entry doors to storage and work areas.
  - Ensure that everyone is aware of the nature of harmful material. This means labelling the room, cabinet or individual containers holding the harmful material. Labels should include the identity and hazard presented by the material.
  - Institutions may restrict access to areas where there are significant risks to the health and safety of staff or visitors. Signs indicating where this is the case must be clearly displayed at the entrance to such areas.
  - Evacuation routes must be clearly displayed in all relevant localities within buildings and staff and visitors must be made aware of the position of these as well as their content.

Examples of labelling for different types of hazard.

- **Training**
  - All collection staff should receive practical training on collection activities posing risks and hazards to them, and they should not be allowed to carry out such activities unless they know the risks involved and the precautions to be taken.
  - The institutions must offer training/an induction programme to all new employees to communicate the hazards and risks associated with the collection.
  - Training workshops should be provided in both general and specific (e.g., lifting heavy objects or dealing with hazardous substances) aspects of health and safety.
  - Retraining must be provided, as required, whenever there is a change in job assignments, equipment or processes that present a new hazard.
  - Additional retraining must be conducted whenever a periodic inspection reveals, or whenever the employer has reason to believe, that there are deviations from or inadequacies in the employee's knowledge. Repeated training is also important to reinforce behaviours.

- Conservation and cleaning needs to be undertaken by trained collection staff in controlled environments as staff are the most susceptible to the dangers given their potential long term exposure to hazards.
- Collection staff engaged in the handling of collections must have adequate knowledge of, and experience in administering basic first aid.
- All staff, students and volunteers participating in field work must be appropriately briefed on the risks and the mitigation measures that have been documented.



Signage at the entrance to a collection storage room

8.6.2 Use of Personal Protective Equipment (PPE)

- Institutions must provide Personal Protective Equipment (PPE) when it has been determined that its use is required and that such use will lessen the likelihood of occupational injuries and/or illnesses.
- The users must be aware that PPE does not eliminate the hazard. Additionally, if the equipment fails, exposure may occur. To reduce the possibility of failure, PPE must be properly fitted and maintained in a clean and serviceable condition.
- The institution and the PPE users must understand the equipment's purpose and its limitations.
- The PPE users must be trained on how to use and care for the selected PPE and how to recognize PPE deterioration and failure.
- When handling large glass containers used in some fluid preserved collections, protective aprons and leather wrist support and forearm guards should be worn.
- Suitable clothing such as laboratory coats or overalls should always be worn when dealing with fluid preserved collections and protective goggles are recommended when collection objects are being handled or fluids changed.
- Special care will be required for PPEs when handling animal tissues where these may be considered a risk in terms of hazardous biological materials. Sterilisation of PPEs and handling of potentially contaminated PPEs during disposal or cleaning must be considered.
- When preparing fossils, clothing such as laboratory coats or overalls, earpieces, protective goggles and a dust mask should be used.

Different types of PPEs that may be required for work in natural science collections - image from Pinterest (https://za.pinterest.com/pin/333618284867730187/).

Example of PPEs worn while carrying out activities in natural science collections. The cloth face masks are worn as a precaution during the Covid-19 pandemic - *Image provided by SAIAB.*

8.6.3 First aid and emergency stations

- However effective the policy, accidents will happen, and it is important that emergency preparedness procedures are in place to deal with them. Telephone numbers for local first aiders and emergency services should be easily available in all relevant places.
- Institutions must provide first aid kits for each of their sections, and they should be kept at a central location which is clearly indicated by a sign, and where the contact details of the person responsible for the first aid kit are displayed. These first aid kits must have the required items for the particular type of hazards at the institution and must not hold items that are not approved or required for an institutional first aid kit. Appendix A8.5 provides a list of items that a general first aid kit should include.
- Collection work rooms should have their own emergency stations, including such facilities as those for emergency washing of eyes. Staff and visitors at risk of accidents involving chemicals getting into their eyes must be trained in the use of the eye wash station. Where an employee at a workplace is exposed to or can be exposed to a potential hazard or injury or absorption through the skin as a result of sudden contact with a large amount of toxic, corrosive, high risk or similar hazardous substance, a fast-reacting deluge-shower with clean water or a similar facility in the immediate vicinity of the high-risk area must be available, and staff working in this area must be made aware of this and know how to use it.
- Institutions must have at least one fully trained first aider for every 50 staff on duty at all times. This means that two or three staff (if one is on leave, another must be available) for every 50 employees should be fully trained, and training must be current. In institutions where there are toxins or hazardous chemicals, the first aiders must be trained in dealing with accidents related to these hazards.

Example of signs indicating first aid and emergency stations.

8.6.4 Good housekeeping

Good housekeeping entails:

- Ensuring that staff members have a clear, unimpeded area to work in.
- Keeping workplaces clean, orderly and free of materials, tools and similar things, which are not necessary for the work done in such workplaces.
- Keeping all floors, walkways, stairs, passages and gangways in a good state of repair, skid-free and free of obstructions, waste or materials.

8.6.5 Health and safety related documentation

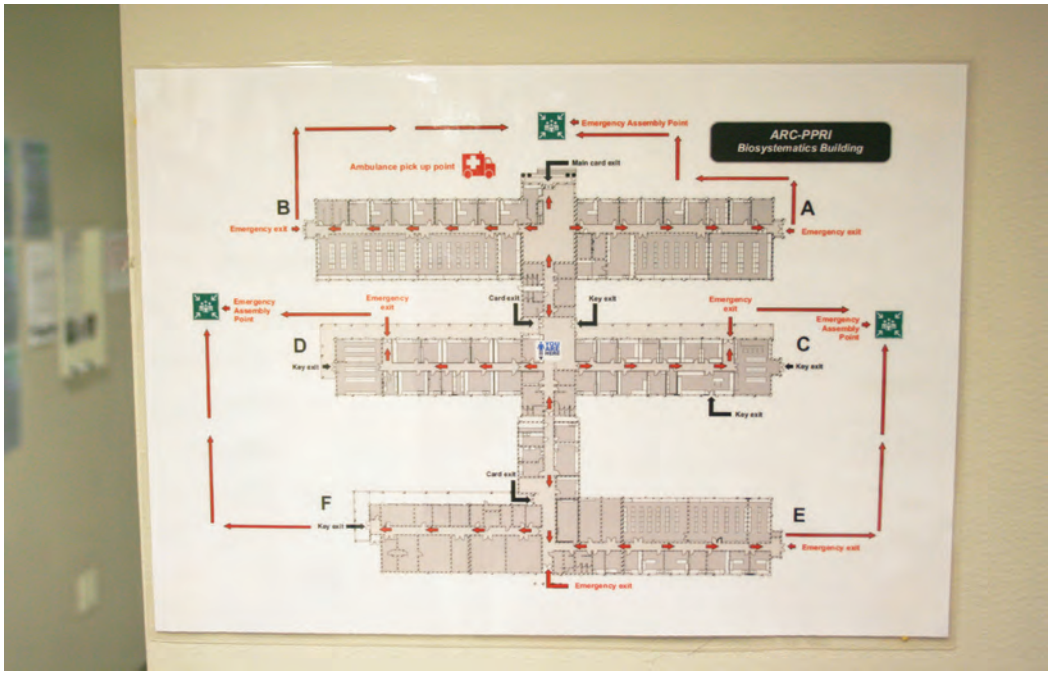
- Maintenance of some records related to staff health and safety is a legal requirement; while for others, these would be required if there was ever an investigation into any incident. Thorough record keeping is critical for effective management of health and safety in any institution.
- The institution's Health and Safety Policy, risk assessments, mitigation plans and emergency response documents (see Chapter 7) should be retained in a file which is accessible to all staff.
- All results from monitoring of risks and tests of equipment and impacts on staff health must be retained.
- Incident reports must be completed and kept on file.
- Details of all training events (including attendance registers) should be documented and maintained.
- Emergency contact details for all aspects of health and safety must be made available / displayed in appropriate locations and must be updated as soon as there are any changes resulting from staff or service provider changes.

8.7 Health and Safety Standards Required for Main Risks Associated with Work in Collections

8.7.1 Fire risks associated with collections

- **Protection of staff against fire**
  - Institutions must have mechanisms in place to prevent fire, to detect it and to respond quickly and appropriately should a fire occur. These mechanisms must protect staff and visitors, as well as the collections.

- **Building structure**
  - Collection buildings must be designed or adapted to minimise the risk of fire, to prevent its spread, and to reduce the risk to staff. This could include fire doors in high risk areas and locating offices away from high-risk collection areas.
  - Collection buildings should be inspected by the fire department at least once a year to identify, prevent, reduce and eliminate hazards that contribute to the occurrence of fires, and to check evacuation routes and any hazards associated with these. These inspections can also be conducted by health & safety officers who have been trained by the Fire Department.



Example of an institution floor plan, marking evacuation route and exits in the building - *image provided by ARC.*

- **Fire detection and suppression infrastructure**
  - All parts of the building must be covered by an automatic fire-detection and alarm system. These should be monitored and linked to the fire department.
  - Sections of the building with flammable liquids should also be fitted with relevant preservative detector alarms (ethanol or formalin sensors).
  - Fire suppression systems should not harm humans if the system is triggered (e.g., FM200).
  - Premises must be equipped with fire-fighting equipment, the minimum being the correct type of fire extinguishers and a hose.

Example of a smoke detection system - *image provided by ARC.*

Example of a gas fire suppression system in a collection storage area and the gas cylinders that supply the system.

  - The extinguishing medium for fluid-preserved collection fires is a water sprinkler system, dry chemical (carbon dioxide) and / or alcohol resistant foam. Dry collection fires should be put out using a dry chemical or carbon dioxide.

Fire extinguisher and water hose for use during a fire emergency - *image provided by ARC.*

- All fire detection, suppression and firefighting items must be tested and maintained annually or as required.
- A fire team should be constituted, with delegated roles and responsibilities, and be appropriately trained.
- Fire drills must be held regularly.
- Fire drills must accommodate various disabilities (e.g., individuals who have limited mobility, or those who have sensory impairment (hearing or sight disabilities)). Elevators cannot be used during an evacuation, and so mechanisms to assist disabled individuals must be available (e.g., Evacuation chairs). Lights and other visual or vibrating alerting devices to supplement audible alarms, tactile signage and maps, audible directional signage should be used.

An evacuation chair which is used to assist individuals with limited mobility during an evacuation.

- All staff and volunteers should receive annual training in fire prevention and response, so that staff are prepared to handle a fire emergency, including sounding an alarm and using fire extinguishers.
- Doors and all emergency exits must always be accessible and clear of obstructions.
- Institutions must enforce a non-smoking policy.
- There should be special precautions put in place during construction, renovation, and repair activities. (i.e., have a fire watch during construction projects).

The Environmental Regulations for Workplaces (1987) require the following in relation to fire:
"In order to expedite the evacuation of a workplace in case of fire, every employer shall ensure that:

a. any emergency escape door from any room or passage or at a staircase shall, as far as is practicable, be hung so as to open outwards.
b. every door of a room in which persons may be present, and every door of a passage or at a staircase serving as a means of exit from such room, shall be kept clear and capable of being easily and rapidly opened from inside so as to ensure quick and easy evacuation.
c. the provisions of paragraphs (a) and (b) shall also be complied with in respect of the outer escape exit from the workplace.
d. staircases and steps leading from one floor to another or to the ground shall be provided with substantial handrails.
e. staircases intended to be used as fire escapes shall:
   i. be constructed of non-combustible material;
   ii. be kept clear of any material or other obstruction; and
   iii. not terminate in an enclosed area."

8.7.2 Explosions resulting from flammable vapour build up

- Evaporation of ethanol from containers can lead to explosive concentrations in storage rooms, cabinets and workrooms. Formalin and other chemicals used in collections and analyses may also release flammable vapours. Topping up of ethanol collections will result in high levels of ethanol vapours, which present a very high risk for explosion.
- In relation to this, the General Safety Regulations states the following requirements: "No employer shall require or permit any person to work in a place where

the vapour of any flammable liquid is generated to such an extent that it constitutes an actual or potential fire or explosion hazard or endangers the safety of any person, unless the provisions of sub-regulations (2) to (12) of this regulation are complied with."

The sub-regulations that are most relevant to collections work include:

1. No employer shall require or permit a flammable liquid to be used or applied other than in a room, cabinet or other enclosure specially constructed for this purpose of fire-resisting material or in a place which, owing to its situation or construction or any other feature or circumstance, is of such a nature that-
   (a) no fire or explosion hazard is, can or may be created thereby;
   (b) any vapour resulting from such use or application is efficiently dispersed and diluted into the atmosphere, subject to the provisions of the Air Pollution Prevention Act, 1965 (Act 45 of 1965); and
   (c) no other workplace can or may be contaminated by such vapour.
3. An employer shall cause every room, cabinet or enclosure contemplated in sub-regulation (2) to be fitted with an efficient intake and exhaust ventilation system to remove any vapour therefrom and to prevent its recirculation in a manner which may lead to the contamination of any other workplace or the creation of a fire or explosion hazard.
4. the ventilation system contemplated in sub-regulation (3) to conform to the following requirements:
   (a) if the air supply and extraction is horizontal, the average air speed measured at a level of 1.5 meters above the floor, or at the level of the platform on which persons stand to work, shall not be less than 0.5 meters per second.
   (b) if the air supply is vertical and the extraction thereof is done through slits or a grill along the side walls at floor level, the average air speed measured at a level of 1.5 meters above the floor, or at the level of the platform on which persons stand to work, shall not be less than 0.4 meters per second; or
   (c) if the air supply is vertical and the extraction thereof is done through a grill over the whole of the floor area, the average air speed measured at a level of 1.5 meters above the floor, or at the level of the platform on which persons stand to work, shall not be less than 0.3 meters per second.
5. With regard to the ventilation system contemplated in sub-regulation (3) the employer shall cause:
   (a) all ducts, trunks and enclosures of the system to be of fire resistant material with a smooth interior finish and to be constructed in such a manner as to facilitate the cleaning thereof;
   (b) the system to be kept in operation during working hours as well as for at least the period of time thereafter that may be necessary to clear the vapour from the atmosphere of the room, cabinet or enclosure to below 25 per cent of the lower explosive limit of that vapour; and
   (c) the work to be so organized that the flow of air towards the intake of such ventilation system is not obstructed and draws the spray or vapour of the flammable liquid away from any employee operating the equipment.

6. With regard to any room contemplated in sub-regulation (2), the employer shall cause every such room:
   (a) with a floor area exceeding 20 square meters to have at least two separate entrances at opposite ends of the room, which shall be fitted with doors opening outwards that cannot be locked; and
   (b) to be fitted with an inspection window of strengthened and shatterproof glass that cannot be opened.
7. (a) An employer shall not permit:
      (i) any fire, flame or naked light or anything which may generate static electricity or any other thing which may ignite a flammable liquid or its vapour, to be used in or taken into any room, cabinet or enclosure contemplated in sub-regulation (2) in which any such flammable liquid is used, sprayed or stored, and shall affix a suitable and conspicuous sign prohibiting any such act at all the entrances to any such room, cabinet or enclosure.
      (ii) any person to, and no person shall, smoke in any place in which flammable liquid is used or stored, and such employer shall affix a suitable and conspicuous notice prohibiting such smoking at all the entrances to any such place; and shall not allow,
      (iii) any process capable of causing sparks or fire, or the application of any heat for the drying of sprayed or treated articles, to take place in any room, cabinet or enclosure used for spraying, before the space or atmosphere has been cleared of all vapour.
8. With respect to any room, cabinet or enclosure contemplated in sub-regulation (2), the employer concerned shall ensure that:
   (a) discarded cotton waste, cleaning rags or similar material to be removed daily and safely disposed of;
   (b) only the quantity of flammable liquid needed for work on one day to be taken into or kept in such room, cabinet or enclosure; provided that partially consumed stock may be stored in a properly marked, fireproof wall cabinet inside the workplace;
   (c) all drums, cans, canisters or similar containers holding flammable liquids to be kept tightly closed when not in actual use and, after their contents have been used up, to be removed from the workplace and safely disposed of daily; and
   (d) every such room, cabinet or enclosure to be kept clean and all fans, ducts, trunks and enclosures of the ventilation system contemplated in sub-regulation (3) to be kept clean and in good working order provided that any cleaning, scraping or scouring shall be done with implements that cannot cause sparking if the concentration of the vapour exceeds 25 per cent of the lower explosive limit of that vapour.
9. An employer shall cause every flammable liquid store to be:
   (a) separated by means of fire-resisting material with a fire-resistance of two hours from any room, cabinet or enclosure contemplated in sub-regulation (2);
   (b) constructed of fire-resisting material with a fire-resistance of two hours;
   (c) constructed in such a way that, in case of spillage, a volume of the flammable liquid in question equal to the quantity of flammable liquid ordinarily kept in store plus 10 per cent of that quantity can be contained;

d) ventilated to the open air in such a manner that vapour cannot accumulate inside the store; and
(e) clearly marked with a sign indicating that it is such a store and also indicating the amount of flammable liquid which may be stored therein.

10. Taking into account the construction and location of the premises in question and the quantity and types of flammable liquids involved, an employer shall "install an adequate amount of efficient fire-fighting equipment in suitable locations in and around every building in which such substances are used, handled or stored, or as may be recommended by the fire chief of the local authority concerned."

8.7.3 Hazardous chemical substances (HCS)

- **Documentation relating to hazardous chemicals**

- An inventory of all stored hazardous substances must be kept, including the location where it is kept. The inventory should be duplicated, with one copy kept away from the storage area. The inventory should be available at all times for inspection.
- A Material Safety Data Sheet (MSDS) for all chemicals used must be obtained from the suppliers and kept on file, which is accessible to any interested or affected person. The MSDS sheets provide detailed information about the chemical, including the product and company identification; composition / information on ingredients, hazards identification, first-aid measures, fire-fighting measures, accidental release measures, handling and storage; stability and reactivity, toxicological information, ecological information, disposal considerations, transport information, regulatory information, and other any other information required.
- The Hazardous Chemical Substances Regulations require that:
  "An employer shall:
  (a) keep records of the results of all assessments, air monitoring, and medical surveillance reports, provided that personal medical records shall only be made available to an occupational health practitioner.
  (b) make the records, excluding personal medical records, available for inspection by an inspector.

(c) allow any person subject to formal written consent of an employee, to peruse the records with respect to that particular employee.
(d) make the records of all assessments and air monitoring available for perusal by the relevant health and safety representative or relevant health and safety committee.
(e) keep all records of assessments and air monitoring for a minimum period of 30 years.
(f) keep all medical surveillance records for a minimum period of 30 years and if the employer ceases activities, all those records shall be handed over or forwarded by registered post to the relevant regional director; and,
(g) "keep a record of the investigations and tests carried out (b) and of any repairs resulting from these investigations and tests, and the records shall be kept for at least three years."

• **Assessment of potential exposure of staff to HCS**

The Hazardous Chemical Substance Regulations require that regular assessments of potential exposure be carried out:

1. An employer shall after consultation with the relevant health and safety representative or relevant health and safety committee, cause an immediate assessment to be made and thereafter at intervals not exceeding two years, to determine if any employee may be exposed by any route of intake.
2. An employer shall inform the relevant health and safety representative or relevant health and safety committee in writing of the arrangements made for the assessment, give them reasonable time to comment thereon and ensure that the results of the assessment are made available to the relevant representative or committee who may comment thereon.
3. When making the assessment, the employer shall keep a record of the assessment and take into account such matters as:
   (a) the HCS to which an employee may be exposed.
   (b) what effects the HCS can have on an employee.
   (c) where the HCS may be present and in what physical form it is likely to be.
   (d) the route of intake by which and the extent to which an employee can be exposed; and
   (e) the nature of the work, process and any reasonable deterioration in, or failure of, any control measures.
4. If the assessment indicates that any employee may be exposed, the employer shall ensure that monitoring is carried out in accordance with the provisions of regulations 6 (air monitoring) and 7 (medical surveillance) and that the exposure shall be controlled.
5. An employer shall review the assessment forthwith if —
   (a) there is reason to suspect that the previous assessment is no longer valid; or
   (b) there has been a change in a process involving an HCS or in the methods, equipment or procedures in the use, handling, control or processing of the HCS."

• **Air monitoring**

In areas where staff may inhale hazardous chemical substances, the regulations require a measurement programme to be carried out showing the airborne concentrations of the chemicals.

"Where the inhalation of an HCS is concerned, an employer shall ensure that the measurement programme of the airborne concentrations of the HCS to which an employee is exposed, is:

(a) carried out in accordance with the provisions of these regulations.

(b) carried out only after the relevant health and safety representative or relevant health and safety committee has been informed thereof and given a reasonable opportunity to comment thereon;

(c) carried out by an approved inspection authority or by a person whose ability to do the measurements is verified by an approved inspection authority .... at intervals not exceeding 24 months."

Image showing air monitoring devices - *image provided by SAIAB.*

- **Medical surveillance**

1. An employer shall ensure that an employee is under medical surveillance if:
   (a) the employee may be exposed to a substance listed (in Appendix A8.4).
   (b) the exposure of the employee to any substance hazardous to his or her health is such that an identifiable disease or adverse effect to his or her health may be related to the exposure, there is a reasonable likelihood that the disease or effect may occur under the particular conditions of his or her work and there are techniques to diagnose indications of the disease or the effect as far as is reasonably practicable; or
   (c) the occupational health practitioner recommends that the relevant employee should be under medical surveillance in which case the employer may call on an occupational medicine practitioner to ratify the appropriateness of such recommendation.
2. In order to comply with the provisions of sub-regulation (1) the employer shall, as far as is reasonably practicable, ensure:
   (a) that an initial health evaluation is carried out by an occupational health practitioner immediately before or within 14 days after a person commences employment, where any exposure exists or may exist, which comprises:
      i. an evaluation of the employee's medical and occupational history,
      ii. a physical examination, and
      iii. any other essential examination which in the opinion of the occupational health practitioner, is desirable, in order to enable the practitioner to do a proper evaluation.

(b) that subsequent to the initial health evaluation contemplated in paragraph (a) the relevant employee undergoes examinations as contemplated in paragraph (a)(ii) and (iii), at intervals not exceeding two years, or at intervals specified by an occupational medical practitioner.

3. An employer shall not permit an employee who has been certified unfit for work by an occupational medicine practitioner to work in a workplace or part of a workplace in which he or she would be exposed: Provided that the relevant employee may be permitted to return to work which will expose him or her if he or she is certified fit for that work beforehand by an occupational medicine practitioner.
4. The employer shall record and investigate the incident contemplated in sub-regulation (3) in compliance with regulation 8 of the General Administrative Regulations."

The Hazardous Chemical Regulations appendices provide detailed explanations of medical surveillance practices, as well as the full list of chemicals which may pose a risk to human health, and the acceptable levels of exposure for these chemicals. Medical surveillance is a specialist field, and it is recommended that an Occupational Health Practitioner be consulted to assist institutions in developing an appropriate programme.

- **Control of exposure to HCS**

1. An employer shall ensure that the exposure of an employee is either prevented or, where this is not reasonably practicable, adequately controlled: Provided that:
   (a) where there is exposure for which there is a recommended limit, the control of the exposure shall be regarded as adequate if the level of exposure is below that limit or if the relevant area is zoned and the level of exposure is reduced to below that recommended limit, by means of adequate personal protective equipment only after the level has been reduced to as low as is reasonably practicable by any other means than personal protective equipment; or
   (b) where there is exposure for which there is a control limit, the control of the exposure shall be regarded as adequate if the exposure is at a level as low as is reasonably practicable below that control limit: Provided that in the case of temporary excursions above the control limit, the employer shall ensure:
      i. that the excursion is without a significant risk from exposure,
      ii. that the excursion is not indicative of a failure to maintain adequate control,
      iii. that during the excursion, the area is temporarily demarcated; and
      iv. the provisions of regulation 11 (PPEs) are complied with.
2. Where reasonably practicable, the employer shall control the exposure of an employee:
   (a) by limiting the amount of an HCS used which may contaminate the working environment.
   (b) by limiting the number of employees who will be exposed or may be exposed.
   (c) by limiting the period during which an employee will be exposed or may be exposed.

(d) by using a substitute for an HCS.
(e) by introducing engineering control measures for the control of exposure, which may include the following:
    i. Process separation, automation or enclosure,
    ii. the installation of local extraction ventilation systems to processes, equipment and tools for the control of emissions of an airborne HCS,
    iii. use of wet methods, and
    iv. separate workplaces for different processes.
(f) by introducing appropriate work procedures which an employee must follow where materials are used or processes are carried out which could give rise to exposure of an employee and that procedures shall include written instructions to ensure:
    i. that an HCS is safely handled, used and disposed of,
    ii. that process machinery, installations, equipment, tools and local extraction and general ventilation systems are safely used and maintained,
    iii. that machinery and work areas are kept clean, and
    iv. that early corrective action can be readily identified.

What these regulations mean in terms of hazardous chemicals in the collections or associated laboratories is as follows:

- Institutions must know which chemicals are used or are present in the collections (including residues on collection objects), and which of these are considered to be hazardous chemical substances.
- They must know whether staff are being exposed to or absorbing these chemicals and at what levels and through what route.
- They must know whether the health of staff is being affected by exposure to these chemicals through conducting regular medical assessments for members of staff who are exposed to hazardous chemical substances.
- They must put in place all the specified measures to remove or reduce the exposure of staff to these chemicals.
- They must ensure that members of staff are aware of the chemicals they are exposed to and the associated risks and take the required measures to remove or limit exposure. Staff must be trained in proper handling, use, storage and disposal of hazardous materials.
- They must follow the regulations in terms of disposing of expired hazardous chemical substances, the empty containers that held such chemicals, or PPEs that have been contaminated with the substances.
- Staff at institutions must obey instructions from their employer regarding the prescribed handling and disposal of hazardous chemical substances and report any situations that might pose a risk to their or other people's health; and report all incidents.

Staff should also be made aware of the following points:

- Collection staff suffering from any ailment, or who are taking medication that would aggravate or suppress the symptoms of poisoning by a pesticide, should not be permitted to handle such a pesticide or another type of pesticide unless prior approval (endorsed on the staff's work-exposure record card) has been obtained from an occupational medical practitioner.

- If any symptom of illness or discomfort is experienced (for example headache, dizziness, vomiting, diarrhoea, tightness of the chest) or if abnormal behaviour becomes apparent after a hazardous collection/substance has been handled, an occupational medical practitioner shall be consulted immediately.

- **Handling and exposure to chemicals and toxins: some points to consider**
  - It is good practice to assume that hazardous pesticides are present in or on collection objects and treat them with necessary precautions unless testing has been undertaken. Hazardous materials may have been used in the past for preparing and preserving collection objects, and so care should be taken in handling collections whose status or history is unknown. Examples are: Arsenic oxide (skins and fluid-preserved collections), mercuric chloride (botanical collection objects) and DDT (dry collections).
  - Where appropriate, gloves should be used, and hands should be washed before and after handling collection objects. In some cases, more effective PPEs might be necessary.
  - During handling, decontamination and disposal procedures of collections contaminated with pesticides, the appropriate protective clothing and equipment should be worn.
  - Containers of fluid-preserved collection objects should be opened inside a fume cabinet (fume hood), or in front of a bench-top fume collector, to avoid inhalation of vapours.
  - The collection storage area should be equipped (according to required resource for that collection type) with a spill kit containing absorbent pads, a flood barrier, nitrile gloves, protective eyewear, and sturdy plastic bags for cleaning up preservative spills, and tongs for picking up broken containers.
  - Some minerals may release toxic gases or vapours. Since collection object cabinets should be well sealed, such gases should not escape. If a cabinet is left closed for extended periods of time the concentration of these gases can become high. An individual may become exposed to these high concentrations when a cabinet is first opened. Label all cabinets housing such minerals with the appropriate hazard warning symbol. This will ensure that anyone opening the cabinet, including staff, visitors and emergency personnel are aware of the potential hazard, and will know what protection they require.

8.7.4 Preventing physical injuries to staff in the collections

- No person shall work in an elevated position unless such work is performed safely from a ladder or scaffolding. Ladders must be sufficiently sturdy so that the user does not feel insecure at high elevations. The General Safety Regulations (1986) provide detailed specifications for scaffolding and if these structures are used, the legal requirements must be met.
- Care is also required to prevent items falling on staff or visitors, and staff must ensure that all shelving is sturdy and securely fixed and that collection objects are not stacked or stored in such a way that they could fall and injure someone working in the storeroom. If crates or containers are piled on top of each other there is a high risk of staff trying to access the lower containers injuring their backs or dropping heavy containers on themselves or others.

8.7.5 Exposure to and handling of Hazardous Biological Materials

- In some cases, diseases can be contracted from live or dead animals brought into the institution, either by staff themselves or by external researchers or members of the public. The risk of zoonoses (e.g., Ebola, bird flu, Coronavirus) is increasing and staff need to be aware of these risks not only to themselves, but also to others in their workplace or even those outside the institution who may be exposed while transporting or disposing of materials.
- The Regulations for Hazardous Biological Materials, 2001 would apply to any staff member who works with animals, including blood or other tissues, where these may potentially harbour micro-organisms that could be transmitted to humans. These Regulations require that risks be identified, as well as the precautions to be taken by an employee to protect him - or herself against the health risks associated with the exposure, including:
  - the wearing and use of protective clothing and respiratory protective equipment,
  - safe working procedures regarding the use, handling, storage, labelling, and disposal of hazardous biological materials in the workplace,
  - the procedures to be followed in the event of exposure, spillage, leakage, injury or any similar emergency situation, and
  - decontaminating or disinfecting contaminated areas.
- It is essential that all staff and others who might be exposed to hazardous biological materials are aware of the risks and the procedures to be followed and are appropriately trained. Periodic medical examinations may also be required, especially if staff potentially exposed to hazardous biological materials are frequently unwell or have unusual symptoms.

- Some of the precautions recommended by the Regulations include:
  - limiting the number of employees who will be exposed or might be exposed,
  - introducing engineering control measures for the control of exposure, which may include the following:
    (i) process separation, automation or enclosure,
    (ii) the installation of local extraction ventilation systems to processes, equipment and tools for the control of emissions of an airborne Hazardous Biological Agent,
    (iii) separate workplaces for different processes,
    (iv) proper access control to prevent unauthorized access; and
    (v) immediate personal or environmental disinfection.
  - Previously used PPES must not be reused unless they have been effectively sterilised or decontaminated, and potentially contaminated PPEs must be stored in appropriate containers before being discarded or decontaminated in an appropriate manner; ensuring that anyone handling the PPEs, whether on site or via an external service provider, is aware of the risks and takes the required precautions.
  - Eating, drinking, and smoking, keeping food or beverages or applying cosmetics in an HBA workplace must be prohibited, as well as leaving the work area without removing contaminated PPEs.
- The Animal Disease Control Act also has requirements in terms of collecting animals or samples from animals and for handling and holding these (see Chapter 10).
- Some plant poisons can enter the skin without mechanical action. When the sap of some plant species gets onto the skin surface, it can lead to painful skin irritation or irreversible damage. Some species can even cause temporary or permanent blindness if a person touches broken parts of the plant and then their eyes. Employers must have procedures to follow on how to handle such cases and must teach staff how to recognise poisonous plant groups (e.g., Euphorbiaceae, Solanaceae, Apocynaceae).

8.7.6 Mitigation plans for field work

- All relevant risks identified for the specific type of field work carried out must have a detailed response and mitigation plan developed. The following measures should be included, in addition to specific risks and responses:
- Contact details for all emergency services and institutional managers must be available in a specified location in each vehicle, and regularly updated. The cell phone number of the expedition leader and the alternate must also be available in the vehicle.
- The mitigation measures / response should be printed out and kept in each vehicle in a specified location.
- One fully trained first aider must accompany each field trip.
- A fully equipped first aid kit that is checked before every field trip must be available in every vehicle. There should be clear guidelines included in the kit regarding any medicines it contains. A first aid booklet should also be provided in the first aid kit.
- Vehicles must be checked before departing on a field trip to ensure that they are mechanically sound, that the spare tyre is sound and that all necessary tools such as wheel spanners and jacks are present and in working condition.

APPENDICES

A8.1 Summary of documentation required for Health and Safety

- We assume that all institutions will be compliant with the Occupational Health and Safety Act of 1993, and have all the relevant documents, structures and procedures required for compliance. Some of the documents listed below may already exist, although they may not be collection specific. Some of the documents listed below may still need to be developed or the specific hazards associated with particular collections may be lacking.

POLICY

- Institutional Health and Safety Policy that is displayed around the workplace is required by the Act.

REGISTERS

- **Assessment of all health and safety hazards –** comprises all of those related to work with collection objects or in collection storerooms, or on field trips, and identification of precautionary measures that should be taken for each hazard (required by the Act).
- **Inventory of contents of first aid kits.**
- **List of emergency contacts for an emergency.**
- **Register of incidents** (required by the Act).
- Documentation related **to medical surveillance** (confidential) (required by the Act).
- **List of first aid box contents.**

STANDARDS AND PROCEDURES

- **Procedures document for the health and safety officers to use in carrying out health and safety checks.** This should include a list of the hazards to check and the precautionary measures that have been put in place to prevent or reduce their impact on staff including how to carry out the check and how often checks are required. It should also include a workflow showing how the information gathered during checks should be recorded and filed, how it should be conveyed to the relevant structures, how to follow up on responses (re-inspection once action has been implemented, and what to do if no response is received).
- **Standards and procedures document for professional assessments of hazards including chemicals, air quality monitoring, medical surveillance** (i.e., what hazards require professional monitoring or assessment, how often, in which locations, what is required from these services and what will be done in response to the results).
- **Procedures document for informing staff and visitors about hazards** covering briefing sessions, signage and any documents that are made available.
- **Communication procedures document:** for informing staff about the findings of the health and safety checks, the precautions put in place in response to any hazards identified, about when there has been an incident, and about any other health and safety information that may be required.
- **Health and safety training standards and procedures.** This should document all the training needs, in line with the Act, who will be trained, how often training is required, and how training events will be documented.

- **Procedures document for reporting and recording all health and safety related incidents:** including which ones must be reported to the Department of Labour, and how and when the incidents report book must be filled in.
- **Emergency procedures:** to be followed in the case of an accident, which deals with different types of accidents and different levels of severity.

A8.2 Incident report form

INCIDENT REPORT FORM **INSTITUTION LOGO**

Reported by: _____ Date: _____

Title/Role: _____ Incident No.: _____

EMPLOYEE INCIDENT INFORMATION

Employee name: _____ Employee role: _____

Incident date: _____ Time of incident: _____

Location: _____

Specific area of location: _____

_____

Other people involved: _____ _____

_____

Incident description: _____

_____

_____

Does incident require medical attention or hospitalisation: _____

Hospital address: _____

_____

Hospital telephone number: _____

_____	_____	_____
Employee name	Employee signature	Date
_____	_____	_____
Reporting staff name	Reporting staff signature	Date

A8.3 Dealing with common hazardous chemicals in natural science fluid preserved collections

ETHANOL

Potential Ethanol health effects

- **Eye contact:** Ethanol eye contact causes severe eye irritation. It may cause painful sensitisation to light. It may also cause chemical conjunctivitis and corneal damage. To treat ethanol eye contact, gently lift eyelids and flush continuously (10 mins to 15 mins) with room temperature water - then get medical attention.
- **Skin contact:** Ethanol skin contact causes moderate skin irritation. It may also cause cyanosis of the extremities.
  To treat ethanol skin contact, flush skin with plenty of soap and water. Wash clothing before reuse. Get medical attention if still experiencing pain and discomfort.
- **Ingestion:** Ethanol ingestion may cause gastro-intestinal irritation with nausea, vomiting and diarrhoea. It may cause systemic toxicity with acidosis or it may cause central nervous system depression, characterised by excitement, followed by headache, dizziness, drowsiness, and nausea. Advanced stages may cause collapse, unconsciousness, coma and possible death due to respiratory failure. To treat ethanol ingestion, do not induce vomiting. If the victim is conscious and alert, give 2-4 cups of milk or water. Never give anything by mouth to an unconscious person. Get medical attention.

- **Inhalation:** Inhalation of high concentrations may cause central nervous system effects characterised by nausea, headache, dizziness, unconsciousness and coma. It causes respiratory tract irritation. It may cause narcotic effects in high concentration. Vapours may cause dizziness or suffocation.
  To treat ethanol inhalation, remove the victim from exposure and move them into fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention. Do NOT use mouth-to-mouth resuscitation.

Note to Physician: Persons with skin or eye disorders or liver, kidney, chronic respiratory diseases, or central and peripheral nervous system diseases may be at increased risk from exposure to this substance. Always inform the treating physician or general practitioner of your medical history.

Large spillage of ethanol

- Evacuate personnel to safe areas and restrict access to area until completion of clean-up procedure.
- Eliminate all sources of ignition (this includes your cellular phone) and wear protective personal equipment, as listed below.
- Stop leak if you can do it without risk. Large quantities should be absorbed into sand, vermiculite or an equivalent absorbent material and removed to a safe area for disposal.
- Avoid runoff into drains, water bodies, storm sewers and or other water collection points. If contamination of waterways has occurred advise local emergency services.
- Seal in properly labelled container and dispose of waste using the chemical disposal agent. Incineration is the recommended method of disposal.
- Flush the contaminated area with plenty of water.
- Provide ventilation. A vapour suppressing foam may be used to reduce vapours.
- For all spills that cannot be managed by the collection staff, chemical disposal agents must be urgently called.

Protective personal equipment (PPE) to minimise contact with skin during spill

- **Eyes:** protective eyeglasses or chemical safety goggles.
- **Skin:** nitrile / neoprene gloves, apron, and/or clothing to prevent skin exposure.
- **Clothing:** protective clothing to prevent skin exposure.
- **Respirators:** air purifying respirator with an organic vapour cartridge or canister.
- **Safety shoes**: wear boots or shoes that are non-slippery as well as non-conductive. The safety shoe should have metal insoles to protect against puncture wounds (by broken glassware).

Engineering control for ethanol

- Facilities storing or utilising this material should be equipped with an eyewash facility and a safety shower.
- Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.
- Ventilation fans and other electrical services must be non-sparking and have an explosion-proof design where possible.

PROPANOL

Potential Propanol health effects

- **Eye Contact:** Propanol eye contact may cause serious eye damage. To treat propanol eye contact, immediately wash in and around the eye area with large amounts of water for at least 15 minutes. Eyelids to be held apart. Remove clothing if contaminated and wash skin. Urgently seek medical assistance.
- **Skin Contact:** If skin contact occurs, remove contaminated clothing and wash skin with running water. If irritation occurs seek medical advice.
- **Ingestion:** Rinse mouth with water. If swallowed, do NOT induce vomiting. Give a glass of water and seek medical advice.
- **Inhalation:** If patient finds breathing difficult and develops a bluish discolouration of the skin (which suggests a lack of oxygen in the blood - cyanosis), ensure airways are clear of any obstruction and have a qualified person give oxygen through a face mask. Apply artificial respiration if patient is not breathing and seek immediate medical advice.
- **Remove victim from area of exposure -** avoid becoming a casualty. Remove contaminated clothing and loosen remaining clothing. Allow patient to assume most comfortable position and keep warm.

Fire-fighting measures for propanol

- **Extinguishing Media:** Small fires can be put out with CO2 powder. For larger fires, use alcohol resistant foam. If that is not available, fine water spray or water fog can be used.
- **Flash Point:** 22°C.
- **Auto-ignition Temperature:** 371°C.
- **Explosion Limits: Lower:** 2.2% Upper: 13.7%.

Specific hazards from the propanol

- Highly flammable liquid.
- Causes serious eye irritation/damage.
- Specific target organ toxicity (single exposure).

Procedure for cleaning a propanol spill

- Evacuate personnel to safe areas and restrict access to area until completion of clean-up procedure.
- Remove all sources of ignition.
- Absorb spill onto sand, vermiculite or an equivalent absorbent material, using only non-sparking tools and equipment, then remove to a safe area for disposal. Seal in a properly labelled container.
- Clean up immediately, wearing protective personal equipment as suggested below to prevent skin and eye contact and breathing in vapours.
- Avoid runoff into drains, water bodies, storm sewers and or other water collection points. If contamination of waterways has occurred advise local emergency services.
- Dispose of the waste using a chemical disposal agent (SpillTech, EnviroServ, Drizit, etc.). Land disposal of the substance is restricted.

Protective personal equipment (PPE) to minimise contact with skin during propanol spills

- **Eyes:** protective eyeglasses or chemical safety goggles.
- **Skin:** butyl rubber / neoprene gloves, apron, and/or clothing to prevent skin exposure.
- **Clothing:** protective clothing to prevent skin exposure.
- **Respirators:** air purifying respirator with an organic vapour cartridge or canister.
- **Safety shoes:** boots or shoes that are non-slippery as well as non-conductive. The safety shoe should have metal insoles to protect against puncture wounds (by broken glassware).

Engineering controls for propanol

- Facilities storing or utilising this material should be equipped with an eyewash facility and a safety shower.
- Use adequate general or extractor ventilation to keep airborne concentrations below the permissible exposure limits.
- Ventilation fans and other electrical services must be non-sparking and have an explosion-proof design where possible.

FORMALIN

Potential Formalin health effects

- **Eye contact:** Formalin contact causes eye burns. It may also cause ulceration of the conjunctiva and cornea.
  To treat formalin eye contact, flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical assistance immediately. Do NOT allow victim to rub or keep eyes closed.
- **Skin contact:** Formalin contact may cause skin irritation or rash. It may cause skin sensitisation, an allergic reaction, which becomes evident upon re-exposure to this material.
  To treat formalin skin contact, immediately flush skin with plenty of soap and water for at least 15 minutes. Remove contaminated clothing and shoes and wash them before reuse. Get medical assistance if irritation develops or persists.
- **Ingestion:** Ingestion of formalin may cause irritation of the digestive tract. It may cause damage to internal organs.
  Do not induce vomiting. Do not use mouth-to-mouth method if victim ingested or inhaled the substance. Give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Call a physician or Poison Control Centre immediately.
- **Inhalation:** Formalin inhalation may cause difficulty in breathing, chest pain, muscle pain or flushing.
  To treat a victim of inhaled formalin, move them into fresh air. If breathing is difficult, give oxygen. Do not use mouth-to-mouth method if victim ingested or inhaled the substance. Give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Immediate medical attention is required.

Symptoms of overexposure may be headache, dizziness, tiredness, nausea and vomiting. Allergic reactions may include rash, itching, swelling, trouble breathing, tingling of the hands and feet, dizziness, light-headedness, chest pain, muscle pain or flushing.

Fire-fighting measures for formalin

- **Extinguishing Media:** Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide. Cool closed containers that are exposed to fire with water spray.
- **Flash Point:** 81°C.
- **Auto-ignition Temperature:** No data available.
- **Explosion Limits: Upper -** No data available. Lower - No data available.

Specific hazards from formalin

- Has combustible vapours (formaldehyde gas).
- Risk of ignition.
- Containers may explode when heated.
- Thermal decomposition can lead to release of irritating gases and vapours. Keep product and empty container away from heat and sources of ignition.
- Formalin is a carcinogenic substance.

Procedure for cleaning formalin spill

- Evacuate personnel to safe areas and restrict access to area until completion of clean-up procedure.
- Remove all sources of ignition and use personal protective equipment (PPE).
- Absorb spill with inert material (e.g., vermiculite, soil or sand), using only non-sparking tools and equipment, then place in suitable containers in a safe area for disposal. Seal in a properly labelled container.
- Avoid runoff into drains, water bodies, storm sewers and or other water collection points. If contamination of waterways has occurred advise local emergency services.
- Provide ventilation. A vapour suppressing foam may be used to reduce vapours.

Protective personal equipment (PPE) to minimise contact with skin during spills

- **Eyes:** protective eyeglasses or chemical safety goggles.
- **Skin:** butyl rubber / neoprene gloves, apron, and/or clothing to prevent skin exposure.
- **Clothing:** protective clothing to prevent skin exposure.
- **Respirators:** air purifying respirator with an organic vapour cartridge or canister.
- **Safety shoes:** boots or shoes that are non-slippery as well as non-conductive. The safety shoe should have metal insoles to protect against puncture wounds (by broken glassware).

Engineering controls for formalin

- Facilities storing or utilising this material should be equipped with an eyewash facility and a safety shower.
- Use adequate general or extractor ventilation to keep airborne concentrations below the permissible exposure limits.
- Ventilation fans and other electrical services must be non-sparking and have an explosion-proof design where possible.

SULPHURIC ACID

Potential sulphuric acid health effects

- **Eye contact:** Sulphuric acid is extremely corrosive to all body tissues, causing rapid tissue destruction and serious chemical burns.
  Eye contact requires immediate first aid. To treat sulphuric acid eye contact flush thoroughly with water for at least 15 minutes. Get immediate medical assistance. If medical assistance is not immediately available, flush for an additional 15 minutes.
- **Skin contact:** Skin exposure to sulphuric acid causes severe skin irritation or burns.
  Immediately remove contaminated clothing under safety shower using large quantities of water.
  Get medical assistance.
- **Ingestion:** Ingestion of sulphuric acid can cause a severe local reaction with subsequent tissue damage.
  Clean mouth with water and drink plenty of water afterwards. Never give anything by mouth to an unconscious person. Get medical attention immediately. Do not induce vomiting.
- **Inhalation:** In case of accidental inhalation of vapours, remove the victim from further exposure and move them into fresh air. Inhalation of sulfuric acid mist or fumes may produce irritation of the nose, throat and respiratory tract. High levels of acid mist are also irritating to the skin and eyes.
  If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance and call a physician. If breathing has stopped, administer artificial respiration. Monitor breathing until medical assistance arrives.

Note about the chemical: Sulfuric acid is not very volatile and workplace exposures are therefore primarily due to accidental splashes or to processes or actions that generate an acid mist. Chronic inhalation of acid mist may cause pitting and erosion of tooth enamel.

It is extremely corrosive to all body tissues, causing rapid tissue destruction and serious chemical burns on contact with the skin or eyes.

Sulfuric acid is not listed as a carcinogen by Occupational Safety and Health Administration (OSHA), but the American Conference of Governmental Industrial Hygienists (ACGIH) and the National Toxicology Program (NTP) have concluded there is sufficient evidence that occupational exposure to strong inorganic acid mists containing sulfuric acid is carcinogenic or potentially carcinogenic to humans.

Overexposure causes respiratory irritation from excessive breathing of mists and/or vapours. Overexposure for prolonged period of time may result in damage to the lungs. It is expected to cause severe eye irritation or serious damage to the eye. It is expected to cause severe skin irritation or burns. It is expected to be severely irritating or corrosive to mucous membranes, the oesophagus and gastrointestinal tract.

Fire-fighting measures for sulphuric acid

- **Extinguishing Media:** Do not use water.
  It is non-flammable but reacts violently with water generating large amounts of heat with potential for spattering of the acid. It can react with combustible materials to generate heat and ignition. Reacts with most metals, particularly when diluted with water, to form flammable hydrogen gas which may create an explosion hazard. Use dry gas (e.g., carbon dioxide) to put out a fire.
  Do not allow run-off from firefighting to enter drains or water courses. Exposure to decomposition products may be a hazard to health.
- **Flash Point:** Not flammable.
- **Auto-ignition Temperature:** Not applicable.
- **Explosion Limits: Lower -** Not applicable. Upper - Not applicable.

Specific hazards from sulphuric acid

- Extremely corrosive to all body tissues, causing rapid tissue destruction and serious chemical burns.
- Sulphuric acid mist causes eye irritation at high concentrations.
- Can decompose at high temperatures forming toxic gases such as sulphur oxides.
- It is highly toxic to aquatic organisms and plant life.

Procedure for cleaning an acid spill

- Human lives come first, evacuate personnel to safe areas and restrict access to area until completion of clean-up procedure. Handling the spillage depends on how much spillage is being dealt with. Chemical and acid neutralising spill kits should always be available in the collection area / laboratory / the working room, or nearby in cases where there is no storage space for it in the same area.
- Neutralise spill with sodium bicarbonate / baking soda, soda ash or 2-5% caustic soda solution. However, be careful and wear appropriate PPEs (listed below) because the neutralisation process is often vigorous, causing splashes and yielding large amounts of heat.
- Wait until bubbling / fizzing (neutralisation reaction) has stopped. Use pH paper strip to determine when acid spills have been neutralised.
- When using a neutralising spill kit, the kits are buffered and will not have a bubbling action. Be careful not to over-neutralise
- Once neutralised, the material can be transferred into an appropriate secondary container for disposal - can be mopped up and rinsed down the drain (to the sanitary sewer).
- Wipe all surfaces with a sponge and wash all the material down the sink.
- Some acids cannot be neutralised and will require special procedure for spill clean-up. Examples: chromic acid and hydrofluoric acid.
- Decontaminate the spill area and affected equipment by ventilating it, as necessary. Open windows or use a fan unless the area is under negative pressure. For most spills, conventional cleaning products, applied with a mop or a sponge, will provide adequate decontamination. A health and safety officer can arrange for a test of the air to ensure that hazardous vapours are gone.

Protective personal equipment (PPE) to minimise contact with skin during acid spills

- **Eyes:** close-fitting chemical safety goggles or a combination of safety goggles and a face shield where splashing is a possibility. An emergency eyewash and shower should be provided near the work area. Workers should wash immediately whenever skin becomes contaminated.
- **Skin:** Acid resistant gloves (fluoro-carbon rubber, butyl-rubber, etc.), acid resistant protective suit to prevent skin exposure.
- **Clothing:** Acid resistant protective clothing to prevent skin exposure – coveralls, lab coats, aprons.
- **Respirators:** air purifying respirator with an acid gas cartridge should be worn where exposure to hazardous levels of mist or fume is possible.
- **Safety shoes:** rubber boots.
- Fire fighters must use positive pressure breathing apparatus (that prevent inward leaking), due to possible release of toxic fumes.

Engineering controls for acids

- Facilities storing or utilising this material should be equipped with an eyewash facility and a safety shower.
- Use adequate general or extractor ventilation to keep airborne concentrations below the permissible exposure limits.
- Ventilation fans and other electrical services must be non-sparking and have an explosion-proof design where possible.

A8.4 List of the Hazardous Chemical Substances from the Regulations, 1995, showing carcinogenic compounds

Exposure of collection staff to a substance listed in this table requires the staff to undergo medical surveillance.

Substance	Carcinogenicity
Acetaldehyde CH3CHO	Animal Carcinogen
Acrylamide CH2=CHCONH2	Suspected Human Carcinogen
Acrylonitrile CH2=CHCN	Suspected Human Carcinogen
Aldrin C12H8Cl6	Suspected Human Carcinogen
Allyl Chloride CH2=CHCH2Cl	Suspected Human Carcinogen
4-Aminodiphenyl	Confirmed Human Carcinogen
Amitrole	Suspected Human Carcinogen
Aniline and homologues C6H5NH2	Suspected Human Carcinogen
Anisidine (o & p) isomers NH2C6H4OCH3	Suspected Human Carcinogen
Antimony compounds - as Sb, Sb	Suspected Human Carcinogen
Arsenic and compounds except Arsine (as, As) As	Confirmed Human Carcinogen
Arsine AsH3	Suspected Human Carcinogen

Substance	Carcinogenicity
Asbestos - all forms	Confirmed Human Carcinogen
Asphalt - petroleum fumes	Suspected Human Carcinogen
Benz(a)anthracene	Suspected Human Carcinogen
Benzene C6H6	Confirmed Human Carcinogen
Benzidine	Confirmed Human Carcinogen
Benzo(b)fluoranthene	Suspected Human Carcinogen
Benzo(a)pyrene	Suspected Human Carcinogen
Benzyl acetate	Animal Carcinogen
Benzyl Chloride C6H5CH2Cl	Suspected Human Carcinogen
Beryllium and compounds - as Be, Be	Suspected Human Carcinogen
1,3-Butadiene (Buta-1,3-diene) CH2=CHCH=CH2	Suspected Human Carcinogen
tert-Butyl Chromate - as CrO3	Suspected Human Carcinogen
Cadmium compounds Cd	Suspected Human Carcinogen
Calcium Chromate	Suspected Human Carcinogen
Captafol (ISO) C10H9Cl4NO2S	Suspected Human Carcinogen
Captan (ISO) C9H8Cl3NO2S	Suspected Human Carcinogen
Carbon Black C	Suspected Human Carcinogen
Carbon Tetrachloride CCl4	Animal Carcinogen
Chlordane (ISO) C10H6Cl8	Suspected Human Carcinogen
Chlorinated Camphene (Toxaphene)	Suspected Human Carcinogen
Chlorodiphenyl (42% Chlorine)	Suspected Human Carcinogen
Chlorodiphenyl (54% Chlorine)	Suspected Human Carcinogen
Chloroform CHCl3	Suspected Human Carcinogen
bis(Chloromethyl) ether	Confirmed Human Carcinogen
Chloromethyl methyl ether	Suspected Human Carcinogen
beta-Chloroprene CH2=CClCH=CH2	Suspected Human Carcinogen
Chromite Ore processing - as Cr	Confirmed Human Carcinogen
Chromium IV compounds	Confirmed Human Carcinogen
Chromyl Chloride	Suspected Human Carcinogen

Substance	Carcinogenicity
Chrysene	Suspected Human Carcinogen
Coal Tar pitch volatiles - as cyclohexane soluables	Confirmed Human Carcinogen
Cobalt metal - dust and fumes Co	Animal Carcinogen
Crotonaldehyde CH3CH=CHCHO	Suspected Human Carcinogen
DDT (Dichlorodiphenyltrichloroethane) C14H9Cl5	Suspected Human Carcinogen
Diazomethane CH2N2	Suspected Human Carcinogen
Dichloroacetylene ClCCCl	Suspected Human Carcinogen
p-Dichlorobenzene C6H4Cl2	Animal Carcinogen
3,3'-Dichlorobenzidine	Suspected Human Carcinogen
1,4-Dichloro-2-butene	Suspected Human Carcinogen
Dichloroethyl ether	Suspected Human Carcinogen
1,3-Dichloropropene CHClCHCH2Cl	Suspected Human Carcinogen
Dieldrin (ISO) C12H6Cl6O	Suspected Human Carcinogen
Diglycidyl ether (DGE) (OCH2CHCH2)2O	Suspected Human Carcinogen
Dimethyl carbamoyl chloride	Suspected Human Carcinogen
1,1-Dimethyl hydrazine	Suspected Human Carcinogen
Dimethyl sulphate (CH3)2SO4	Suspected Human Carcinogen
Dinitrotoluene CH3C6H3(NO2)2	Suspected Human Carcinogen
Dioxane OCH2CH2OCH2CH2	Suspected Human Carcinogen
Di-sec-octyl phthalate	Suspected Human Carcinogen
Epichlorohydrin OCH2CHCH2Cl	Suspected Human Carcinogen
Ethyl acrylate CH2=CHCOOC2H5	Suspected Human Carcinogen
Ethyl bromide C2H5Br	Suspected Human Carcinogen
Ethylene dibromide BrCH2CH2Br	Suspected Human Carcinogen
Ethylene dichloride ClCH2CH2Cl	Suspected Human Carcinogen
Ethylene imine CH2CH2NH	Suspected Human Carcinogen
Ethylene oxide	Suspected Human Carcinogen
Formaldehyde	Suspected Human Carcinogen

Substance	Carcinogenicity
Gasoline	Suspected Human Carcinogen
Heptachlor and heptachlor epoxide C10H5Cl7	Suspected Human Carcinogen
Hexachlorobenzene - Skin	Suspected Human Carcinogen
Hexachlorobutadiene	Suspected Human Carcinogen
Hexachloroethane CCl3CCl3	Suspected Human Carcinogen
Hexamethyl phosphoramide	Suspected Human Carcinogen
Hydrazine NH2NH2	Suspected Human Carcinogen
Lead - inorganic dusts and fumes - as Pb	Suspected Human Carcinogen
Lead Chromate	Suspected Human Carcinogen
Lindane C6H5Cl6	Suspected Human Carcinogen
Methoxychlor (ISO) C16H15Cl3O2	Suspected Human Carcinogen
Methyl bromide - Skin CH3Br	Suspected Human Carcinogen
Methyl chloride CH3Cl	Suspected Human Carcinogen
Methylene chloride (Dichloromethane) CH2Cl2	Suspected Human Carcinogen
4,4'-Methylene bis(2-chloroaniline) (MOCA)	Suspected Human Carcinogen
4,4'-Methylene dianiline H2NC6H4CH2C6H4NH2	Suspected Human Carcinogen
Methyl hydrazine	Suspected Human Carcinogen
Methyl iodide CH3I	Suspected Human Carcinogen
beta-Naphthylamine	Confirmed Human Carcinogen
Nickel metal and insoluble compounds	Confirmed Human Carcinogen
Nickel, soluble compounds as Ni	Confirmed Human Carcinogen
p-Nitrochlorobenzene	Suspected Human Carcinogen
4-Nitrodiphenyl	Confirmed Human Carcinogen
2-Nitropropane CH3CH(NO2)CH3	Suspected Human Carcinogen
N-Nitrosodimethylamine	Suspected Human Carcinogen
Oil mist, mildly refined cont. benzene	Confirmed Human Carcinogen
Pentachlorophenol C6Cl5OH	Suspected Human Carcinogen
Perchloroethylene (Tetrachloroethylene) CCl2=CCl2	Animal Carcinogen

Substance	Carcinogenicity
N-Phenyl-beta-naphthylamine	Suspected Human Carcinogen
o-Phenylenediamine C6H4(NH2)2	Suspected Human Carcinogen
Phenylglycidylether (Phenyl-2,3-epoxypropylether) C6H5OCH2CHCH2O	Suspected Human Carcinogen
Phenylhydrazine C6H5NHNH2	Suspected Human Carcinogen
Propane sultone	Suspected Human Carcinogen
beta-Propiolactone	Suspected Human Carcinogen
Propylene dichloride	Suspected Human Carcinogen
Propylene imine	Suspected Human Carcinogen
Propylene oxide	Suspected Human Carcinogen
Rosin, core solder pyro products - formaldehyde	Sensitiser, reduce exposure as much as possible
Strontium chromate as Cr	Suspected Human Carcinogen
Styrene, monomer C6H5CHCH2	Suspected Human Carcinogen
1,1,2,2-Tetrachloroethane	Suspected Human Carcinogen
Tetranitromethane	Suspected Human Carcinogen
o-Tolidine	Suspected Human Carcinogen
o-Toluidine	Suspected Human Carcinogen
p-Toluidine	Suspected Human Carcinogen
1,1,2-Trichloroethane CH2ClCHCl2	Suspected Human Carcinogen
Trichloroethylene	Not Suspected as a Human Carcinogen
1,2,3-Trichloropropane CH2ClCHClCH2Cl	Suspected Human Carcinogen
2,4,6-Trinitrotoluene (TNT) CH3C6H2(NO2)3	Suspected Human Carcinogen
Uranium, all compounds - as U, U	Suspected Human Carcinogen
Vinyl acetate CH3COOCHCH2	Animal Carcinogen
Vinyl bromide CH2CHBr	Suspected Human Carcinogen
Vinyl chloride	Confirmed Human Carcinogen
4-Vinyl cyclohexene	Suspected Human Carcinogen
Vinyl cyclohexene dioxide C6H12O2	Suspected Human Carcinogen
Vinylidene chloride	Suspected Human Carcinogen

Substance	Carcinogenicity
Welding fumes	Suspected Human Carcinogen
Wood dust (certain hardwoods)	Suspected Human Carcinogen
Soft wood dusts	Suspected Human Carcinogen
Xylidene, mixed isomers (CH3)2C6H3NH2	Suspected Human Carcinogen
Zinc chromates	Confirmed Human Carcinogen

A8.5 Minimum contents of a First Aid Box (from the General Safety Regulations, 1986)

In the case of shops and offices, the quantities stated under items 1, 8, 9, 10, 14, 15, 17, and 18 may be reduced by half.

Item 1: Wound cleaner / antiseptic (100ml)
Item 2: Swabs for cleaning wounds
Item 3: Cotton wool for padding (100g)
Item 4: Sterile gauze (minimum quantity 10)
Item 5: 1 pair of forceps (for splinters)
Item 6: 1 pair of scissors (minimum size 100mm)
Item 7: 1 set of safety pins
Item 8: 4 triangular bandages
Item 9: 4 roller bandages (75mm x 5m)
Item 10: 4 roller bandages (100mm x 5m)
Item 11: 1 roll of elastic adhesive (25mm x 3m)
Item 12: 1 Non-allergenic adhesive strip (25mm x 3m)
Item 13: 1 Packet of adhesive dressing strips (minimum quantity 10 assorted sizes)
Item 14: 4 First aid dressing (75mm x 100mm)
Item 15: 4 First aid dressings (150mm x 200mm)
Item 16: 2 Straight splints
Item 17: 2 Pairs large and 2 pairs medium disposable latex gloves
Item 18: 2 CPR mouth pieces or similar devices

NOTES:

CHAPTER 9: COLLECTION ETHICS

9.1 Background

9.1.1 Ethics definitions

Ethics is a complex subject, and it can be defined in several ways, but in simple terms, the definition of ethics is the "moral principles that govern an individual's behaviour or the conducting of an activity". Ethics can also be considered to involve recommending the concepts of right and wrong behaviour. In this Chapter, the moral principles and the right behaviour for institutions and individuals involved in natural science collections are presented.

The information presented in this Chapter includes points from the ICOM Code of Ethics for Natural History Museums (2013).

9.1.2 Ethics and natural science collections

Many people believe that ethics is only related to research involving human subjects and do not consider that the collections comprise materials which in many cases required killing animals or plants, or the removal of a fossil from the site where it formed. Apart from ethical collection of collection objects, there are also ethical issues relating to ownership of the collections, and to the duties of institutions and staff for providing access to the collections, for protection of collections for future generations, and for use of the collections for ethical research.

9.1.3 Need for ethics committees

Increasingly permit issuing authorities, funding agencies and scientific journals are requiring ethical clearance for all projects before issuing a collecting permit or awarding funding or accepting a manuscript for publication. Such approval must be granted by an independent and properly constituted ethics committee which applies the ethics policy of the organisation / institution. The composition of animal ethics committees is prescribed by the National Health Research Ethics Council (NHREC), and there are standards for the use of animals for scientific purposes (SANS 10386:2008, The care and use of animals for scientific purposes).

In addition to ethical clearance for biodiversity studies, whenever people are the subject of a study, such as when questionnaires are used to gather data on opinions of the public, or their understanding, or indigenous knowledge systems are studied, ethical clearance, and prior informed consent from those involved in the study are essential.

9.1.4 Decolonisation and social injustice in collections

Globally there are various initiatives to decolonise museums and collections, but amongst natural scientists this is seen as irrelevant because the collections and work are considered as "hard sciences" and not perceived to be associated with culture or politics in the same way as, for example, anthropology or cultural history collections and research. However, we must recognise that many of the natural science collections and the institutions that hold them were established under colonial or apartheid rule, and that collection objects were collected without the permission of the people on whose land the collecting was done, without their involvement, and without their right to visit the institution where the material is held, and where positions as scientists were reserved for the minority of people. Indigenous knowledge systems, including use of biodiversity, naming and classifications systems have been disregarded and discarded even though they are relevant to the vast majority of people in South Africa. It is a reality that racism, oppression and injustice still exist in our society and our institutions. The natural science collections community must therefore be aware of the need for a different set of moral principles to those that reflect the past and must constantly guard against elements of unacceptable practices and behaviours whenever they emerge today.

9.1.5 Main areas of work in natural science collections where ethics is relevant

- **Collection ownership:** institutions and staff are custodians rather than owners of the collections; conflict of interest where staff may have their own private collections or hold objects they collect out of the main collection to prevent other researchers from accessing these.
- **Collections as irreplaceable, valuable assets:** in many cases, natural history collections may document a world that no longer exists. As such, these collections should be treated with the care and attention merited by such an important resource.
- **Access to collections and data:** collections held in storage should be freely available, in line with the aims of conservation / preservation of those collections, for legitimate research, and data relating to the collection should also be made available without incurring a commercial charge.
- **Use of the collections while protecting them for future generations:** there is a need to balance use of the collections for research, public learning, inspiration and enjoyment and their preservation for future generations.
- **Collection of materials** must be legal, ethical and have minimal impact on the long term survival of the population and cause the least harm possible to the environment.
- **Research ethics:** staff or researchers using the collections must be held accountable to the public and must adhere to social and moral values as well as research ethics codes.

- Intellectual property ownership: **all data generated through research,** photographs taken, drawings produced, and research findings are the property of the employing institution. The World Intellectual Property Organization (WIPO) provides useful information on intellectual property (https://www.wipo.int/about-ip/en/) including a template for a research institution Intellectual Property Ownership Policy. The Intellectual Property Rights from Publicly Financed Research and Development Act, 51 of 2008 (IPR Act) must also be considered, although this will not apply to collection object data, which is considered to have been generated through surveys, which are not considered to be "creations of the mind that are capable of being protected by law", and where much of the data was collected before 2010 (see https://nipmo.dst.gov.za/).

9.2 Collection and Acquisition of Biodiversity Collection Objects

9.2.1 Acquisition of collections

- Institutions should ensure that all collections are obtained legally. Collection object/s should never be purchased, imported, collected or removed in contravention of national and international legislation or conventions pertaining to such collections.
- It is recognised that it is sometimes difficult to establish legal acquisition. If a collection is acquired and subsequently discovered to have been collected illegally, the relevant authorities should be informed, and further steps be taken as required by the country or countries involved. If more than one institution is involved, refer to the ICOM Code 6.2, which states that, if possible, dialogue should be established between museums in preference to government or political action.

9.2.2 Collection of collection objects

- Collection of materials must be legal, ethical and have minimal impact on the long term survival of the population and cause least harm to the environment.
- No collection object should be collected that would threaten the sustainability of the species. Rare breeds of domesticated stock and farm or zoo breeding programmes of rare and endangered animals and birds may be acquired for display if they have to be euthanized for legitimate reasons such as ill health or trauma.
- When collecting from nature the smallest possible number of collection objects necessary should be taken, with as little disturbance to habitats as possible.
- Any animal killed under the guidance of an institution should not involve animal pain or distress. Individual institutions should maintain up-to-date manuals on the accepted methods by which each group of animals in its collection will be humanely killed.
- Environmental sustainability and animal welfare should be considered in determining the sample size of collections. In determining whether an animal will be killed by a member of an institution, the following considerations should be made:
  - Collection should occur only after a decision has been made that it is justified, weighing the predicted scientific or educational value against the potential effects on the welfare of the species.

- Killing of any animal must result in as many different components being preserved or used for study as possible (skeletal collection object/s, skin, tissues, organs).
- Replacement: Techniques that totally or partially replace killing animals for the collection should be sought and used wherever possible.
- Reduction: Each project must use no more than the minimum number of animals necessary to ensure scientific and statistical validity.
- Refinement: Animals must be suitable for the scientific purpose, taking into account their biological characteristics including phylogenetics and distribution.
- Ethical guidelines laid down by the institution ethics committee should be followed.

9.3 Use of Collections

- There is a need to balance use of the collections for research, public learning, inspiration and enjoyment and their preservation for future generations.
- Natural science collections held in storage should be freely available, in line with the aims of conservation / preservation of those collections, for legitimate research without incurring a commercial charge.
- Information relating to the collection should also be made available, taking into account confidentiality agreements, its inclusion in on-going research projects, and species protection. Collection data access should not be run as a commercial activity.
- Photographic restrictions should normally only apply if the specific collection concerned is new, unpublished, or on-going research may be jeopardised, or if the collection is politically sensitive or covered by intellectual property legislation. However, institutions retain the right to charge market rates to commercial entities wishing to use images for profit-making activities.
- Animal remains should be displayed with respect and dignity, regardless of the species or its origins. It is understood that 'respect' may be interpreted differently depending on the country, the institution as well as the lands, cultures or peoples from which the animal collection originated. Institutions should develop guidelines appropriate to their own milieu and audience and apply these consistently.

9.4 Codes of Nomenclature Requirements

9.4.1 Plants

- For plants, the following recommendation from the International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) (2018) (Recommendation 7A) should be followed:

  It is strongly recommended that the collection on which the name of a taxon is based, especially the holotype, be deposited in a public herbarium or other public collection with a policy of giving bona fide researchers access to a deposited collection, and that it be scrupulously conserved.

9.4.2 Animals

- For animals, the following recommendation from the International Code of Zoological Nomenclature 1999 (Recommendation 72F) should be followed:

Every institution in which name-bearing types are deposited should:

- Ensure that all are clearly marked so that they will be unmistakably recognised as name-bearing types.
- Take all necessary steps for their safe preservation.
- Make them accessible for study.
- Publish lists of name-bearing types in its possession or custody.
- As far as possible, communicate information concerning name-bearing types when requested.

9.5 Rocks, Minerals, Fossils

- Institutions that collect minerals, rocks or fossils for display or research purposes should ensure that the collection object is collected in a manner that does minimum damage to the deposits from which they are extracted. If such acquisitions are the result of large-scale commercial activities, every reasonable effort should be made to ensure that the activities do not end in the destruction of a site or deposit.
- Institutions that collect minerals, rocks or fossils for display or research purposes should ensure this is done following the legislation of the source country and of their own country.

9.6 Human Remains

- Human remains should be stored and displayed with dignity, in appropriate environmental conditions as per the ICOM code of ethics recommendation.

9.7 Collecting

A number of individual countries and communities have restrictions on collecting for research purposes. Such restrictions are necessary to protect vulnerable species, deposits, habitats and communities and are usually based on sound science.

The international Nagoya Protocol on Access and Benefit Sharing recognises the right of countries and of local communities to benefit from the use of their genetic resources and traditional knowledge about these. The primary role of the Nagoya Protocol relates to commercialisation, but it does also include the export of genetic resources (= virtually any biodiversity samples) for research other than bioprospecting. This means that South Africa must benefit from our biodiversity and practise research on it, and if we collect material from other countries, we must ensure that the country-of-origin benefits.
The type of benefit in the case of research could include collaboration on projects for local scientists, training opportunities or even donation of equipment or consumables. For collecting or sharing material there must always be the required

permits, compliance with conditions stated in the permits and appropriate documents such as material transfer and benefit sharing agreements. Supplying researchers whose work is in any way linked to bioprospecting or bioprospecting companies with material must have the required consent and permits. The Nagoya Protocol relies on ethical behaviour in terms of the concept of prior informed consent for the collection of material, and in cases where any traditional knowledge will be used in research. This means that the purpose of collection and/or research must be disclosed. This topic is dealt with in more detail in Chapter 10. While legislation may restrict the collection and use of materials, even to the point of limiting valid scientific effort, best practice research and accessing materials for natural science collections must always remain within the bounds of existing legislation. The most critical points are provided below:

- If permits are required for the collection or export of collection object/s these should be sourced and any associated ground rules established prior to a research trip being undertaken. Collectors should follow the policy and legislation for collecting both in the locality in which the collection is made and in the locality in which the institution is based (i.e., if the region in which the institution (museum / herbarium) is based has more stringent animal ethics requirements than the region in which the collection is made, then the more stringent of the requirements should be followed).
- Institutions and individuals should ensure, wherever possible, that information gathered in the field is made available at the earliest opportunity to the relevant authorities or institution within the country in which the collection object is collected.
- The deposition of all collection object/s collected should be determined before fieldwork commences. This is important if one or more parties outside the country of origin will be 'adding value' to collection objects (e.g., preparing collected fossils to a paleontological standard, or identifying objects). If required to do so, all collection object/s collected should be shared between a local institute in the country in which the collection is collected, and the initiating individual or research institute which is undertaking the work.

9.8 Restitution of Collections and Objects

- Restitution is a process whereby objects in a museum collection are returned to an individual or community, usually when there is a claim that the objects were obtained illegally by the museum / holding institution. ICOM provides the following guidance on restitution:
- If a collection is already held outside its country of origin, whereupon 'value' is added, it shall be deemed, except in rare cases, the property of the holding institution. Exceptions include cases in which the collection object was collected without a permit when one was required from the originating country, or in which the collection object/s has a significant connection to indigenous peoples. Scientific or monetary value alone is not sufficient to support restitution.
- Internationally there are vast collections of collection objects of South African origin but the return of all of these is not feasible. Digital access, in the form of photographs, and access to collection object data should be promoted in such cases.

- There should be an awareness of the need for collectors and researchers from outside of South Africa who collect material here to deposit at least duplicates and definitely holotypes in South African collections. This is usually a permit requirement, but it is not always enforced, and a large number of types continue to be deposited outside the country, meaning that they become largely inaccessible to South African researchers.

9.9 Duty of Care for People and Collection Objects

- Institutions have an obligation to ensure that their activities do not impinge on the health and safety of staff, visitors and others. This includes use and disposal of hazardous chemicals and the storage and handling of collection objects.
- All natural heritage collections held within our institutions, and the related information about them, should be considered to be in global custodianship rather than the sole property of the institution in which such collection resides.
- Exchanging or selling either biological or geological collection objects that have been donated to the institution for the public good to agencies outside the institution sector is strongly discouraged and must not be done when the collection object is of importance to indigenous peoples and/or other cultural groups.
- Collection objects should be stored and cared for according to best practice guidelines. ICOM suggests that these guidelines be adhered to as minimum standards for best practice internationally.
- Neglect of part or all of the collection is never acceptable. In situations where capacity to care for or store collection objects/s properly becomes limited, every effort should be made to put the collection object/s into a position of low activity or secure maintenance. Deaccession, even for transfer to another institution, should be viewed only as a last resort.
- Display of natural science collection objects should be undertaken in a manner that is mindful of collections' conservation standards. Collection objects should be displayed in appropriate environmental conditions, away from harmful chemicals or other substances that may cause them damage over time. While on display, collection objects should be adequately supported and protected from human interference (e.g., unwanted handling or theft).
- Collection managers are encouraged to keep abreast of agents of deterioration that might affect particular collection objects in their care and to seek specialist advice where necessary.

9.10 Access to Data and Publication

- ICOM actively encourages the free flow of knowledge and a minimum of restrictions while safeguarding the collection objects and natural populations encompassed by collections within institutions and associated institutions. Commercial interests should not prevent access to scientific datasets or bona fide research into a species, or species group, especially when their conservation is at stake.
- It is frequently the case that data collected never reaches the scientific literature. Researchers are strongly encouraged to publish, or alternatively make their data

records available through other sources, so that other workers may benefit from their findings.

- Publication of data should be in peer-reviewed journals that are readily accessible by the scientific community.
- Researchers must publish in order to advance research and scholarship, not just to advance their own career. Avoid wasteful and duplicative publication. This point should be considered not only by collection-based researchers, but also in requests for destructive sampling of collection objects.
- The principles of honesty, integrity, objectivity, carefulness, openness, respect for confidentiality, respect for intellectual property rights and copyright, social responsibility and competency are essential for collection-based staff and researchers.

9.11 Conflict of Interest

Conflict of interest is where a decision you make is tainted by personal gain or favouritism. For example, if you are asked to review a research grant application that you know you will benefit from, this would be a conflict of interest. If you sit on a selection panel for a job that one of your family members is being interviewed for, this is a conflict of interest. If you are asked to decide on whether to grant access to the collection or data to a competitor working in the same field as you, this could be perceived as a conflict of interest. While it may not always be possible to avoid a conflict of interest, and fair decisions may be possible even in conflicted situations, a conflict of interest must always be declared.

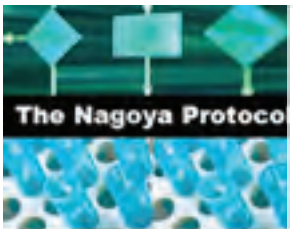
APPENDIX

A9.1 Summary of documents related to ethics in collections

POLICY

- Ethics policy: all institutions should have a policy that guides the behaviour of staff in terms of collections and associated research. This should commit staff to adherence to policies of the institution, especially in terms of protection of the collections, providing access to others, conflict of interest, especially in terms of private collections (including data and images) and providing access to collections and data when this falls within a researcher / curator's own research interests. Field collecting must be done within the law and according to principles of limiting impact on the environment and populations, and according to prescribed practices for animal welfare and for avoiding the spread of disease. Consideration of collecting outside of South Africa, and the benefits that should accrue to the country of origin should be included in the policy.
- The donation of material to institutions outside of South Africa and under which conditions this would be done should be covered. The policy should indicate whether an institutional ethics committee will be established, or whether an external ethics committee will be used for ethics approval for projects. Issues relating to intellectual property should also be included in the policy.
- Code of ethical conduct for staff: this should be based on the content of the Ethics Policy and should be signed by all staff who work in the collections.

CHAPTER 10 : PERMITTING REQUIREMENTS FOR PRESERVED NATURAL SCIENCE COLLECTIONS



10.1 Background

Natural science collections, specifically preserved plants, animals, fungi and fossils require a range of permits relating to the Convention on Biological Diversity, as well as biosecurity and protection of heritage assets. The number of permits and the complexity of these have increased dramatically over the last 10 to 15 years as new legislation and regulations have been enforced and this presents many challenges for natural science institutions.

Permits are legal requirements and so these should not be considered as optional. Non-compliance with legislation means contravention of the law, which can lead to prosecution, conviction and fines and/or a prison sentence and/or confiscation of specimens from institutions or destruction of materials at ports of entry; either nationally or internationally. The NSCF does not provide permits, and cannot exempt, condone or protect institutions or individuals from operating outside of the law.

This Chapter is intended to provide staff in collection institutions with guidance about what permits are required, and the conditions under which they are granted. It is not a critical review of the legislation or the permitting process or the impacts of permit requirements on the work of natural science collection institutions and their staff. However, the permitting environment is highly complex (there are over 20 different laws, some of which have been repeatedly amended and some are currently being revised), some of the provincial ordinances are outdated and do not align with the national legislation, some of the wording in the legislation is ambiguous or even contradictory, and what it means for collection institution activities is open to interpretation. There is very limited relevant information available on permits for biodiversity research, and also limited expertise with knowledge of both the work carried out by collection institutions and the relevant legislation. This means that providing clear guidance for all legislation relating to permits is impossible, and we have highlighted those areas where we are not certain about the requirements.

10.2 Activities Requiring Permits

Natural science collection activities that require permits include:

- Collection of materials / specimens.
- Acquisition of materials from a donor.
- Donating materials to a third party, including supplying materials for destructive or consumptive sampling (e.g., DNA extracts or material for DNA extraction).

- Possession of materials of some species (Threatened or Protected Species (ToPS), CITES, biobanked materials from animals).
- Exporting specimens or materials outside of South Africa, either on a temporary or on a permanent basis.
- Importing specimens or materials into South Africa from another country.
- Importing donated material / specimens into the province where they will be held.
- Exporting specimens outside of the province where they are held.
- In several cases, the same activity may require more than one permit.
- There is some uncertainty about permit requirements for exporting specimens from one province either permanently or temporarily, such as when material is sent on loan, moving specimens through a province, and importing specimens into a province if they were collected outside the province, or if they are received on loan from outside the province. Most of the provincial legislation requires that permits be obtained for this type of activity, but the aim of this seems to be related to controlling illegal hunting (poaching) and trade in wildlife and protected plants, and in some cases control of alien invasive species, rather than for regulating the movement of preserved specimens for scientific research purposes.

10.3 International, National and Provincial Levels of Legislation

South Africa is a signatory to the Convention for Biological Diversity (CBD) and under this, also to the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization, and to the Convention on International Trade in Endangered Species (CITES). These international conventions have been translated into national legislation. There are also global requirements relating to biosecurity that must be adhered to for a country to trade in agricultural products, and for materials from South Africa to be accepted into other countries. At a national level, legislation falls under the Department of Environment, Forestry and Fisheries (DEFF), the Department of Agriculture, Land Reform and Rural Development (DALRRD) and the Department of Sports, Arts & Culture (DSAC).

All nine provinces have legislation relating to the collection, transport and exchange of natural science / biological materials.

10.4 National legislation: National Environmental Management: Biodiversity Act (NEMBA)

10.4.1 NEMBA Regulations: Threatened or Protected Species (ToPS) (February 2007, with various amendments including in December 2007, 2008, 2011, 2012)

The ToPS Regulations provide lists of threatened species and protected species of plants and animals, for which permits are required to carry out any restricted activity. These species are threatened by overharvesting or commercial activities rather than through habitat loss or degradation. The ToPS list must not be confused with Red Lists, although some species on Red Lists are included on the ToPS list. The current ToPS list was published in 2007 and is available on the DEFF

website, but there are several amendments to the original document, which can be confusing.

The regulations and the species lists have been under review for a number of years, and it appears that the new version is before Parliament at the moment. Once the latest version is approved, this will result in some changes to the information presented here.

- The ToPS Regulations require that permits be obtained for any of the following restricted activities:
  - catching or killing, gathering, collecting or plucking, picking parts off, cutting,
  - importing into the country or exporting from the country, having in possession,
  - conveying or moving any specimen (does not specify only live specimens and includes parts or derivatives),
  - selling or otherwise trading in, and
  - buying, receiving, giving, donating or accepting as a gift, or in any way acquiring or disposing of any specimen of a listed threatened or protected species.

Permits are issued by the Minister (DEFF) for officials from organs of state or where the application relates to marine species or for restricted activities involving threatened or protected species in a national protected area. However, permits from the province where the restricted activity will be carried out are also required. The provincial MEC for environmental affairs issues permits for restricted activities in a particular province, excluding to officials from organs of state or for marine species or for national protected areas (according to amendments of 2012).

- "Organ of State" is defined in Section 239 of the Constitution as "*(a) any department of state or administration in the national, provincial or local sphere of government; or (b) any other functionary or institution— (i) exercising a power or performing a function in terms of the Constitution or a provincial constitution; or (ii) exercising a public power or performing a public function in terms of any legislation but does not include a court or a judicial officer".* This should include all those institutions that are established through an Act, which suggests all of those institutions participating in the NSCF. The 2011 amendments provide an exemption to organs of state from paying fees for obtaining permits.

- **Registration as a scientific institution**

All scientific institutions that carry out restricted activities on ToPS listed taxa are required to register with the DEFF. In the December 2007 amendments, scientific institutions are defined as: *"museum, organ of state involved in research, registered research unit of a tertiary institution or herbarium where specimens of a listed threatened or protected species are kept or used for research, scientific, information or identification purposes".* The application form for registration is included in the 2007 Regulations. The registration will be valid for three years, after which it must be renewed.

- **Permits for carrying out restricted activities on ToPS**

There are two types of permits for carrying out any of the restricted activities involving any of the listed species:

i. An Ordinary Permit: may be issued for the:

(a) once-off carrying out of a restricted activity, or a combination of restricted activities, involving one or more specimens of one or more listed threatened or protected species; or
(b) continuous carrying out of a restricted activity, or a combination of restricted activities, for a maximum period of 12 months, involving one or more specimens of one or more listed threatened or protected species

ii. A Standing Permit may be issued to carry out restricted activity for any listed species, on an ongoing basis; including possession of material, but this would need to be issued to the head of a registered scientific institution or a person approved in writing by such an institution. (The Minister issues permits for organs of state and marine species, the MEC for other applications).

If the restricted activity applied for will be carried out on land of which the person who will be the holder of the permit is not the owner, the applicant must obtain the written permission of the landowner to undertake the restricted activity and submit this permission with the permit application.

- **An inventory of all ToPS material held by the institution**

For registration as a scientific institution and for the Standing Permit for possession of ToPS material, a list of all specimens / materials of these species must be submitted with the application, and an update should be submitted annually. This means that all ToPS material will need to be captured into the collection database, and the following information included: scientific names; common name; quantity and size; markings (where applicable).

While the 2007 Regulations do not include the following requirements, it is very likely that the future version will and so it is important to keep a register containing the following information which will be required when applying for or renewing registration as a scientific institution and/or Standing or Ordinary Permits, and which may be requested if the institution is inspected by an official from the DEFF:

- the restricted activity or activities that have been carried out.
- the date on which the restricted activity or activities have been carried out.
- the common and scientific names of the species to which the restricted activity or activities relates.
- the number of specimens involved.
- the markings of specimens involved (if applicable).
- if the permit relates to the transport and export of a specimen, and to the extent applicable, the name and physical address of the person where the specimen has been transported or exported to.

There are additional requirements for details of elephant ivory or rhino horn possessed by an institution, and these need to be measured and marked according to exact standards that are specified in the regulations.

- **Penalties for contravening the TOPS Regulations (2011 amendments)**

The penalties for contravening or facilitating the contravention of any of these regulations is liable upon conviction to:

(a) imprisonment for a period not exceeding 5 years, or
(b) a fine not exceeding R5 million; or

(c) both a fine and such imprisonment, and
(d) in the case of a second or subsequent conviction, a fine not exceeding R10 million or imprisonment for a period not exceeding 10 years, or both such fine and imprisonment.

- **Sending loans or material for destructive sampling**

Note that institutions may only loan / issue biomaterials to end-users that are in possession of valid ToPS permits. Failure to do so is in contravention of the permit conditions. The two permits need to form part of the loan agreement pack or biomaterial transfer document pack. For international institutions, these should be CITES registered.

10.4.2 NEMBA Regulations: Threatened or Protected Marine Species (May 2017)

Any person or organization which intends carrying out a restricted activity for scientific purposes involving a listed threatened or protected marine species, must lodge an application with the Minister (Environmental Affairs). These regulations don't provide any further details for research permits.

10.4.3 NEMBA Regulations: Convention on International Trade in Endangered Species (CITES), 2010

- These regulations cover the following: import, export, re-export of any specified materials for CITES listed species (Appendix I, II, III).
- The list of species for each Appendix is available at https://www.cites.org/eng/app/appendices.php.
- Information on how CITES works is provided at http//www.CITES.org and this is important because different processes are required when applying for permits for material listed on the different appendices.
- The Minister of the DEFF issues permits relating to import, export and re-export of specimens of CITES-listed species to organs of state for marine species, and in marine protected areas, while the MEC of the provincial department responsible for nature conservation is responsible for CITES species related issues in the case of non-marine species and non-organs of state.

- **Exemptions**

The Convention provides an exemption from the normal permitting requirements for trade in the case of scientific exchange and this exemption covers the following:
(a) non-commercial loans.
(b) donations and exchanges between scientific institutions registered by the Management Authority.
(c) herbarium specimens.
(d) other dried, preserved or embedded museum specimens.

The most recent Conference of the Parties (CoP18) made several statements and resolutions regarding the scientific exchange of materials and extended this exemption to animal (non-live) and plant specimens, including forensic research specimens, that are legally acquired by a scientific institution.

- Scientific institutions must register to be exempt and will need have a "label" issued by the Management Authority (DEFF) which accompanies the material

that is being exported. These labels are actually in the form of a book of "permits", which is issued by the DEFF to registered institutions and institutions are required to report on the labels used and the material exported. Appendix 4 of the regulations provides the information that is required on a label for "non-commercial loan, donation or exchange of herbarium or museum specimens from CITES registered Scientific Institutions in South Africa". The latest notification states that exemption should be limited to legally obtained specimens, which means that there should be a collecting permit for any material that is sent outside the country.

- Most of the collection institutions are registered (see Appendix 1), and this registration is separate from that required for the ToPS Regulations. The process for registration of additional institutions is unclear at the moment. The latest CITES notification (2019) includes the standards for registration of collections, which include the following:
  - professional curation.
  - specimens being accessible to all qualified users, including those from other institutions.
  - all accessions recorded in a permanent catalogue, permanent records maintained for loans and transfers to other institutions.
  - specimens prepared and collections arranged in a manner that ensures their utility.
  - accurate data maintained on specimen labels, permanent catalogues and other records.
  - acquisition and possession of specimens must accord with the laws of the State in which the institution is located, and
  - all specimens of species listed under Appendix 1 permanently and centrally housed under direct control of the scientific institution and managed in a manner to preclude the use of such specimens for decoration, trophies or other purposes incompatible with the principles of the Convention.

These requirements are very much in line with the standards set by the NSCF, but the CITES registration requirements mean that the standards must be met for an institution to operate within the Convention and the law.

The latest resolutions of the Convention state that *"registered institutions should be subject to renewal at the discretion of the registering management authority, to ensure that only current, valid institutions are eligible for scientific exchange"*. This means that material of CITES listed species can only be sent on loan or donated to other institutions outside South Africa using the label if these are CITES registered. If they are not, then a standard permit will need to be applied for.

Note that currently it is not possible to obtain the book of "labels" or special permits for registered institutions, and the long standard process must be followed to obtain permits to export any CITES listed species' material.

- **Integrated permits**

The Regulations state that if a permit is issued in terms of the CITES Regulations and the species is also a threatened or protected species, this permit must include the requirements of the Threatened and Protected Species Regulations 2007, as amended, to form a single integrated permit, which shall be valid for these

regulations and the Threatened and Protected Species Regulations, 2007. It is unclear whether this only refers to materials not covered by the exemption.

10.4.4 NEMBA Regulations: Biodiversity Access and Benefit-Sharing Regulations, 2015

- **Export permit for biological resources**
- A permit is required for export of any genetic or biological resources for research other than bioprospecting. This includes all materials, whether these are whole specimens or tissue or DNA extracts, and whether the export is an exchange, donation for destructive sampling or a loan. The Regulations currently relate only to indigenous species, but this will probably change in line with the Nagoya Protocol, to include alien or exotic species as well.
- The MEC is the issuing authority for export permits for research other than for bioprospecting, and this is the MEC in the province where the material was collected, and not the province where the institution is based.
- Note that the Regulations require the issuing authority to:

"(a) give the applicant or stakeholder access to any guidelines, information on practices that have been developed or any other information in the possession of the issuing authority that is relevant to the permit application; or (b) advise the applicant or stakeholder, either in writing or by way of discussions, of the nature and extent of any of the processes that must be followed in order to comply with the Act and these Regulations, provided that such advice, discussion or the lack thereof, shall in no way impact on the applicant's duty to comply with the provisions of the Act or these Regulations".

A permit may only be issued to or submitted by-

(a) a juristic person (institution) registered in terms of South African law.
(b) a natural person, who is a South African citizen or a permanent resident of South Africa; or
(c) a juristic person that is not registered in terms of South African law or a natural person who is not a South African citizen or a permanent resident of South Africa, if that juristic person or foreign national applies jointly with a juristic or natural person referred to in paragraphs (a) or (b) above.

An application for an export permit for research other than bioprospecting must be accompanied by the following:

(a) the specification of the indigenous genetic and biological resources involved.
(b) the specification of the quantity of the indigenous genetic and biological resources involved.
(c) the specification of the source of the indigenous genetic and biological resources.
(d) the purpose for which such indigenous genetic and biological resources are to be exported; and
(e) a non-refundable fee must be paid.

The application requires that a full project proposal be attached to the application, certified copies of identity document / passport of the project leader and duly

authorised person of juristic body as well as the recipient and any collaborators, and the duly authorised person of juristic body and the project leader must sign and initial all pages.

The issuing authority needs to consider the following in deciding whether to issue a permit:

"documentary proof that the applicant has obtained the prior consent of any person, including any organ of state or community providing or giving access to the indigenous genetic and biological resources to which the application relates, and material transfer and benefit-sharing agreements have been entered into with such stakeholders".

This means that a collecting permit for the material, or written landowner permission must be obtained and provided with the permit application. The implication is that if there is no such written permission or permit, the material cannot be exported. It is unclear whether issuing authorities request a Material Transfer Agreement and Benefit Sharing Agreement with the landowner for material for non-commercial export purposes, but it appears that this is only relevant to bioprospecting and biotrade.

The issuing authority must also:

(a) *assess the manner in which the potential impact of the research, other than bioprospecting on the indigenous genetic and biological resources will be minimized and remedied.*

(b) *assess that the impact of the research other than bioprospecting, on the indigenous genetic and biological resources will be negligible or will not deplete an indigenous genetic and biological resource beyond a level where its integrity is jeopardized.*

An export permit for research other than bioprospecting must be issued subject to the conditions that:

- *the indigenous genetic and biological resources to which the permit relates may only be used for non-commercial research purposes and not for research that might lead to commercial use or for bioprospecting.*
- *the indigenous genetic and biological resources to which the permit relates may not be sold, donated or transferred to a third party without the written consent of the issuing authority, which will not be given if the third party intends using the indigenous genetic and biological resources for bioprospecting purposes; and*
- *the permit holder must, on an annual basis or such alternative timeframe as determined by the issuing authority, submit a status report to the issuing authority in a format determined by the issuing authority.*

The permits are only valid for a specific period and involve only the indigenous genetic and biological resources relating to such permit. This means that a permit is required for each loan or each consignment of materials sent outside of the country.

A Material Transfer Agreement (MTA) and a Benefit Sharing Agreement (BSA) between the institution sending the material and the recipient must be signed. The Regulations provide examples of these agreements, but they are for bioprospecting rather than other research. The MTA should specify what can and what cannot be done with the material, as described above and the BSA should state what benefits must be provided to South Africa by the recipient of the material. In the case of research, examples of benefits include:

(a) conservation of the indigenous genetic and biological resources.
(b) support for further research on indigenous genetic and biological resources and traditional knowledge.
(c) enhancement of the scientific knowledge and technical capacity to conserve, use and develop indigenous genetic and biological resources.
(d) any other activity that promotes the conservation, sustainable use and development of indigenous biological resources for the benefit of South Africa.

10.5 Marine Living Resources Act (1998)

This legislation is mainly targeted at controlling harvesting and other commercial activities related to marine resources. Its only reference to research is that the Minister (Environment) *"may, notwithstanding the provisions of this Act, permit any scientific investigation or practical experiment".* Permits for sampling any marine organism, irrespective of where the sampling will be carried out, must be obtained from the national DEFF.

10.6 The National Forests Act (84 of 1998)

A "license" (permit) is required from the Minister of the Department that is responsible for state forests. This was previously the Department of Agriculture, Forestry and Fisheries, but Forests have now been transferred to the Department of Environment, Fisheries and Forestry (DEFF).

This Act states that no person may -

(a) cut, disturb, damage or destroy any indigenous tree in a natural forest; or
(b) possess, collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any tree, or any forest product derived from a tree in a natural forest without a permit (referred to as a license).

In addition, the Minister publishes a list of protected trees, which includes 47 species, which could be considered important for conservation and as iconic such as camel thorn, baobab, marula, stinkwood species, and yellowwood species. There is also a list of "Champion trees" which are of particular historical significance, visual impact in the landscape and size. These specific individual trees are also protected, and apparently licenses to do anything to them are seldom granted.

For the protected tree species, a permit (license) is required to cut, disturb, damage or destroy any protected tree; or possess, collect, remove, transport,

export, purchase, sell, donate or in any other manner acquire or dispose of any protected tree, or any forest product derived for a protected tree.

A list of protected trees is published (http://saforestryonline.co.za/indigenous/protected-trees-in-south-africa/).
Access to State forests for research purposes requires a permit (license), and cutting, disturbing, damage or destruction of any other forest produce, and removal or receipt of any forest produce also requires a permit / license. These licenses do not replace the provincial collecting permits, which are required before the national department will issue the license.

It is unclear whether applications for licenses to work in state forests are submitted to and issued by regional offices, or the national office.

10.7 Animal Disease Control Act, (No 35 of 1984, Section 20)

The main purpose of this legislation is to prevent infection and spread of infection among animals and people by diseases that are transmitted by animals.

Section 20 of the Act states the following:

"No person shall, except under a permit and in compliance with the conditions which are prescribed or, in any particular case, determined by the director:

a. *conduct any investigation, experiment or research with .... any biological product which consists or originates wholly or partially of, or from, any micro-organism, or of or from the glands, organs, fluids, or any other part, of an animal or parasite,*
b. *or for the purposes of any investigation, experiment or research referred to in paragraph (a), ii. introduce into or collect in the Republic, or have in his possession, or remove or transport from the place where it is normally found or kept, any controlled animal or thing, or any protozoon, bacterium, virus, fungus, parasite, other organism or agent which is capable of spreading any animal disease or parasite".*

The DALRRD provides guidelines for the application of a permit under Section 20 of the Animal Disease Control Act, 1984 and a meeting was held with the Departmental officials to obtain clarity on some of the challenges that natural science collections staff face regarding implementation of the Act. Some of the main points relating to the Section 20 permits and the work of the collections staff are provided below, but the full guidelines should also be checked. The guidelines and the application form are available on the Department's website at: https://www.daff.gov.za/daffweb3/Branches/Agricultural-Production-Health-Food-Safety/Animal-Health/disease-control/research.

The Animal Disease Control unit in the DALRRD recommends that a query should be sent to them before collection of animal specimens and that they will advise on whether a permit must be applied for or not.

- **Collection of specimens / samples from the field**

The Act defines animals as vertebrates, and so it is only applicable to any vertebrate, as well as any parasite, or disease vector, or disease agent (protist, virus, bacteria or fungus). Marine taxa are not dealt with by the Animal Disease Control Act.

When specimens or samples from the animals / agents will be collected, the researcher needs to do the following:

  - Obtain a letter from the State Veterinarian for the District in which the collection will take place. If the collection will take place in more than one district, letters from all the state vets for those districts must be obtained. The state veterinary letter will state whether the land on which the activity is being carried out is under official quarantine for suspicion or incidence of any controlled or notifiable disease; and that the State Veterinarian is aware of the research, sampling or use of the animals from the area and either has no objection or provides reasons for any objection to this. In the case of the species to be collected having a low risk of disease then it may be possible for the Animal Disease Control Section 20 staff to notify the provincial Director rather than getting state vet letters, but this can't be guaranteed.
  - An application form, which includes details of what will be done, what species are involved and where the activities will be carried out, together with the sate vet letter/s, are submitted to the Section 20 permit unit who will assess the risk of disease associated with the activities. If there are risks, then requirements to mitigate these will be prescribed in the permit.
  - If possible, areas where there is a disease risk associated with the species / group that will be sampled should be avoided. For example, collection of mammals in an area with high rabies or anthrax prevalence will be a risk.

- **Donations of specimens**
  - For specimens / samples that are donated to the institution, a Section 20 permit must have been obtained for the collection of these samples.
  - When accepting donations there must be information about the samples / specimens and this must be maintained by the receiving institution. This includes specimens brought in by EIA consultants which will need a Section 20 permit.
  - For specimens and samples that are brought into the facility, approved protocols must be followed for processing and handling the specimens.
  - If the facility is evaluated for biosafety and biosecurity, and the DALRRD determines that all health and safety requirements are met, then it may be possible to accept opportunistically collected samples. This will also depend on the group involved (e.g., for bats a BSL3 facility is required because of the disease risk), and all specimens coming into the institution will require a Section 20 permit.

- **Processing of samples**
  - For issuing a Section 20 permit, DALRRD needs to assess the risks associated with processing of samples that are collected, so they will require information about where processing will be done, when it will be done and what will be done.

- An especially important aspect of processing is waste disposal and what will be done with any biological waste (carcases or tissues that are not needed), and how other potentially hazardous materials will be disposed of (tissue paper, gloves, masks that were used in the preparation of the specimen or samples). Only registered waste disposal companies and facilities may be used for the removal of waste generated during or by the research / study. The evaluating official may request a copy of the registration certificate of the waste disposal company.
- Standard Operating Procedures should be available and strictly adhered to in the preparation of specimens and materials.
- All laboratories where samples may be used or prepared and processed must be evaluated by the DALRRD.

• **Storage of specimens and samples**

The implications of storing tissues or other materials are especially important where there is potential for spread of disease, such as storage of tissues potentially or known to contain harmful viruses or bacteria. Remember that the Covid-19 global pandemic possibly originated from materials held in a biobank or from animal tissues in a market, so the risks are real and impacts potentially massive.

- Under the Animal Disease Control Act, the DALRRD requires that they audit / register a biobank facility before issuing Section 20 permits to anyone collecting material for the biobank or supplying materials from this facility. This would include museums that hold DNA or tissue samples. A checklist of the assessment criteria is available on the website.
- The data for each sample are critical and it is essential to keep comprehensive records of where samples came from, how they have been handled, and if they have been used.
- Access control for the facility / samples is important, especially for the higher risk taxa.

• **Use of samples / specimens**

- What will be done with the samples is important and permits are required for the supply of samples to users who request these from the collection / biobank.
- If being transported by road, all samples must be packed and transported in accordance with the Regulations of the National Road Traffic Act, 1996. For transport by air, samples must be packaged in accordance with IATA requirements.
- If samples are to be exported, Section 20 permits are not required specifically for export, but the requirements of the country to which the material is being sent must be considered. They may need animal disease permits.

• **Import of specimens / samples / materials**

Under the Animal Disease Control Act there are also permit requirements for the import of any animal materials, parasites or infectious materials into South Africa and permit applications are provided for hides and skins and other materials.

- The following requirements must be met for the import of materials:
  1) Animal material must be fixed in 10% formalin as this destroys any pathogens.

2) Specimen material must be shipped in formalin (although this poses problems for couriers) OR if the importer can prove that the fixation step has taken place, then material can be shipped in 70% EtOH following IATA regulation.
3) The material must be air freighted and not brought into the country via hand luggage or postal service etc.
4) The DALRRD or state vet must be notified when the consignment is in transmit and ETA at port of entry.
5) The state vet must examine the consignment and then issue a release letter

- All export and import documents must accompany the consignment while in transit and copies be made available for authorities to inspect when it lands in the country – preferred port of entry = OR Tambo airport.
- If the material being imported is needed for DNA extraction, then it cannot be preserved in formalin and extracted DNA will need to be imported rather than the tissue.

- **Section 20 Permits for survey work**

Note that each individual project needs to obtain clearance / a Section 20 permit. It is not possible to be issued with a blanket permit because the disease risks are specific to individual areas or taxa or the activities that will be carried out. However, if the same type of work will be carried out, and the area is known and can be specified, as well as the group that will be collected / sampled, and how this will be done and when, then it may be possible to get a permit for the whole project over a number of years. This would apply to, for example, a survey of reptiles (a low disease risk group) in a specified province, over a three-year period. It would not apply to a survey of rodents or bats, because they have a higher risk of transmitting diseases, and this is taxon and area specific.

10.8 National Heritage Resources Act (Act No. 25 of 1999)

- **Collection of fossils**

The NHRA states that: *"no person may destroy, damage, alter, deface, disturb, excavate, remove from its original position, collect or own, trade in or sell, export or attempt to export from South Africa, any fossil without a permit from the South African Heritage Resources Agency (SAHRA). A person found guilty of breaking the law is liable for a fine and several years' imprisonment, or both. Customs officials are aware of the law and have confiscated fossils when attempts have been made to export them without permission in the past."* (The Palaeontological Society of Southern Africa, http://www.palaeontologicalsociety.co.za/palaeontology-and-law.html)

In addition, the import of fossils from outside the country requires that the permits from the country of origin are provided to customs officials.

- **Identified types of objects that are protected and may not be exported without a permit from the South African Heritage Resources Agency (SAHRA). Notice gazetted in April 2019).**

In line with the provisions of the NHRA, the SAHRA has identified heritage objects for which a permit is required if they are intended to be exported from South Africa. These objects are incorporated into the South African Revenue Services' (SARS) Prohibited and Restricted Goods List (the List) which is accessible on, www.sars.gov.za. The following types of heritage objects or parts and components thereof, are deemed to be heritage objects and are subject to the provisions of the NHRA: Natural History collections and specimens, in particular type specimens in all disciplines including zoological, paleontological and botanical specimens.
For zoological and botanical specimens, the NSCF has recommended to SAHRA that only the following specimens should require a permit for export:

- Name bearing types (holotypes, syntypes, neotypes, and lectotypes).
- Specimens that are 100 or more years old.

Export permits may be refused if the object fulfils the criteria and "is of such a degree of national importance that its loss to South Africa would significantly diminish the national heritage".

Permit applications for temporary or permanent export must be made online on the South African Heritage Resources Information System (SAHRIS), accessible on https://sahris.sahra.org.za/.

10.9 Provincial Ordinances

Each province has its own legislation controlling the collection of biological material and the possession, export and import of this. This legislation is extremely complex to navigate for collections staff because it is of varying ages, with some predating democracy, and therefore being applicable to the former homelands. For example, the Eastern Cape currently operates under three ordinances; one for Transkei, one for Ciskei and one for the Cape Province, and how these are interpreted together is unclear. North West Province also has a similar challenge with its ordinances coming from Bophuthatswana, the Transvaal and the Cape Province. Some provinces (Western Cape, North West Province, Eastern Cape and KwaZulu-Natal) have produced new biodiversity ordinances, but these are not yet in force. Existing ordinances are not readily accessible on the provincial departments' websites, but they can be obtained from the Centre for Environmental Rights website (https://cer.org.za/virtual-library/legislation). Some provinces have introduced online permit applications, but these are not all functional.

In order to determine which species require collection permits, the actual ordinances have to be read with a number of schedules that list the different categories of protection and of species under each of these. The categories and definitions vary between provinces, and the species included in these differ in each province. In many cases the genus and/or species names and the classifications are outdated. In most cases the sections of the ordinances relating to animals are in the context of hunting, game ranching and poaching and not the collection, export, import, or receipt of specimens for research.

Some of the key points that are common across provinces are provided below, but it is suggested that before any restricted activity or potentially restricted activity is carried out, the permit issuing authority for the province is consulted. It should also be recognised that any material collected without a permit, even if this is not required by the province, cannot be legally exported because the BABS regulations require an export permit for which written landowner permission and a collection permit must be submitted.

- **What about areas under the control of SANParks, SANBI, iSimangaliso and municipalities?**

Note that institutions which manage protected areas, like SANParks, iSimangaliso, SANBI and municipalities cannot issue permits to collect material. They are considered as landowners and must give permission to collect on land under their control, but the relevant provincial or national issuing authority still needs to provide permits to collect and export the material from the province, if relevant. These landowners usually require that a project proposal be submitted before giving permission to collect material. This would have to provide details of what will be collected, where, how much will be collected and how it will be collected. They may, as in the case of SANParks, require that a provincial permit be obtained before they will give permission for collecting in a National Park. These landowners might set their own conditions for collecting and this must be checked carefully.

- **Some general key points about provincial legislation and permits**
  - Collecting in protected areas and removal of material from protected areas requires a permit, and in some cases the registration of a research project.
  - Collecting outside of protected areas requires a permit for any of the specified species but not for others in some provinces. Landowner permission is required in writing for the collection of any specimens on private land.
  - No collecting of any plant or animal is permitted on roads or within 100m on either side of the centre of the road (in some provinces 100m on either side of road). The Northern Cape and Cape Nature will issue a permit for collection on roads but the other provinces just state that it is not permitted. A permit may be obtainable from municipalities or from the National Roads Agency (SANRAL) for roads under their authority.
  - Receipt of any specimens as a donation requires details of the donor and the recipient, and in some cases, such as specimens collected for research or environmental assessment, the permit under which it was collected and the landowner's permission, including when the donor is also the landowner.
  - In the case of the Northern Cape permits do not allow for the transfer of materials collected to any third party unless the permitting authority authorises this in writing. This may be the case in other provinces as well.
  - Export from or import into a province of the listed species requires a permit.
  - Transporting any plant or animal through a province requires documentation that proves that the specimen was lawfully obtained (permit/s, donation form, landowner permission).
  - Import of any plant or animal, whether live or dead, into provinces requires an import permit in the case of most provinces, and proof of legal collection is required to obtain this import permit. This would also cover materials

collected outside of South Africa and being brought into collection institutions in this country.
- Fish are treated separately from other animals in most of the ordinances.

10.10 Recommendations for Registrations and Permits

(Note that this is according to our best interpretation of the legislation and is not a full legal opinion)

10.10.1 Registration as a scientific institution

This is required in the following cases:
- To qualify for exemption from the normal permitting process to allow export / exchange of CITES material for research purposes (through National DEFF).
- With the DEFF for carrying out restricted activities for Threatened or Protected Species (ToPS).
- If the institution holds collections of preserved vertebrates, or parasites or disease vectors and receives material of these groups, then it must be audited / certified by the DALRRD.
- If the institution holds biobank materials of frozen materials of vertebrates, parasites, disease vectors or pathogens then the biobank must be audited by DALRRD.

10.10.2 Restricted activities relating to preserved plant, fungal and animal material

a. Possession of ToPS listed specimens
- NEMBA: ToPS listed species: institutions need to check which of the listed species they hold in their collections. If any are held, then a Standing Permit should be applied for to possess these.

b. Loans and donations

bi. Within South Africa:
- No ToPS species included in the loan; no permit required.
- If the material includes ToPS listed material, then an Ordinary or a Standing permit will be required to send the material on loan. The receiving institution will also be required to have either a Standing or an Ordinary permit which will allow them to carry out restricted activities including possession, even if it's on a temporary basis.
- If the material will be donated (e.g., tissue for DNA extract), irrespective of what species are included, then permission from the original issuing authority to donate the material to a third party must be obtained.
- For donations or material for destructive sampling, a Material Transfer Agreement or contract must be signed between the donor and recipient institutions.
- If the material being donated is frozen tissue of a vertebrate, or a parasite or disease vector, or a pathogen, then a Section 20 (Animal Disease Control Act) permit will be required from DALRRD.

bii. Outside of South Africa:

- Presumably in the case of a loan, this will be covered by the Standing Permit if the material includes ToPS species, but the receiving institution will need to be CITES registered. If they are not, then a permit is probably required, but the regulations are not very clear on this.
- An export permit for the NEMBA: Biodiversity Access and Benefit Sharing Regulations is required from the province where the material was collected if the material is being donated or is for destructive sampling. A Material Transfer Agreement or contract with the receiving institution and a Benefit Sharing Agreement will be required. This is for any/all material, irrespective of whether it is from a ToPS or not.
- If the material includes CITES listed species, then the loaning / donor institution must be CITES registered as well as the receiving institution, and the CITES label (permit) must accompany the material. If the two institutions or either one of them are not CITES registered, then a standard CITES permit must be obtained. In the case of marine CITES species the permit will be obtained from DEFF and for other species, from the provincial authority.
- If the material includes name-bearing types or is more than 100 years old, then a permit from SAHRA is required.
- In the case of a donation or material for destructive sampling, permission from the original issuing authority for the collection of the material to send it to a third party must be obtained.
- It is advisable to check with the recipient country regarding any biosecurity clearance that may need to accompany the material (veterinary certificates,

biii. Receiving a donation:

- The collecting permits must be provided by the donor. If these is not available, then consult the provincial issuing authority or DEFF to get advice / permission for accepting the donation.
- A formal donation form must be completed, that includes the details of the donor and the recipient, as well as any restrictions the on use of the material.
- Permission from the original issuing authority to collect the specimens to transfer these to a third party must be provided.
- Care must be taken if the donation is considered to be from high disease risk species such as rodents, bats or ungulates. In such cases, if the donor does not have a Section 20 permit, the Animal Disease Control Unit at DALRRD should be contacted for advice. Museums that house collections of this type of material will need to follow all the appropriate protocols for handling such materials, and these protocols must be documented, and the DALRRD officials must have previously certified the institution.

b.iv. Import of material (loans / donations / tissues / DNA extracts)

- For the import of animal materials, a veterinary certificate is probably required. Check with DALRRD officials.
- For the import of dried plant materials, it is possible that a phytosanitary certificate may be required, although this does not seem to be common practice, and the phytosanitary guidelines don't specify this. Check whether the material is covered by the requirements and is specified at: https://www.gov.za/services/export-permits-import/phytosanitary-permit.

- For CITES listed species, if both the institution exporting and the institution importing the material are CITES registered, then the CITES labels must b used. If one of the institutions is not CITES registered, then an export and an import permit are required for Appendix I listed species, and an export permit is required for other CITES listed species, but this must be obtained by the exporting institution.
- An import permit is required from the province into which specimens are being imported in the case of materials collected in another province or country. Proof of legal collection of the material is required in order to obtain the import permit.
- The requirements of the country of origin of the material must be respected in terms of the Nagoya Protocol. This is especially true when researchers from South Africa have collected material outside South Africa and then imported this into South African institutions.

c. Collecting material for the collections

- When TOPS listed taxa are to be collected, a permit from the national DEFF (for organs of state, marine threatened or protected species, or in a national protected area).
- A Non-TOPS listed taxa (inland) permit is required from the provincial issuing authority (for collection, and if the institution is in a different province to where the material will be collected, then also for export). While some provinces only issue permits for listed species or for collecting in a protected area, collection institutions should try to obtain a permit for any material collected so that there is formal permission to collect the specimen/s.
- If the species to be collected are not known (e.g., general survey of an area) then the permit application will need to state the focus of the survey to the taxonomic level that is known.
- ToPS permits cannot be issued retrospectively and there is some uncertainty about the process if a ToPS is collected in a general survey, but the issuing authority should be notified if a ToPS listed species has been collected as part of a general survey.
- Collecting of marine species / materials: permit required from the national DEFF (Marine Living Resources Act, 1998).
- Collection of all material should have landowner permission, in writing for collecting, and this must be obtained prior to the collecting. In some cases, the landowner will be a private individual or a local chief. In other cases, the landowner will be a public entity such as SANParks, or SANBI, or iSimangaliso, in which case a project may need to be registered and some form of permission issued.
- Collection of any material from a protected tree species or a champion tree requires a permit from the DEFF.
- If collecting is to be done in a forest, a license (permit) must be obtained from the DEFF, according to the National Forests Act, 1998, in addition to the regular collecting permit from the relevant issuing authority.
- If animal material (including any vectors or parasites) is to be collected, a Section 20 permit from the DALRRD is required. Before this is obtained, a letter from the state vet for the area where the collecting will be done is required. Advice can be requested from the officials in the Animal Disease Control Unit.

- Check carefully what permit conditions are related to collecting along roads, and if this is an important method of collecting, check who could issue a permit for the specific area and road type that will be covered during collecting.
- It is advisable to get a permit to export the material from the province where it was collected if the home institution is outside the collection province. Some provinces require an import permit to bring preserved materials into their province.

APPENDICES

A10.1 Documentation related to permitting

PROCESSES

- **Workflow document on filing and recording of permits** associated with the collection of collection objects and linking of these to the object record in the database.
- **Workflow process for registering institution** with DEFF for holding ToPS and / or CITES listed materials, and for restricted activities relate to these, and meeting the required reporting obligations associated with registration.
- **Workflow processes for obtaining permits** for collecting, exporting and importing material, including the authorisation process.

A10.2 South African Institutions with preserved collections currently registered for CITES

Code	Address
ZA 001	Address: University of Fort Hare, Private Bag X1314, ALICE, 5700
ZA 002	Address: University of the Orange Free State, P.O. Box 339, BLOEMFONTEIN, 9300
ZA 005	Address: Rhodes University, P.O. Box 101, GRAHAMSTOWN, 6140
ZA 006	Address: University of Cape Town, Private Bag RONDEBOSCH, 7700
ZA 007	Address: University of KwaZulu-Natal, Private Bag X54001, DURBAN, 4000
ZA 008	Address: University of Pretoria, PRETORIA, 0002
ZA 009	Address: Stellenbosch University, Private Bag X1, MATIELAND, 7602
ZA 012	Address: University of the Western Cape, Private Bag BELLVILLE, Cape, 7530
ZA 014	Address: University of the Witwatersrand, Private Bag 3, WITS, 2050
ZA 017	Address: Alexander McGregor Memorial Museum, P.O. Box 316, KIMBERLEY, 8300
ZA 018	Address: Durban Natural Science Museum, City Hall, Smith Street, DURBAN, 4001
ZA 020	Address: Amathole Museum, P.O. Box 1434, KING WILLIAM'S TOWN, 5600
ZA 021	Address: Bloemfontein National Museum, P.O. Box 266, BLOEMFONTEIN, 9300
ZA 022	Address: Port Elizabeth Museum, P.O. Box 13147, Humewood, PORT ELIZABETH, 6013
ZA 023	Address: Iziko Museum of Cape Town, P.O. Box 61, CAPE TOWN, 8000
ZA 024	Address: Transvaal Museum, P.O. Box 413, PRETORIA, 0001
ZA 025	Address: Natal Museum, Loop Street, PIETERMARITZBURG, 3200
ZA 026	Address: Department of Entomology SA Institute for Medical Research, Hospital Hill, JOHANNESBURG, 2001

Code	Address
ZA 027	Address: Kirstenbosch Research Centre South African National Biodiversity Institute, Private Bag X7, CLAREMONT, 7735
ZA 028	Address: Bews Herbarium (NU), Scholl of life Sciences, University of KwaZulu-Natal, Private Bag X01, SCOTTSVILLE, 3209
ZA 029	Address: The South African Institute for Aquatic Biodiversity (SAIAB), Private Bag X1015, GRAHAMSTOWN, 6140
ZA 030	Address: Natal Herbarium South African National Biodiversity Institute, P.O. Box 52099, Berea Road, DURBAN, 4007
ZA 031	Address: National Herbarium South African National Biodiversity Institute, Private Bag X101, PRETORIA, 0001
ZA 032	Address: Compton Herbarium South African National Biodiversity Institute, Private Bag X7, CLAREMONT, 7735, Cape Town
ZA 033	Address: Selmar Schonland Herbarium Albany Museum, Somerset Street, GRAHAMSTOWN, 6139

A10.3 Useful resources relating to permits

International

Convention on Biological Diversity: https://www.cbd.int/convention/.

Nagoya Protocol: https://www.cbd.int/abs/.

CITES: https://www.cites.org/ (includes lists of CITES species by Appendix).

National legislation and permits

Department of Environment, Forestry and Fisheries: all acts and regulations arranged by year: https://www.environment.gov.za/legislation/actsregulations.

Department of Environment, Forestry and Fisheries: information relating to Biodiversity Access & Benefit Sharing: https://www.environment.gov.za/projectsprogrammes/bioprospectingaccess_benefitsharing_babs_clearinghouse.

Department of Environment, Forestry and Fisheries: information and application forms for TOPS permits (Standing and Ordinary) and registration as scientific institution: https://www.environment.gov.za/topspermitandregistrationapplicationprocess.

Department of Environment, Forestry and Fisheries:

South African Heritage Resources Agency: National Heritage Resources Act: https://www.sahra.org.za/Wordpress/wp-content/uploads/2020/01/National-Heritage-Resources-ACT-1999-1.pdf.

South African Heritage Resources Agency: Heritage objects and information about export permits: https://www.sahra.org.za/heritage-objects/.

Department of Agriculture, Land Reform and Rural Development: Section 20 permits, application forms and guidelines: https://www.daff.gov.za/daffweb3/Branches/Agricultural-Production-Health-Food-Safety/Animal-Health/disease-control/research.
Center for Environmental Rights: includes all legislation and amendments. https://cer.org.za/virtual-library/legislation.

SANParks: guidelines, application form, contact details, schedules for approvals are all available at https://www.sanparks.org/scientific-services/research-applications/register-a-research-proposal.

Provincial permits and guidelines:

Eastern Cape: projects must be registered through Eastern Cape Parks and Tourism if collecting will be done in one of the parks under their control (no information is provided on their website), and permits must be obtained from the Eastern Cape Department of Economic Development and Environmental Affairs (DEDEA). Permits might be needed at a district level. The website does not include any information on permits or applications.

Free State: permit application forms available. http://www.destea.gov.za/?page_id=1375.

Gauteng: https://www.gauteng.gov.za/TaxonomyItems/CPM-001030. Includes list and information on all biodiversity-related permits. In most cases the link to the application form is not live, but this might change.

KwaZulu-Natal: Guidelines, project registration and permit application forms available: http://www.kznwildlife.com/Research%20Project.html.

Limpopo Province: ledet.gov.za has some information about the different roles of the staff relative to wildlife trade regulation, including permits, but no details or application forms.

Mpumalanga: application forms for research project registration and for collecting protected plants available: http://www.mpumalanga.com/our-provincial-parks/wildlife-protection-services/permits-cites, but links don't seem to work.

Northern Cape: http://denc.ncpg.gov.za/ but website not operational or may require a registration before access possible (no registration possible). May be possible to use the following address: dencpermits@ncpg.gov.za / dencpermits@gmail.com.

North West Province: permit applications to be made through https://nw.nipas.co.za. Requires registration before access is possible. Not sure whether applications for research permits are available.

Western Cape: Cape Nature. All permit application forms online at this address: https://www.capenature.co.za/permits-information/.

NOTES:

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