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# Preservation at the Royal Danish Library – Achievements and Future Perspectives

**Abstract:** The Royal Danish Library is Denmark's national library. It serves as the library for several Danish universities and holds the national legal deposit collections as well as significant national cultural heritage collections. Collection care and preservation is a cornerstone in the mission of the Royal Danish Library. Safeguarding the collections calls for a mix of actions including preventive measures, mass treatments and conservation treatments of individual objects to make them accessible and usable for readers. To prioritise actions and resources for preservation it is important to understand the nature, significance and size of the collections. Likewise, it is necessary to survey the collections to obtain information on the chemical and physical composition of the materials, their state of preservation and their storage conditions. Altogether, this knowledge forms the foundation for the library's preservation strategy and day-to-day decision-making. The challenges from growing collections are met with storage in several climate zones designed to preserve different types of vulnerable materials. The library rejected mass deacidification and chose to direct resources into preventive measures while important objects with physical damage still undergo conservation treatment.

This chapter also describes how decisions around collection care have been adapted to changes in the general library strategy and changing internal organisational structures. Furthermore, it puts into perspective how external political priorities and responses to global challenges such as climate change have an impact on the library's preservation decisions and considerations around sustainability in heritage preservation.

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**Article note:** I thank all current and former employees in the preservation department and in the Royal Danish Library for their contribution to the work performed by the preservation department to preserve cultural heritage.

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# 1 Introduction

The Royal Danish Library has its roots in Copenhagen University Library, established in 1482, and The Kings Library, founded in 1648 by King Fredrik III. It has a long history of mergers leading to shifts in purpose and collection practices.

At the beginning of the twenty-first century political focus in Denmark was on merging state institutions within the area of museums and libraries, research and educational institutions. In the library sector this fusion happened with the Royal Danish Library as a central focus point. Mergers did not happen in order to make savings in the budget but to strengthen digital developments, give easy access to more library resources and support Danish universities in becoming top ranked in the global context.

Merging libraries with the Royal Danish Library started with the Natural and Medical Science University Library in 2005, The Folklore Archives in 2008, Danish Art Library in 2017 and The State and University Library in 2017. Today the library holds more than 100 shelf kilometres of cultural heritage collections stored in several locations. The main tasks of the library are multifaceted. It serves as the national library, university library for most universities in Denmark and loan centre for Danish public libraries, has research activities and provides cultural activities for the public audience.

This chapter focuses on the library's role as a national library since this part of the organisation is responsible for the care and preservation of all cultural heritage collections including old university library collections. While the library has digital as well as physical collections the aim here is to describe strategic considerations around preservation of physical materials.

A large part of the physical collections stem from legal deposits of publications including books, journals, pamphlets, newspapers, maps and music prints. Another part, the special collections, are collected through donations and acquisitions and include manuscript collections; music and drama collections; Oriental and Judaica collections; maps, prints and photographic collections; folklore archives; and art and architectural collections.

## 2 From Bookbinder's to Conservation Workshop – A Gradual Change

### 2.1 Tasks

The Royal Danish Library had its own bookbinders from 1664 when two French bookbinders received an appointment at the King's library. Its main duty was to bind and repair volumes, as binding was the basic measure to make collections robust to wear and tear. With the legal deposit law in 1697 the bookbinders would bind and maintain the publications and special collections materials of unique origin that the library received from printers in Denmark.

However, the bookbinders could not keep up with the industrial developments for new bindings in the private workshops who therefore took over this task in the 1950s. The bookbinders subsequently concentrated on the rebinding and maintenance of the books and materials already stored in the library.

Several bookbinders took part in the rescue action after the catastrophic flood in Florence in 1966 which destroyed many important books and other works of art. This disaster increased awareness of cultural heritage preservation in general and made it clear that the library needed to develop the practical preservation actions to meet the needs in collections. An overall disaster and preservation policy was developed in the 1970s including standards for the practical bookbinding and conservation work and for emergency plans and stacks. Furthermore, the workshop established a wet room for treatment of paper and the first leaf-casting machine in Denmark was introduced.<sup>1</sup> The workshop also changed its name to Binding Section, Preservation and Restoration Workshop to mark this change of responsibilities.

### 2.2 Skills

In the beginning the staff consisted of bookbinders who took up conservation methods, and new generations had to undergo apprenticeships to learn the conservation craft. The growing understanding of the field of conservation in Denmark led to the founding of the School of Conservation (today Institute of Conservation) as part of the Royal Danish Academy in 1973. Since then, the institution has educated students at the bachelor, master and PhD levels in book, paper and photographic conservation, preparing them for jobs in workplaces such as archives and libraries.

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<sup>1</sup> Larsen et al. 1992, 1–47.

This gradually led to a shift in the staff's educational background, as conservators replaced retired bookbinders over a time span of 15 years. Today, the main core of the staff are conservators holding degrees from all academic levels, from bachelor up to senior researcher, with the addition of a few bookbinders.

## 2.3 Organisation

In the mid-1990s the library made an important strategic decision regarding the development of the conservation work. Instead of being a small bookbinding and conservation section in a multi-sectional department the workshop changed into a preservation department on its own. In 1996, a head of the preservation department was hired, with the professional requirement being an academic conservation degree. Of equal importance was the direct reference of the head of preservation to a deputy director who is also a member of the executive board. This structure supports an acknowledgement of preservation issues at the highest organisational level.

# 3 Strategic Preservation Planning

## 3.1 Collection Survey 1999–2001

The professionalisation of the conservation field led the library to initiate a comprehensive survey in 1999–2001 of all cultural heritage collections.

The planning of the survey started in the collection departments with a discussion of the historic significance of each collection. This led to a strong focus on collections of importance for future generations and excluded only collections going on loan outside the secured reading room. The survey design ensured reliable statistical results for each collection in order to have a sound foundation for strategic decision-making around collection care.

This survey<sup>2</sup> documented an urgent need for conservation efforts and concluded that it required a radical change in the conservation policy. Thus, the conservation work was to include more preventive work and an extensive prioritisation by the collection departments had to be implemented. Conservation had to be reserved for the most valuable objects. A large number of objects were in need of

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2 Bevaringsplan 2010, 1–88.



housing and some unstable materials such as brittle paper, cellulose nitrate negatives and acetate negatives were found to be in a highly deteriorated state and in demand of substitution into high quality copies. A greater focus on preventive measures was highly recommended as preventive efforts would benefit all collections. Most storage facilities were of poor quality and an improvement of climate conditions was necessary to preserve the vulnerable materials.

### **3.2 National Commission – Status of Cultural Heritage Preservation**

The library survey made the Ministry of Culture aware of the major challenges with the preservation of cultural heritage in the public collections in Denmark. The persistent work of library director Erland Kolding Nielsen convinced the politicians to arrange a hearing about cultural heritage preservation at the Danish Parliament in 2001.

After the hearing the Ministry of Culture set up a commission of key persons from the cultural heritage field. Their work resulted in a report<sup>3</sup> which gave a national overview and a number of recommendations for future actions. The serious lack of good quality storage for cultural heritage collections in almost all institutions was emphasised and the report uncovered the massive need of resources and funding for conservation of objects. Directly related to the libraries and archives was the necessity of action on the large amounts of acidic paper becoming brittle and thus impossible to handle. Furthermore, the urgent need for more storage space in a quality giving long-term preservation to heritage collections was addressed.

### **3.3 Combining of Conservation and a Preventive Programme**

The national report led to multiple national grants given to cultural heritage institutions in 2004 and onwards until today. The library received 95% of the estimated resources needed to bring care for collections up to a reasonable level. This grant enabled the appointment of ten conservators and the department built up detailed expertise in various areas. The scope of preventive work was increased and it became possible to focus on many different areas within the library which included dialogue with other staff groups and a formal set up to ensure progress. A wide range of actions were introduced to support careful handling in every library

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3 *Udredning om bevaring af kulturarven* 2003.

process from transport to the user, either internal digitisation or external users in the reading room. A regular inspection of storage areas and other premises with objects only kept there on a temporary basis was strengthened to increase order and cleaning standards. Quality of storage environment and disaster management was in focus because of problematic issues in the buildings. This work had to support an enhanced level in the storage environment, prevent disasters and, if it was to occur, minimise damage. The boxing of library materials has been part of prevention work since 1995, but with a new box machine and a minute review of all processes in box production the production of boxes has increased with a substantial number. Due to more resources it was also possible to standardise the procedures for taking private archival materials into the library. Conservators check for dust and pests, sort and pack the material according to stability and appropriate climate zone in the storage, and collection staff add it to the catalogue. Preventive tasks shifted focus over time and pest management has become a major task in preventive work because of the introduction of new species.

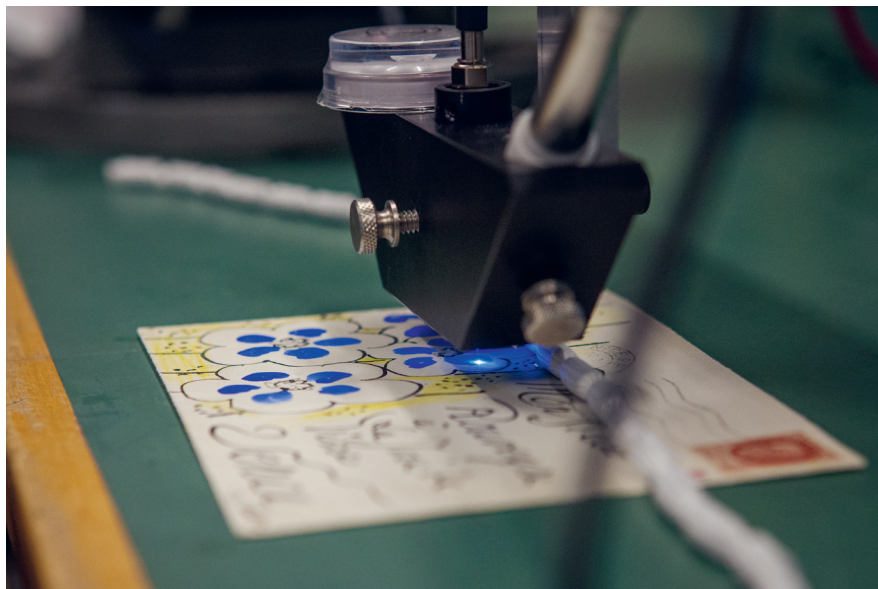
It is important for the preservation department that all preventive work is carried out by professionals who can assess whether a possible threat to an object is critical or can be ignored. Involvement of other staff groups is a necessity since library materials are in a constant flow from storage into use and back to storage. The main core of materials has a standard flow in a library but to secure a special and more protective flow for cultural heritage materials and for the very precious objects it is necessary to keep a constant eye on general library issues which might affect the flow. Working with other professionals in the library should be formalised in working groups meeting on a regular basis, but good informal contact to colleagues can also bring preventive work forward.

A serious concern in exhibiting cultural heritage is preventing a possible fading of the objects and giving the right recommendations for light exposure is of high importance. Exhibitions are an important part of the library's profile and conservators have become an integrated part of the whole process from beginning to end. Mounting of materials improved with a new design<sup>4</sup> and exhibition areas in the library expanded out of the traditional exhibition areas and into the open public library hall in the library building, known as the so-called Black Diamond. These areas have different light quality and objects to be exhibited have a wide range of light sensitivity. This led to the development of a light mapping of the exhibition areas to enhance the decision-making process during planning of the exhibitions.<sup>5</sup> The light mapping project also led to establishing a micro fading tester and this

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<sup>4</sup> Hansen 2019, 117–120.

<sup>5</sup> Hansen et al. 2013, 15–24.



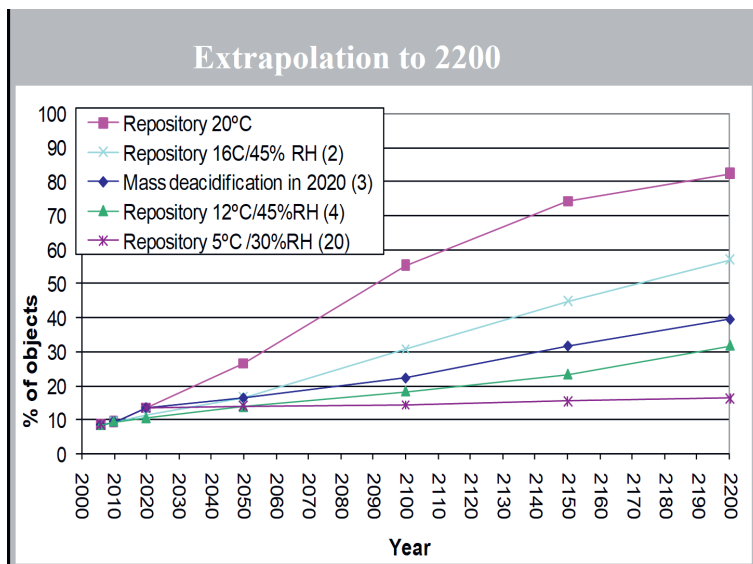
**Fig. 1:** Micro fading of colours has become standard analysis before exhibiting an object. Photo: Annemette Kuhlmann

analysis is now mandatory before any works are selected for exhibitions (Figure 1). Depending on the light sensitivity of the objects and the prescribed light policy, objects might be rejected for exhibition if the total amount of light exposure cannot be adjusted to the required level. The measured levels of light sensitivity and exhibition exposures are kept in a database for future evaluation and decisions concerning exposure.

## 4 Preservation of Unstable Library Materials

### 4.1 Acidic Paper – Cold Storage or Treatment?

A major preservation challenge for the library is the preservation of paper collections, books and archival material from the nineteenth and twentieth century. Following the national recommendations in 2004, a committee for the consideration of mass deacidification as a possible treatment was formed. The library was part of this committee and initiated a survey in the collections to get a proper understanding of the amounts of acid papers and their state of deterioration. The results of the



**Fig. 2:** Lifetime estimations by different means for The Royal Danish Library's collections from 1850–1985. Image: Royal Danish Library

survey showed that in 2006 93% of the paper from 1850–1985 was acidic and that 7% was already brittle and breaking after three hand folds. Lifetime estimation by different means was calculated from the age, pH and brittleness of the examined objects, which showed a great difference in the various measures (Figure 2). A cold environment would effectively slow down the degradation rate so that the number of objects that exceeded breaking after three hand folds would only increase three percent (from 13% to 16%) from 2020 to 2200.

Since preventive conservation is preferred to treatment which often has side effects in the short or long term, the costs of cold storage versus mass deacidification were also calculated. At that time, 2006, it was possible to decrease the temperature to 10°C for 190 years for the price of mass deacidification.

The committee report on mass deacidification<sup>6</sup> had a clear conclusion for the collections in the Royal Danish Library. Based on a review of the advantages and disadvantages of cold storage and mass deacidification, respectively, the Royal Danish Library took the position that in the future focus would only be on expanding the capacity to store the collections cold as mass deacidification was neither a conser-

<sup>6</sup> *Bevaring af surt papir i de statslige samlinger* 2008, 1–45.

vation-wise nor economically competitive method compared to cold storage, shown in Figure 2.<sup>7</sup> The library also concluded that this was in line with the Ministry of Culture's own report on the preservation of cultural heritage from 2003 which recommended that acidic, wood pulp paper should be stored at around 5°C.

## 5 Library Collection Storage

### 5.1 Storage Policy

The conclusion of the mass deacidification committee's work stated in 2008 that the library would give priority to cold storage of acid paper and set a clear strategy for the future storage plans. Each type of material, depending on its susceptibility to deterioration, was to have a designated climate zone decreasing the rate of deterioration to the lowest possible level. In practice, this would mean sorting all existing and incoming collections into different climate zones since collections traditionally were kept in order with their topic or provenance.

### 5.2 Growing Collections and Lack of Storage Space

Throughout the library's history the constant flow of incoming materials has made a lack of space a recurring problem. Although the library built a new facility in 1998 it was still lacking quality storage as emphasised by the national commission in 2003. Therefore, in 2004 the Ministry of Culture approved building a new storage facility where the strategy of climate zones could be implemented. The facility was designed with a cold zone for photographic materials and a cool zone for books.<sup>8</sup> To keep energy consumption of the mechanical ventilation system as low as possible, the cool book storage has a so-called passive climate curve where the temperature is allowed to fluctuate slowly over the year, having a cool set point during winter (8°C) and a higher temperate set point during summer (16°C). Compared to a fixed set point of 12°C, a slowly fluctuating climate curve over a full year makes it possible to save approximately one third of the energy consumption.

Cellulose nitrate negatives are unstable and spontaneously combustible and therefore require cold storage separated from the rest of the cultural heritage col-

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<sup>7</sup> Hansen 2009, 59–66.

<sup>8</sup> Vest et al. 2008, 808–814.



**Fig. 3:** The building site for a new storage facility in Vinge. Photo: DS Flexhal

lections. The Danish Film Institute thus inaugurated a frost storage in 2008 in which the library was able to rent three compartments for storage of the library's nitrate negatives.

It was only with the inauguration of a new large storage facility in February 2022 that the library's space problem was properly addressed (Figures 3 and 4). The new storage located in Vinge in the northern part of Seeland is a common facility for the National Museum of Denmark and the Royal Danish Library. It is the result of long-term work with the preservation of Denmark's cultural heritage, put on the agenda with the report from the commission set by the Ministry of Culture and published in 2003.

### 5.3 State-of-the-Art Storage Facility – Vinge

The new storage facility in Vinge has two different climate zones, which give most types of material an improved lifespan. The most sensitive and easily degradable materials are stored in a cold climate (3–6°C) and the more stable materials are stored in a cool climate (7–14°C). In the long-term, fewer materials will therefore chemically break down, meaning damage will be prevented instead of the material having to undergo conservation. For already damaged objects it will still be





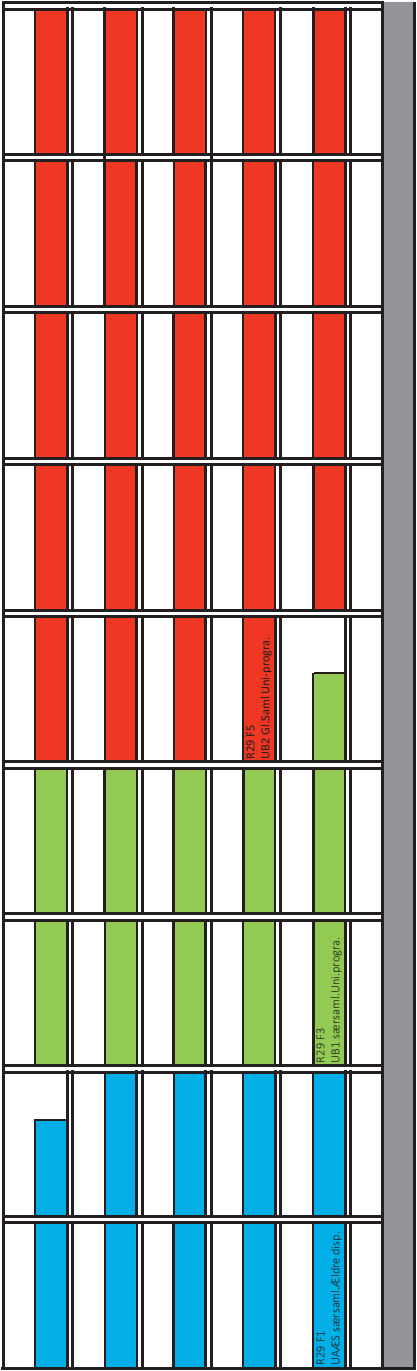
**Fig. 4:** The new storage was ready for moving in collections in 2022. Photo: Atle Clausen

necessary to protect them when they are retrieved from the storage. This will be done with protective boxes, gentle transport and handling. For the damaged and in-demand items conservation will still be a solution to take care of the cultural heritage.

The Vinge storage has approximately 116 kilometres of shelf space distributed over two floors, with the ground floor containing the cool climate zone and the first floor the cold climate zone. Before moving the collections to the new facility they were assigned to the most suitable climate zone. The library has tried to keep the collections together as a whole or make a division in climate zones on a large scale. Still, works were divided into four different shelf formats. The relocation project<sup>9</sup> moving works to the new facility was divided into phases. The first phase started in August 2022 and the second and final phase was completed by the end of 2023. In total the library plans to finish the relocation project and empty the old library building's storage area within three years.

In order to plan the relocation all collections were listed in spreadsheets with format, number of shelf meters and climate zone recommendation included. To come up with a clear plan for the new placement of collections and how they will fill

<sup>9</sup> Pataro and Petersen 2023, 36–40.



**Fig. 5:** A visualisation by Revit of nine shelf racks, each with five shelves and each color representing a collection of books. The name of the collection is added at the first shelf. Image: Royal Danish Library



up the new shelves, the library developed an add-in programme for the construction software Revit. Revit holds all building plans of the library and the add-in programme enables the spreadsheet data to be imported into Revit which visualises all collections on the shelves in floor plans seen from above as well as direct view at the shelves (Figure 5). In the drawings it is possible to see how a large number of collections will fill up a whole storage room and to see the actual placement on a specific shelf with the name of each collection. Finally, the placement codes are exported back to the spreadsheet to complete the overview. Being able to foresee collections placement, the number of shelf meters and free shelving space is a major achievement in storage planning for the library. Earlier large moving projects always had an element of uncertainty with regard to this part of the storage planning which has now decreased to a minimum.

The new storage facility meets high security and preservation requirements and at the same time, emphasis was placed on sustainability when both establishing and operating the magazine. Sustainability plays a big role for the library and from the very first initial meetings about a new storage facility emphasis was on low energy consumption without compromising optimal conditions for the cultural heritage. Therefore, the facility is built with extremely dense and heavily insulated facades and roof surfaces. At the same time the stable temperature of the ground is utilised through an uninsulated bottom deck to allow for a cool and slowly fluctuating climate, reflecting the outside temperature. The energy consumption has thereby been minimised to what is necessary for dehumidification and for cooling the cold library storage compartments. To keep this at a minimum geothermal heating is installed.

## 6 Research and Development

The library's strategic preservation plan and the grant enabled the preservation department to expand the workforce and increase specialisation and knowledge about the conservation of archive and library materials. It also led to a more scientific and analytical approach to preservation and has made it possible for the preservation department to engage in more research and development projects.

The library's research focus has included work on the deterioration and treatment of physical collections<sup>10</sup> and how visual analyses can contribute to biocod-

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<sup>10</sup> Rouchon et al. 2013; Hansen and Sørensen 2017; Vila et al. 2021.

icology.<sup>11</sup> It has also reached out to cross-disciplinary fields including trustworthy imaging of cultural heritage, costs of digital preservation and application of machine learning tools to support preservation of cultural heritage.<sup>12</sup>

A long-term experiment was set up in 2009 to investigate how different storage conditions and housing materials affect paper degradation. It is yet to be analysed to draw conclusions, which can occur as soon as degradation is measured to be significant.

Further analytical instruments were acquired to increase the understanding of our library materials. Multispectral scanning analysis has become an additional tool and is now based in the digitisation department. It enables an uncovering of information in documentary materials which is hidden to the naked eye. The most recent addition of analytical equipment is a handheld x-ray fluorescence spectrometer. The main purpose of purchasing this equipment will be the identification of toxic elements in our library materials, such as arsenic.

## 7 A Green Library

In 2019, the Royal Danish Library published its first strategy to become a green library. The vision of the climate strategy is that the library's operations will be climate neutral by 2050. It will focus on reducing CO<sub>2</sub> in the areas of building maintenance and storage facilities, transport and logistics, buying materials and services and waste and recycling.<sup>13</sup> The Department of Preservation works closely together with the department for building maintenance to reduce CO<sub>2</sub> emission from storage facilities. System shutdowns are also implemented as well as reconsidering climate set points. Solar cells have already been installed on several buildings, and heat pumps and geothermal heating are considered in other cases.

The remaining focus points in the strategy will also affect how conservators make the collections last longer. As the largest purchaser of paper and cardboard, the preservation department will have to include quality requirements based on life cycle assessments. Some of the products used for packaging of collections have a large climate footprint and this issue will be addressed in the coming years.

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<sup>11</sup> Fiddymment et al. 2019; Vnoucek et al. 2020b; Vnoucek et al. 2020b.

<sup>12</sup> Wüller and Kejser 2016; Kejser et al. 2011; Gindley et al. 2014; Kejser et al. 2021; Boesgaard et al. 2022.

<sup>13</sup> *A Greener Library* 2021.

## 8 Conclusions and Future Perspectives

With a clear conservation strategy set more than 20 years ago and with financial means to support it, the Royal Danish Library has succeeded in transforming a conservation workshop with roots in the traditional bookbinding craft into a modern preservation and conservation department. With the strengthening of preventive conservation methods and involvement across the organisation we have positioned the preservation department as an integral part of the library rather than being a service that can be ordered according to what others think is necessary.

The conservation experts have been involved in large building and relocation projects in recent years, making valuable contributions, and at the same time have been able to make the necessary compromises without selling out on important preservation principles.

Good storage conditions and materials assigned to the most suitable climate zone will delay the chemical degradation of materials. However, the library reader's constant need for physical materials requires a constant effort to prevent physical damage and to conserve objects which suffer from damage. Still, physical exhibitions are an important part of the library's profile and conservators' expertise is needed to ensure what would have otherwise faded in three months can be stored unaffected in storage for decades. Research and developments in the understanding of materials are essential to support all aspects of a conservator's work and form the future ways of interpreting our cultural heritage with respect to preservation.

Climate change and other changes in library strategy will influence conservators' way of decision-making in the future and challenge traditional ways of working. However, conservators are trained to think about long-term stability in our work and sustainability should therefore be an obvious parameter to incorporate in our work.

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