Seeing Versus Saving

Recommendations for Calculating Research Use-Lighting for Library Special Collections

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The research presented in this paper describes the measurement of light and ultraviolet energy within a special collections facility, with the goal of evaluating whether levels recommended for museums and archival collections are being exceeded during research usage. An Elsec 764 hand-held light meter was used to record the light intensity falling on collection material held within and without V-shaped book mounts and with sequential lights turned on, as occurs in collections' use. The authors developed a simple algebraic formula to calculate cumulative doses of light and incident ultraviolet radiation to determine how many hours collection material could be accessed and illuminated before damage could be expected. The authors calculated the maximum cumulative doses possible based on numbers of access hours and compared these to recommended doses for sensitive media as a monitoring strategy for the long-term preservation of light sensitive special collection materials. The results from this study suggest that the light levels evaluated are not in excess of recommended values and that the use of book mounts reduces the amount of light falling on collection material. Monitoring actions are recommended for institutions wishing to replicate the study.

The potential loss of value to library special collections materials damaged by inappropriate lighting can be estimated with simple measures described in this paper. This research aims to fill a gap in the literature concerning light damage to diverse library collections, with a specific goal of understanding the relationship between variable illumination falling on materials during research use and predicting fading behavior. Additionally, the authors explored the applicability of book mounts to determine whether their use reduces the amount of light falling on surfaces, thereby permitting greater long-term preservation of collection material. Despite numerous published studies recommending specific ranges for library and special collections storage and display illumination, no comprehensive assessment of the cumulative effects of light falling on collections accessed during use and under varying lighting conditions has been conducted.

The authors set out to measure the maximum possible annual light and ultraviolet radiation doses experienced by special collections materials through normal use by undertaking a study at the Young Research Library at the University of California, Los Angeles (UCLA), in a special collections reading room. The findings from the study stress the need for library stewards to know the duration and intensity of light falling on their most sensitive collections because this knowledge

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will ultimately affect the condition of certain materials and inform care practices. Potential responses to managing lighting, such as instituting the use of lighting logs for individual items or the use of lower wattage bulbs, neutral density filters, and ultraviolet filters, are explored elsewhere in the museum lighting literature and are therefore omitted here.[1] The method used, particularly for evaluating lighting where materials are accessed, can be applied to other special collections libraries for both planning and comparative purposes.

This study was inspired by the paradox that librarians encounter—concern with providing access to information coupled with needing to restrict this access in the interest of long-term preservation. To set the context, the authors introduce how light is measured, its sources, and the importance of its cumulative and irreversible effects on special collections materials.

Literature Review: Evolution of Library Lighting Recommendations

The authors examined the literature of environmental preservation guidelines for libraries, archives, historic homes, and museums to chronicle trends in lighting recommendations. Two trends are encountered in the literature reviewed. The first is the adoption of broad ranges of light levels recommended for library reading rooms and stacks with slightly more restrictive light levels for task lighting. The second reveals guidelines and recommendations written specifically about exhibitions for libraries, including those put forward by national libraries and conservation and lighting organizations. The recommendations of lighting organizations more closely align with museum guidelines.

The idea of what is needed to implement best practices in environmental preservation for libraries, archives, and museums has changed during the past sixty years, with numerous and contradictory recommendations put forth.[2] Before detailing these recommendations, the authors first explore the terminology used throughout the literature. Beginning in the 1950s, color scientists established that visual comfort requires a minimum of 50 lux, which is enough light to ensure that the human eye is operating with the full range of color vision.[3] "Lux" is the term used to describe visible light expressed as lumens (light) per square meter.[4] Ultraviolet light is a proportion of visible energy expressed as microwatts per lumen (µW/lm).[5]

Sources agree that lux levels should be set to ensure the most effective balance between the needs of readers and the need to minimize light damage to collections.[6] Light damage is determined by the wavelength of the light, length of the exposure, and the intensity of the illumination, which in excess can accelerate deterioration on the molecular level, resulting in cumulative and irreversible damage.[7] From 1998 to the present, a range of recommendations concerning light levels for libraries and archives have been put forward by authors and private organizations. A guide to library environmental monitoring and control published in 1998 provides specifications of 200–300 lux as an acceptable range for library reading rooms and a more conservative estimation of 50–70 lux for a maximum of 60–90 days for light-sensitive materials.[8] In 2004, Ogden (in a manual for collections preservation in library design) advised values below 300–650 lux for task lighting and between 65–375 lux for inactive lighting of stacks.[9] Despite the range in lux provided, Ogden recommended that "light levels for the stacks should be set to the minimum acceptable to enable book titles and call numbers to be read."[10] A library design guideline published in 2005 with recommendations from the Illuminating Engineering Society distinguished between light levels of 500 lux for active task lighting to permit visibility of fine printed material, 50 lux for storage spaces, and 300 lux for usage spaces depending on the distance from the measured light source.[11] Beech advocated no more than 50 lux for the exhibition of collection material in a paper given at the 2005 Philatelic Congress of Great Britain.[12] A small pamphlet produced in 2007 by Etheredge recommended that libraries "put your collections in a room without windows" to ensure long-term preservation of library special collections.[13] These recommendations illustrate the ranges encountered in the literature, in which the suggested lux levels can range from as high as 650 lux to no light at all for both the use and display of library collections. Despite the numerous suggestions for lux levels in the literature, advice concerning the complex issues that arise with illuminating special collection material accessed during research use is lacking.

Much of the literature for museums and library special collections offers guidelines and recommendations specifically related to the exhibition of unique artifacts. This is largely because both museum collections and special collections spend the majority of their time in dark storage, protected from both light and ultraviolet energy. However, unlike museum objects, special collections receive their greatest light exposure during research use rather than display, and library preservation specialists note that light levels should differ within storage, exhibition, and reading rooms.[14] National standards for the display of library and archival materials approved in 2001 by the American National Standard /National Information Standards Organization (ANSI/NISO) state that for exhibitions most items should be exposed to 50–100 lux, with cumulative annual light exposures of between 42,000–84,000 lux-hours over a twelve-week period, at ten hours a day.[15] A twelve-week exhibition at these times and intensities is recommended only once every two years so that the 42,000–84,000 lux-hours are reduced by half (21,000–42,000) when expressed as an annual total dose. These standards also suggest that at the 50–100 lux level, ultraviolet light exposure should not exceed 75µW/lumen, although Saunders recommends 10µW/lumen.[16] These standards are understandably stringent, as in the case of highly sensitive collections illuminated at 50 lux; this exhibition duration would restrict exposure to 420 hours rather than 3,000 hours of annual display.

Museum conservators in the early 1990s developed lighting policies for the display of collections with annual recommendations of total dosages, which are calculated on the basis of the sensitivity of different media.[17] Differing sensitivities are recognized for library and archival materials so that annual cumulative dosages of light have been adapted for their display.[18] Environmental guidelines for the exhibition of library and archival materials mandated in a directive to the National Archives and Records Administration include restricting the cumulative dose of light and ultraviolet radiation, while normal office lighting modified to exclude all ultraviolet radiation is recommended for research rooms in archival facilities.[19] Preservation guidelines described for special collections storage include the elimination of all natural light and the use of ultraviolet filters on all fixtures.[20] An example of a previous study applying these principles is an environmental assessment of the rare book collection at the University of Tennessee, in which the authors identified collections receiving ultraviolet radiation in excess of recommended values.[21]

Despite past and recent recommendations of environmental standards for the storage and display of library and special collections, the authors of the current study found no published strategies for determining the lighting dose accumulated by special collections during research use. This is a necessary step if cumulative doses are to be compared with recommended annual exposures, thereby permitting an evaluation of damage induced by light.

Special Collections: Issues of Restrictions and Access

Special collections in institutions are created using individually developed collection policies, with preservation of the artifact playing an overarching role.[22] Factors such as monetary value, age, physical characteristics, bibliographic value, and condition are considered by individual institutions to determine whether the item requires the preservation and security handling of a special collections department.[23] Most special collections libraries require users to sign an agreement that includes restrictions on food and beverages, requirements about approved note-taking materials (pencils instead of pens), the use of book mounts, and restrictions on photocopying. UCLA's Charles E. Young Research Library Department of Special Collections requires individual users to complete a registration form with their contact information, proof of identification, and statement of purpose.[24] Additional protocols include specifying that only special collections staff may perform duplication of material, and written protocols about reproduction state that "limits have been established to ensure preservation of the materials."[25]

Restrictions on access and use are necessary in special collections libraries because, unlike general library materials that circulate, special collections are often the most highly valued because of their rarity and preciousness. Unique items may enter the special collections division of the library immediately after acquisition, or they may enter circulating collections and be moved later to a special collection. Materials at the UCLA Department of Special Collections at the Charles E. Young Research Library, where the research was conducted, include illuminated and palm manuscripts, scrapbooks, artists' books, early newspapers, a variety of photographic media, original art works, sheet music, architectural renderings, weapons, cuneiform tablets, historic clothing, and wire recordings. Some of these materials include light-sensitive pigments on organic media, books and graphic documents, albumen prints, color photographs, parchment, leather, and new media.

The same use, display, and storage guidelines suggested for museum materials may be advisable for special collections materials because these items represent the sections within the library in which the materials parallel those found in museums. Despite the irreparable damage done by excesses of light, illumination is a necessary factor for viewing collection materials and must, therefore, be monitored and controlled.

Seeing Versus Saving

In the fall of 2008, the authors conducted a light monitoring study in the Ahmanson Murphy Reading Room at the UCLA's Charles E. Young Research Library. The study involved taking readings of visible light and ultraviolet energy with an Elsec 764 hand-held light meter, with book collections supported both inside of V-shaped book mounts and lying flat. The authors calculated the cumulative exposure of light energy to quantify the time until a just-noticeable fade (JNF) might be detected in the library's collection material. They sought to determine a strategy for measuring the lighting dose accumulated by special collections during research use to permit collections staff to compare cumulative lighting dosages to sensitivity standards. Before launching into a discussion of how the measurement and interpretation of light values are applied in this case study, defining terms used to describe light energy is necessary.

Light Energy and Ultraviolet Radiation: Definitions and Effects

The scientific and descriptive terminology used to describe light energy and its effects on special collection materials help to identify and define problems with inappropriate light levels. Light energy within the visible portion of the spectrum (figure 1) is measured between 400 and 700 nanometers (nm) and is well established as damaging to collection materials.[26] Ultraviolet radiation is measured between 200 and 400 nm, is often more damaging than visible light, and is proportional to visible energy.[27] Ultraviolet radiation is measured as the ratio of ultraviolet radiation intensity (in radiometric units $\mu W/m^2$) to light intensity (in photometric units, lux = lumen/m^2), hence the result is expressed as microwatts per lumen (µW/lm).[28] The light energy from visible and ultraviolet regions can be absorbed by the molecules within an object, causing many possible sequences of chemical reactions, known as photochemical deterioration, which is very damaging to paper.[29]

Damage to library materials from inappropriate lighting will result in irreversible condition issues that ultimately can affect intrinsic and research value. Visible light radiation originates from sunlight and some fluorescent and incandescent bulbs; the latter can cause warming and desiccation of objects if used in close proximity to collections.[30] Infrared radiant energy is seldom sufficient to induce the chemical reactions that are normally encountered in photochemical deterioration, but it can raise temperatures significantly, which can cause a different kind of damage.[31] Garrison and Lull reported that light damage and direct light on collections causes an increase in temperature, fading, yellowing, embrittlement, and weakness.[32] Saunders reported that light damage results in loss of color and strength.[33]

Measuring Light: Interpretation and Use of Values

Light is measured in museum and library contexts with devices called light meters, which contain a photoelectric cell of the type found in cameras.[34] Light meters can be used to record incidental lighting or can be set up to record lighting over a set amount of time with devices called data loggers. Light intensity is measured as visible energy per unit area, expressed as lumens per square foot (footcandle) or, using metric measurements, lumens per square meter (lux). Cumulative exposure is measured as intensity times duration, equaling lux hours (or footcandle hours), with larger quantities expressed as kilolux (Klux) hours or megalux (Mlux) hours.[35] A shift within museums and historic houses from conservation monitoring of incident light and ultraviolet levels to logging cumulative doses occurred in the late 1980s in recognition of how damage actually occurs.[36] Hain noted in 2003 that environmental monitoring of special collections had been augmented by data loggers, which collect light data alongside the temperature and relative humidity data more common to library environmental management.[37] Morris restated the advantages of logging in 2009.[38]

Specialists in museum lighting have proposed various recommended cumulative light exposures for collections.[39] Cumulative light exposure is expressed in terms of a total annual exposure, which is calculated on the basis of typical museum exhibition periods of twelve weeks with an exposure of ten hours per day. Using this type of calculation, Michalski provided the numbers of lux hours (or light intensity multiplied by time) before a JNF would occur for items of differing International Organization for Standardization (ISO) sensitivities (table 1).[40] Material sensitivities are expressed in terms of ISO Blue Wool Standards, using ISO groupings of material sensitivities. ISO Blue Wool Standards

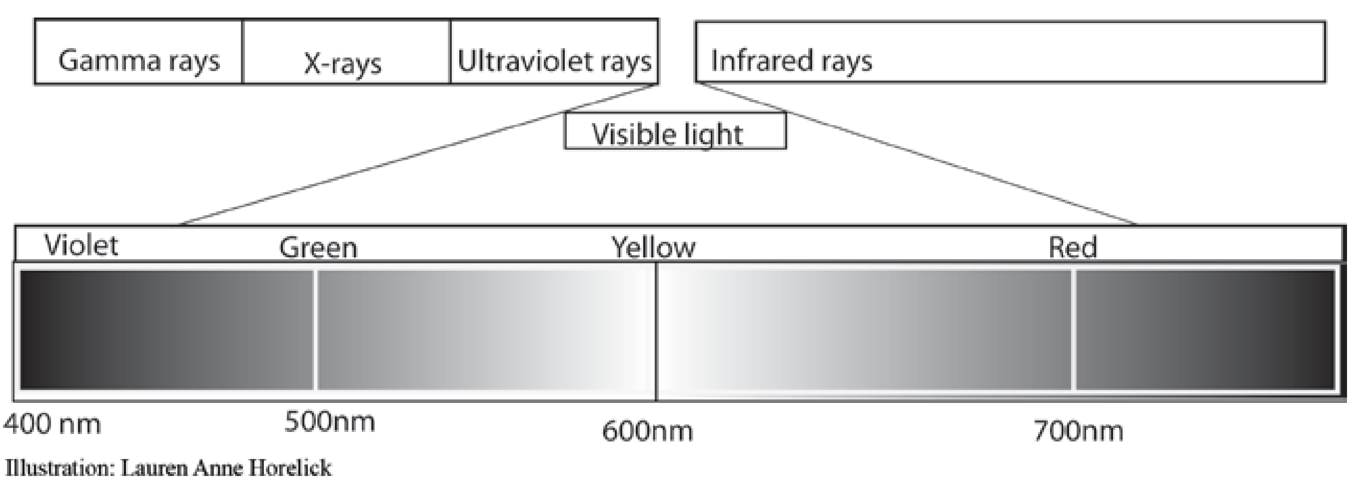

Figure 1. Electromagnetic Spectrum

Table 1. Categories of ISO Sensitive Materials and Associated Fade Time

Category	Examples of Artifacts	Estimated Years to Just Noticeable Fade
High sensitivity ISO 1,2,3	Albumen prints color photographs, plant dyestuffs, 20th c. dyes, tinted papers, ballpoint ink	1.5 to 20 years 0.23 - 3 Mlux hours 1.5 years at 150,000 lux hours per year= 225,000 lux hours till fade
Moderate sensitivity ISO 4,5,6	Parchment, leather, fur, feathers, textiles	20-700 years 3 - 105 Mlux hours 20 years at 150,000 lux hours per year = 3 million lux hours till fade
Low sensitivity ISO 7,8 above	Stone, metals, ceramics, B/W photographs, graphite, mineral pigments	300-7000 years 45 - 1050 Mlux hours 300 years at 150,000 lux hours per year 45 million lux hours till fade

Source: Stefan Michalski, Ten Agents of Deterioration: Light, Ultraviolet and Infrared: How Much Light Do We Need to See? (Ottawa: Canadian Conservation Institute, 2010), table 3, www.cci-icc.gc.ca/crc/articles/mcpm/chap08-eng.aspx#Light (accessed Oct. 9, 2010).

are dyed textiles prepared in a series of eight, with ISO 1 being the most sensitive and ISO 8 being the least sensitive.[41] Fading of these standards corresponds to generally predictable exposure levels of combined light and ultraviolet radiation, allowing users to estimate the cumulative dose that caused particular dyes in the series to fade.[42]

The reciprocity principle, which describes photochemical damage as a factor of both lighting intensity and duration, implies that damage can be mitigated by controlling one or both of these factors.[43] The reciprocity principle may be used to manipulate the variables of visible light and time to achieve necessary illumination while not exceeding cumulative annual light exposures. This concept states that limited exposure to a high-intensity light will produce the same amount of damage as a long exposure to a low-intensity light.[44] An example would be that exposing an illuminated manuscript to 100 lux for five hours would cause the same amount of damage as if it were exposed to 50 lux for ten hours. Adequate lighting is necessary to facilitate viewing, but excessive or inappropriate illumination has an irreversible effect on collection materials. While lighting standards are readily implemented in the case of museum exhibitions, applying lighting standards to special collection reading rooms in libraries is difficult because of the unique needs of researchers.

Case Study: Measuring Variable Illumination of Special Collections Materials with and without Book Mounts

The authors evaluated whether specific lighting standards or protocols are necessary in a special collections reading room by recording measurements of visible and ultraviolet light in the Charles C. Young Research Library Ahmanson Murphy Reading Room on the UCLA campus. See figures 2 and 3 for a floor plan of the reading room. This reading room houses a collection of fifteenth-century Italian manuscripts in wooden cabinets lining the walls of the room and is the sole location where users access the diverse range of special collections materials. The reading room is on the lower level of the Young Research Library and receives no direct or indirect sun light. The collection materials are stored below the reading room in the library and are brought up to the reading room when paged for use. Paged materials are held in the back of the room behind a permanently installed folding screen and are stored on wooden or metal shelves for up to five days, unless special arrangements are made by individual patrons for longer use. The materials are often housed in opaque protective enclosures, stored either vertically or horizontally.

The reading room is illuminated by four different light sources (see figure 2). Forty-two-watt compact fluorescent bulbs are located in the twelve recessed lights situated at the north and south ends of the room—six over the student monitor desk and another six over the storage area behind the screen. Three pendant lamps illuminate the main table, and each also use two 42-watt compact fluorescent bulbs. The reading room has six large conjoined wooden tables capable of accommodating twelve individuals, each with a user-operated desk lamp. Each user-operated desk lamp has one 15-watt incandescent bulb. A row of more than 200 5-watt incandescent bulbs lines the top periphery of the room's bookcases. The recessed lights, pendant lamps, and perimeter lights are used Monday through Friday for ten hours a day.

The authors took light measurements with the main reading room table's sequential user-operated desk lamps turned on to approximate the lux generated when the room is fully occupied. Light readings were taken with and without the use of foam V-shaped book mounts to determine whether the angle of illumination in normal use, which includes book mounts, increased or diffused the total lux hitting collection material. This set of light-monitoring readings was developed to evaluate the risk of overexposure for extremely light-sensitive materials. The potential for overexposure necessitates changes in policy, such as use in a specially lit location, usage logs, or further use restrictions.

Research Method

An Elsec 764 light meter (see table 2 for specifications) was used to gather incidental, quantitative measurements of the amount of visible light and ultraviolet radiation falling on collection materials brought onto the main table in the reading room. In developing the light-monitoring method, the authors considered the potential for increased exposure from individually operated nearby light sources. They took readings from one location on the main table with sequential and adjacent lights turned on. This was done to determine whether these lights, in addition to overhead and ambient lights, increased the total lux hitting collection materials (figure 3 indicates where the readings were taken). Measurements recorded lighting incident on collections during research use and do not include exposure calculations for Italian manuscripts stored in glass front cabinets in the reading room. The authors recorded all visible and ultraviolet energy measurements while laying the Elsec 764 flat on the table, simulating the position of collection items, and then took a second round of readings in the same location measuring the amount of light within foam V-shaped book mounts.

The measured lux, both within and without book mounts, and with sequential illumination is presented in table 3. The authors used the recorded lux from these tables to determine how many hours until a JNF would occur at the given light levels by creating a simple algebraic formula:

$E/L = T_M$

Where,

E = Estimated cumulative lux hours to a just noticeable fade (based on Michalski's ISO 1–8 recommendations. See table 1 for values).

L = Measured incident lux (in a given lighting scenario).

T_M = Total hours (before a JNF occurs).

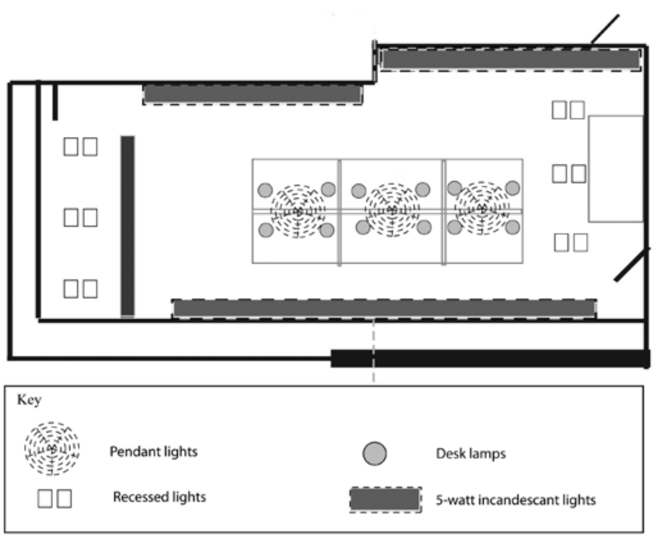

Figure 2. Ahmanson Murphy Reading Room Floor Plan Showing Light Sources

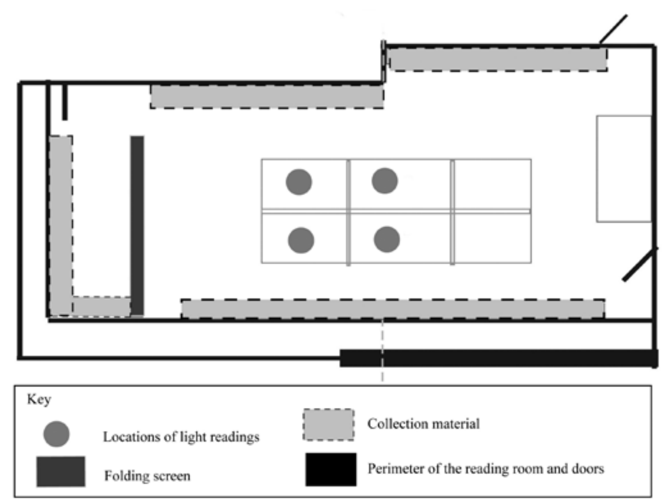

Figure 3. Ahmanson Murphy Reading Room Floor Plan Showing Locations of Light Readings

Table 2. Specifications of the Elsec764

Device	Visible Wavelength Range	Visible Power Range	UV Wavelength Range	Operating Temperature	Accuracy
Elsec 764C	400–700nm (CIE response). No correction required for different light sources.	0.1–200,000 Lux (0.1–20,000 Foot-candles).	300–400 nm	0–50°C	*Light*: 5% +1 displayed digit *UV*: 15% *Temperature*: 0.5oC (0.9oF) *RH*: 3.5%

Source: Pacific Data Systems, ELSEC 764 and 764C, www.pacdatasys.com.au/dataloggers/ELSEC_Specs.htm (accessed Nov. 13, 2010).

To calculate the hours until a JNF occurs, the authors used Michalski's annual dose of 150,000 lux hours (i.e., 50 lux at 3,000 hours) as a starting point and his approximate evaluations of years to fade for ISO sensitive materials (see table 1).[45] The values to JNF were calculated using the above formula and are shown in table 4. The cumulative lux hours predicted to cause JNF over the lifetime of different classes of ISO materials with varying light sensitivities were divided by the cumulative lux measured for routine illumination in the special collections reading room. The value generated from this formula is the number of hours until JNF occurs. The total hour maxima (T_M) should fall under the recommended ISO luminous exposures for the particular sensitivity level of each item to achieve a JNF.

To use this formula, one would first take an incident light reading, the number of which would be used in the "L" position of the formula. For example, the ambient light in the Young Research Library was recorded at 159 lux. To determine the value for "E," numbers are substituted from the ISO sensitivities (high, low, and moderate). For materials that fall under the high sensitivity, the value for "E" is 225,000. For ISO moderate-sensitivity materials, "E" is substituted with 3 million, and for low-sensitivity materials, "E" represents 45 million. To determine the JNF of highly sensitive materials, the equation would read 225,000/159 = T_M. Once solved, T_m (total hours before JNF) is 1,415 hours.

Findings and Discussion

The results from the case study to determine the effects of various illuminations falling on collection material yielded two data sets: lux values recordings and recordings of hours till JNF occurs with and without the use of V-shaped book mounts. The findings established concrete numbers representing hours until fade will occur, thereby allowing library stewards to establish reasonable numbers of usage hours per year for their collections.

Table 3 summarizes the results of the incident readings measured on the main reading room table with and without V-shaped book mounts and with successive user operated lights turned on in addition to ambient room illumination. The top portion of table 3 shows the measurement of lux without the use of V-shaped book mounts, and within the first column of overhead lights only; the recorded value is 159 lux, which is well in excess of the recommended 50 lux for very sensitive materials. The authors note the comparison between the lux from overhead lights to the lux derived from four desk lamps (159 lux to 185 lux). The gain between these varying lighting conditions is 26 lux, which represents a significant increase above recommended values for extremely light-sensitive materials.

Special collections cannot be realistically illuminated to a 50 lux level, therefore the tangible value in collecting the raw data seen in table 3 is realized when it is used to calculate cumulative totals until a JNF occurs. The number of hours until a JNF occurs when collection material is accessed without a book mount was calculated using the formula and shown in table 4, allowing the steward to assess if the collection's materials are in danger of damaging light levels during routine use. By analyzing this data, alternative strategies can be planned for protecting the most valuable and sensitive materials.

With the lighting in the Ahmanson Murphy Reading Room accepted as the minimum required for task lighting, fading damage is estimated to occur on the most sensitive materials after 1,415 hours (140 days) or twenty-eight weeks of exposure. The most significant increase in lux is seen when one desk lamp is used in addition to the overhead lights, causing an increase of 30 lux, which translates to fading in 1,257 hours (126 days) or twenty-five weeks of exposure. Items that fall under the ISO categories of moderate and low sensitivities, as expected, show slower rates of fading, although they too are not immune to excessive light exposure, evidenced by the calculated hours to fading in table 4.

Table 3. Recorded Values of Consecutive Illumination

Light type	Overhead lights only	1 desk lamp	2 desk lamps	3 desk lamps (opposite side)	4 desk lamps (opposite side)
Values without book mounts					
Visible light (in lux)	159	179	181	184	185
Ultraviolet light (in microwatts per lumen)	45	43	43	43	43
Recorded values inside of V-shaped book mounts					
Visible light (in lux)	144	162	164	164	164
Ultraviolet light (in microwatts per lumen)	45	43	43	43	43

Table 4. Calculated Hours to Fading

ISO Blue Wool categories and hours to fading	Overhead lights only	1 desk lamp (reading directly under)	2 desk lamps	3 desk lamps (opposite side)	4 desk lamps (opposite side)
Calculated hours to fading based on light readings when books are flat					
High Sensitivity. Hours to Fading over 1.5 years	1,415	1,257	1,243	1,222	1,216
Moderate Sensitivity. Hours to Fading over 20 years	18,868	16,760	16,574	16,304	16,216
Low Sensitivity. Hours to Fading over 300 years	283,018	251,396	248,618	244,565	243,243
Calculated hours to fading, based on light readings taken within a V-shaped book mount					
High Sensitivity. Hours to Fading over 1.5 years	1,563	1,389	1,372	1,372	1,372
Moderate Sensitivity. Hours to Fading over 20 years	20,833	18,519	18,293	18,293	18,292
Low Sensitivity. Hours to Fading over 300 years	312,500	277,778	274,390	274,390	274,390

The authors recorded a second set of readings taken inside of foam V-shaped book mounts to assess if the use of these mounts affects the amount of light falling on collection material. The lux values from the second round of readings (table 3) showed a decrease in lux falling on collection material in comparison to the readings taken flat on the table. The recorded lux values were used in combination with the formula to derive the number of hours until JNF occurs. The calculated number of hours till JNF is also recorded in table 4.

With the overhead lights only, the lux reading was 144 when taken within V-shaped book mounts, in comparison to 159 lux without. While this is a difference of 15 lux, it translates to a difference of 147 hours (15 days) until JNF occurs. An unexpected benefit of the use of the V-shaped book mounts is the reduced light levels obtained in the readings, which can be seen by the consistent value of 164 lux recorded with two, three, and four sequential lights turned on. Comparing the hours to JNF between the readings taken with and without V-shaped book mounts revealed a dramatic reduction in lux levels. For clarity, only the ISO high-sensitivity materials are discussed. The lux levels taken while using V-shaped book mounts showed a JNF with only the overhead lights on occurring in 1,563 hours over 1.5 years (i.e., 142 days or 28 work weeks). This is a difference of fourteen days when compared to the hours until fading occurs without the V-shaped book mounts. The stable lux readings and the consequently static JNF shown with the use of two, three, or four sequential desk lamps turned on suggests that the book mounts not only protect the physical object, but also the information within.

The estimate of hours to fading within these studies does not account for previous fading and does not help users discriminate between materials of varying sensitivity. However, these exposure limits comply with the stringent AINSI/NISO standards of 420 days per year at 50 lux, that is, lighting in the special collection evaluated is three times as intense as the standard recommendation, so that the days to JNF are reduced to one-third. The ultraviolet radiation measured in the reading room is below the 75μW/lumen recommended by ANSI/NISO standards, but because it does not contribute to the visual access of these materials, the authors recommend filters that reduce the ultraviolet radiation to zero.

An unexpected finding of the measurements taken within V-shaped book mounts and with sequential lights turned can be seen with the reduction in light levels when compared to those readings measured when the books are flat. The finding of the reduced light levels with the use of V-shaped book mounts is unexpected because the authors had anticipated that an increase in light would result in an increase in recorded lux. The numerical difference in the results translates to a small extension of the lifespan of special collections materials. Knowing that one common preservation step taken at the Ahmanson Murphy Reading Room does not create risks in other areas is gratifying.

Conclusions and Recommendations

The primary research question for this study sought to assess the effects of variable illumination on special collections during research use, the results of which have the potential to inform access, care, and library preservation policies. This study illustrates how recording lux hours may be used to determine rates of fading for collections of differing material sensitivities, information that may be used to devise concurrent access and preservation of materials. The assessment of the ambient and direct light within a reading room was conducted to evaluate the incident lux illuminating collection material during use, which is a strategy previously unreported in the literature. The measured values taken were used to calculate the total number of hours until a JNF would occur with the present lighting conditions. These calculations illustrate how various collection materials would fare using Michalski's guidelines for annual light exposure based on specific materials sensitivity.[46] These standards, designed for museum exhibition purposes, demonstrate that the risk of overexposure in a reading room setting is a concern only for the most fugitive and heavily used special collections materials. For these materials, information about lighting conditions and hours until fade may be used to establish an allowable number of use hours per year. However, use times typically required to correlate to a loss of information are not likely to be reached.

The approach taken in this study aimed to quantitatively evaluate the effects of variable illumination on special collections materials and found that the use of adjacent and opposing light sources contributes to the exposure of collection material. In this particular scenario, the variable lighting contributed to a minor increase in light exposure. The use of V-shaped book mounts provides support to collection material and deflects the angle of illumination, thereby diminishing the effects of deterioration by light damage. However, illumination will vary from institution to institution, which points to the need to know what the maximum lux potential can be per institution. Once that information is established, appropriate measures can be taken when very sensitive materials need to be accessed. In this study, the authors applied a museum conservation approach with the full understanding that ideal lighting for very sensitive materials may not always be possible. However, the ability to measure and calculate the lux in a given institution will ensure that access to information will remain possible, which is a concern for both librarians and conservators.

The authors' recommendations for special collections libraries include the implementation of data loggers to record light levels in spaces in which collection materials are accessed, and to collect incident readings simulating patron use to determine whether harmful light levels are present. The formula provided in this study enables collection stewards to evaluate lighting risks and take preservation action where needed. The authors suggest that a light log that records use hours be created and even be maintained specifically in the case of a patron requesting access to a significant subcollection, for example, illuminated and palm manuscripts, scrapbooks, artists' books, early newspapers, photographic media, and original art works within a special collection. These use hours plus the predetermined incident lux and ultraviolet radiation dose can be factored to calculate cumulative dose. The designation of lux hours per year may be used to consider access limitations to cumulative light energy for different collections' material sensitivities.

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