ASSESSING RISKS  
TO COLLECTIONS

an introduction to the

Cultural Property Risk Analysis Model (CPRAM)

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“if you can measure that of which you speak, and can express it by a number, you know something of your subject; but if you cannot measure it, your knowledge is meagre and unsatisfactory.”

Lord Kelvin

“Methodism is likely to flourish in those situations that provide feedback on the consequences of our actions only rarely or only after a long time. In particular, if our plans apply to a field in which we rarely act, our planning gradually degenerates into the application of ritual.”

Dietrich Dorner, 1996

“All models are wrong, but some are useful.”

Box, 1979

# INTRODUCTION

The overall goal of this workshop is to demonstrate to participants the Cultural Property Risk Analysis Model (CPRAM; Waller 2003) first developed and implemented at the Canadian Museum of Nature then further developed and refined by Protect Heritage Corp.

Ideally, we should be able to identify and quantify all risks to a collection or set of collections (Waller, 1994), and be able to establish a set of strategies and priorities for mitigating risks in the most cost-effective manner possible. We will never have the knowledge required to do this precisely. Fundamental uncertainties of random processes, and timing of random events, dictate that, even with perfect knowledge, we could never predict the future precisely.

Still, by attempting to identify all risks to collections, we can be much more comprehensive in our identification of risks. Then, by developing useful estimates of the relative magnitudes of most risks, we can manage the most important risks. This results in better preserved collections.

This workshop outlines the use of the CPRAM for assessing risks to collections and for organizing and presenting the risk information to manage preservation.

### Objective

The overall objective of this workshop is to enable collection care professionals to effectively assume accountability for establishing and communicating what risks impact cultural property, by how much, and what controls are in place, or could be in place to manage those risks.

More specifically, this workshop will enable you to:

* Identify risks – by “agent of deterioration” and “type of risk”.
* Define risks clearly.
* Assess the magnitude of defined risks.
* Evaluate data and present information to stakeholders.
* Systematically plan risk mitigation strategies by:
* Identifying means of control - methods and levels.
* Evaluating costs/risks/benefits of mitigation strategies.

### Methods

The workshop is interactive and participants learn through a combination of:

* lectures
* demonstrations
* brainstorming in small groups,
* group presentations
* exercises, practice
* and discussions

### Organization of the manual

The main part of this manual provides the content of the workshop. It should reduce the need for taking notes and provide a structure in which you can make your own comments and notes. Each major section includes a brief description of the learning objective, outcome, and benefits. These provide a quick reference for you to evaluate whether you have actually learned what you are expected to learn in each section. Most sections include parts that describe a concept followed by parts that provide one or more exercises for working with the concept.

The participant manual also includes a Glossary that should be referred to frequently while you become familiar with the terms.

Following the main part of the manual are four appendices. The first of these provides worksheets. Some of these will be used during the workshop but there are enough blank sheets provided that you will have blank worksheets remaining for later use. The second appendix provides a scenario for completing a risk assessment. It includes all the information required to estimate risks and a completed assessment of risks that can serve as an answer guide.

# CMN’s Collection Management Model

The model of a collection management system developed by the CMN describes the collection management system including three major subsystems: develop, use and preserve.

**Preserve**

**Develop**

**Use**

**Collection Management**

The overall goal of collection management, that is to make a collection available to current society and future generations for the continuance and betterment of humanity. Each subsystem contributes in an interrelated way to this goal. Conservation plays a role in each of these subsystems.

### Develop

#### Definition

The addition to, or removal from, a collection of objects or sets of objects, including all preparation and processing to a set curatorial standard. Further preparation or processing, and restoration of, existing collections are considered development activities.

#### Impact on:

#### Use

* development decisions impact on usefulness of collections

#### Preserve

* unclear legal title increases risk of loss of ownership (Dissociation)
* choice of objects impacts conservation costs
* preparation methods influence stability and preservation

### Use

#### Definition

All activities that require direct reference to an accessioned object, or collection.

#### Impact on:

#### Develop

* usage statistics for kinds of objects influence development
* anticipated use influences preparation and conservation methods

#### Preserve

* influences magnitudes and relative importance of use-related risks
* increases risk to collection but reduces risk/use ratio

### Preserve

#### Definition

The management of risks to collections to keep the rate of loss of collection value at an optimum, low level.

#### Impact on:

#### Develop

* expected life of a kind of object influences development decisions
* cost of preservation of a kind of object constrains development
* failure of preservation will increase demands for restoration

#### Use

* some uses are constrained by need to limit risks to collection

Construction of a system model is essential for being rational and for ensuring that issues are considered within a well-defined, comprehensive framework. Optimizing collection management requires that each of these three subsystems be sub-optimized to give the best overall result.

# PART I - Risk Assessment

This part of the workshop deals with the assessment of risks to collections. We define risks as departures from the goal of preservation.

We do not pretend to present the optimal method of assessing these risks. The preferred method for assessing risks will certainly evolve over time, as more and better information becomes available. Our purpose is to demonstrate that, despite current limitations of knowledge, it is possible to obtain useful estimates of the relative magnitudes of many risks. We now also know that the results of collection risk assessments can be successful in influencing management to allocate resources to preservation. Further, there are numerous benefits to be derived simply from working through the exercise of a risk assessment.

### 1) What are risks?

OBJECTIVE

Participants recognize risks to be departures from the goal of preservation.

OUTCOME

Participants :

* recognize the simple goal of preservation
* see risks are possible departures from the achievement of preservation

BENEFITS

Recognizing risks as departures from a goal:

* permits a clear conceptual understanding of the common nature of all risks
* facilitates creative thinking in identifying risks

##### Concepts – The Goal and the Risks

In its simplest and most absolute sense, the goal of preservation is to convey a collection from one point is time to a future time with no unnecessary damage or loss. Consider this collection of 25 objects: 5 ceramics, 5 prints, 5 textiles, 5 natural history, and 5 paintings.



2117

The Goal

2017

The goal is taking this collection of 25 objects from one point in time to another. We choose a starting time that is not today, or tomorrow, but a time that is enough in the future to allow us to plan strategically for effective preservation.

It may happen that over this time some of the objects are misplaced and lost. Below we see that two of the objects are lost from the collection. This loss of objects by misfiling, non-recorded loans, and so on, are departures from the goal and are, by definition, risks to the collection.



2117

2017

The Goal

It may also happen that some of the collection is placed on exhibit for many decades; here it is the bottom, left quarter of the collection. This has resulted in fading of that part of the collection. This is another departure from the goal and another risk to the collection.



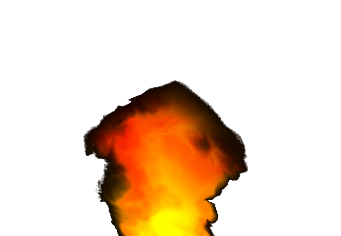


2117

2017

The Goal

Another risk



In addition to these accumulating small events and continuing processes, there is also the chance of all or most of the collection being destroyed in a disaster.

A chance of a disaster risk



2117

2017

The Goal

Risks are scenarios that result in departures from the goal. The goal of preservation is to move the collection forward in time without damage or loss.

Multiple Risks

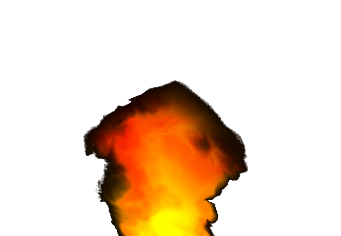
Multiple Risks



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2017

The Goal



### 2) Identifying Risks – Part 1. Agents of deterioration

OBJECTIVE

Participants will acknowledge that all examples of damage or loss to collections can be grouped into an agent of deterioration framework.

OUTCOME

Participants :

* recognize ten (10) agents of deterioration
* can group all specific examples of damage identified within an agents of deterioration framework

BENEFITS

An agents of deterioration framework :

* facilitates identification of all causes of damage
* defines limits to the variety of issues
* is comprehensive and complete
* lends credibility from the conservation planners’ perspective

##### Concepts/ Exercises

EXERCISE - Identifying specific examples of damage

Identify as many specific examples of damage or loss to collections or objects as possible

Write each example on a file card

Be specific about the damage and source of damage (e.g. breakage through handling, or contamination through handling)

TIPS

* Use large print
* Specify both cause and effect
* Only one single idea per card
* Avoid general complaints

If you have one cause resulting in many effects then create separate cards for each unique cause – effect pair.

Concepts- Examples of Damage or Loss from Actions of Agents

|  |  |
| --- | --- |
| AGENT of DETERIORATION | SPECIFIC EXAMPLES of DAMAGE or LOSS |
| PHYSICAL FORCES (PF) | Distortion from poor support, abrasion from constant vibration,breakage from dropping objects, puncture or scratching while placing objects, etc. |
| FIRE (F) | Complete consumption, scorching, soot, smoke and water damage |
| WATER (W) | Tide marks, dissolution, efflorescence, corrosion, swelling, shrinking, warping, cockling, delamination, tenting, buckling from wetting |
| CRIMINALS (Cr) | Disappearance of part or complete objects or collections through theft, or disfiguring through vandalism |
| PESTS (P) | Perforation, grazing or chewing marks, soiling, tunneling, etching, staining, weakening by insects, birds or rodents |
| CONTAMINANTS (Co) | Disintegration, corrosion, staining, discoloring, soiling, etching, by dust, organic vapors, etc*.* |
| LIGHT AND UV RADIATION (LUV) | Fading, disintegration, darkening, yellowing, structural damage, *etc.* through light and UV exposure. |
| INCORRECT TEMPERATURE (T) | Melting or increased chemical reaction from too high a temperature; from too low temperature; (rarely) fracture, disintegration from drastic temperature changes |
| INCORRECT RELATIVE HUMIDITY (RH) | Mould staining and weakening, hydration, corrosion, swelling, crushing from too high RH; shrinking, splitting, fracturing, and dehydration from too low RH; (sometimes) fracture, checking from too drastic a change in RH*.* |
| DISSOCIATION | Inaccessibility, “irretrievability”, loss of objects, loss object data, from misplacing, *etc.* |

Table 1. Agents of deterioration and specific examples of damage (After Michalski, 1990).

### 3) Identifying risks– Part 2. Types of Risks

OBJECTIVE

Participants will recognize that specific risks, “damage resulting from a cause”, can be grouped, according to their frequency and severity, into three (3) types of risks.

OUTCOME

Participants recognize three types of risk, according to their frequency and severity:

* "type 1", which are rare in frequency and catastrophic in severity
* "type 2", which are sporadic in frequency and intermediate in severity
* "type 3", which are constant in frequency and gradual/progressive in severity.

BENEFITS

Recognizing three (3) types of risk:

* Ensures that risks are considered comprehensively and completely
* Makes it easier to consider specific risks within an agent of deterioration
* Allows comparison between risks of different frequencies and severities
* Clarifies the concept that different approaches and sources of information are required to estimate the magnitude of the different types of risk

##### Concepts/ Exercises

Concepts- types of Risks

###### Definitions of types :

Distinction of types of risk is based on expected frequency of occurrence of events:

* *Type 1 Rare* : expect less than one event over next 100 years (e.g., major earthquake),
* *Type 2 Sporadic* : expect more than one event over next 100 years and less than one per year (e.g., major theft),
* *Type 3 Continual :* expect at least one event per year (e.g., seasonal drift in relative humidity) OR an ongoing process (e.g., corrosion)

###### Uses of types :

* Encourages and aids comprehensive risk identification
* Guides us to appropriate sources for information required to evaluate different types of risk
* Clarifies thinking about the nature of, and definition of, specific risks

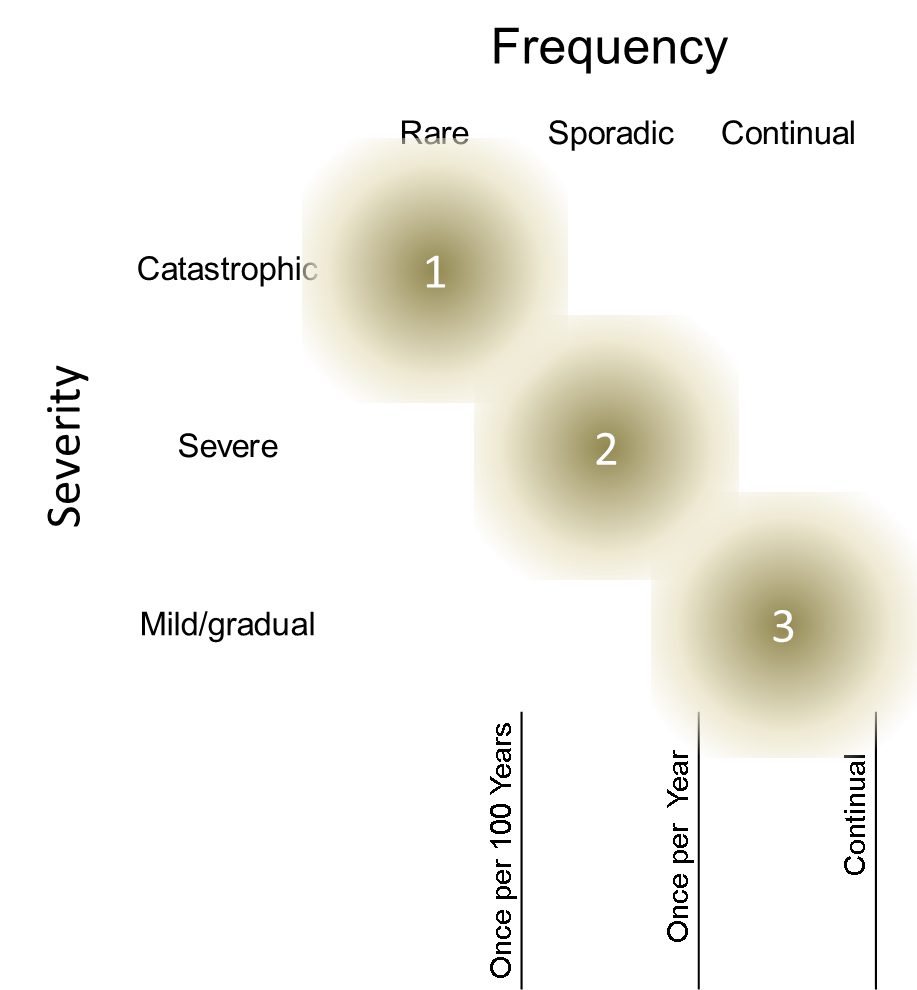


Figure 1. The ranges of frequency and severity of the three types of risks

TIPS

* Rare is defined as less than 1 event in 100 years (on average)
* Allow 0.5 increments in risk types if that is useful for you (e.g. type 1.5 and 2.5)
* Decisions are not right or wrong but rather more useful or less useful

Examples of generic risks (e.g., Fire Type 1, Water Type 2, etc.) are in Table 2.

Within each generic risk, several specific risks are defined. The number of specific risks defined is usually between 1 and 10 and is often just 2 or 3. Learning how to best define a specific risk is discussed in the next section. *4) Defining Risks.*

### 4) Defining Risks

OBJECTIVE

Participants will learn to effectively and efficiently define a specific risk

OUTCOME

* Participants will be able to define a specific risk so that it is:
* Unambiguous
* Quantifiable

Participants will be able to define a set of specific risks so that it is:

* A comprehensive description of a generic risk
* Manageable to assess

BENEFITS

Defining specific risks in the most useful way is a critical step in completing a credible and comprehensive risk assessment.

##### Concepts

Concept- be precise – but not too precise!

|  |  |  |  |
| --- | --- | --- | --- |
|  | Too vague | Too precise | About right |
| Example statements | A collection object breaks. | A sophomore work study student will try to remove the top drawer of a cabinet while standing on a wastebasket. One stiletto heel will puncture the wastebasket resulting in a fall in which two objects are broken into multiple pieces and one object is broken in half. (This will happen on a Friday afternoon.) | Mishandling of a drawer results in the drawer dropping and objects contained break, crush, or dent. |
| Critique of statement | Does not offer a clear idea that can reasonably be quantified | Defined too narrowly to have any reasonable expectation of being able to quantify. Would lead to billions, or more, of specific risks to assess. | Offers a reasonable chance to quantify based on rates of usage, staffing and handling challenges, etc. |

|  |  |
| --- | --- |
| GENERIC RISKS | EXAMPLES OF SPECIFIC RISKS |
|  |  |
| Physical Forces– Type 1 | Earthquake causes collapse of shelves resulting in broken objects |
| Physical Forces– Type 2 | Error in handling results in dropped drawer of objects resulting in broken objects |
| Physical Forces– Type 3 | Gravity acting on poorly supported, deformable objects results in distorted objects |
| Fire– Type 1 | **Fire** ignites then **flashes over** to other objects then **spreads** to other compartments to **consume building** and **destroy entire collection**. |
| Fire– Type 2 | **Fire** ignites then **flashes over** to other objects, **consumes one fire compartment, and** destroys all objects in compartment. |
| Fire– Type 3 | **Fire** ignites but **does not flash over** and destroys only one object at point of ignition **destroying one object**. |
| Water– Type 1 | Water from nearby river overflows banks, inundates basement of building wetting collections to a 1m depth resulting in loss of soluble parts of objects and labels. |
| Water– Type 2 | Water from leaking downspouts runs down interior walls wets objects hung on walls resulting in tide mark stains on objects. |
| Water– Type 3 | **Water** in ground near building s**eeps through basement floor** leading to **corrosion of metal objects** stored directly on floor. |
| Criminals– Type 1 | Professional **thieves** plan a **targeted theft** resulting in **loss of objects**. |
| Criminals– Type 2 | **Persons given access** to collections **steal objects** or parts of objects leading to **loss of objects**. |
| Criminals– Type 3 | Visitors to museum pick at exposed objects resulting in partial loss of objects. |
| Pests– Type 2 or 3 | Insect pests enter collection on returned loans and consume parts of objects resulting in losses from objects. |
| Contaminants– Type 1 | Industrial or transportation accident near museum causes plume of contaminants over building which enters HVAC system and contaminates objects. |
| Contaminants– Type 2 | Corrosive cleaning fluids are accidentally spilled on collection objects resulting in corrosion and surface damage to objects. |
| Contaminants– Type 3 | **Storage hardware** exposed to high temperature and RH **releases acidic gases** which **corrode** sensitive objects resulting in **surface damage to objects.** |
| Light and UV Radiation– Type 2 & 3 | Light from UV filtered exhibit lighting causes fading of object colours. |
| Incorrect Temperature– Type 2 | Mechanical failure of an ultra-cold freezer together with failure of the alarm system leads to melting of samples and degradation of DNA. |
| Incorrect Temperature– Type 3 | Annual average or seasonal **temperatures too high** leading to accelerated **chemical reactions** results in progressive **disintegration of objects**. |
| Incorrect Relative Humidity– Type 2 | High RH excursions due to failure of HVAC systems leading to corrosion of metals resulting in loss of material and obscuring of objects. |
| Incorrect Relative Humidity– Type 3 | Fluctuating relative humidity causes dimensional change leading to rupture of constrained materials in objects. |
| Dissociation– Type 1 | Extraordinary circumstances lead to collection abandonment resulting in complete loss of collections |
| Dissociation – Type 2 | Loss of collection-related documents such as field notes through use or non-use results in loss in value of objects. |
| Dissociation – Type 3 | Detachment of identifying label where label goes missing or cannot be re-associated leads to loss of object value. |

Table 2. Examples of specific risk definitions within each generic risk.

Note the use of the terms “reasonable” and “reasonably”. Defining risks usefully is more an art than a science. It takes practice and retracing your steps from dead ends back to redefining the risk in a useful way. Do not expect that you will always come up with the best definition of a specific risk when you first try. Be patient with yourself as you practice this art.

A humorous spoof on excessively detailed risk identification appeared in The Onion (Everything That Can Go Wrong Listed. The Onion. June 15, 2005 | ISSUE 41•24 <http://www.theonion.com/articles/everything-that-can-go-wrong-listed,1344/>). Note that the small section shown below is from page 55,623. At this level of detail we can never usefully identify risks.



Concept- be comprehensive – but not encyclopedic

Describe a set of specific risks that are a comprehensive representation of the generic risk. The best way to do that is to describe risks by specifying a source of the hazard, an effect on the collection, and whenever useful, a path by which the agent goes from the source to the collection.

For each generic risk chose whether you will try to be comprehensive by source of the hazard, by path, or by effect on collection. Which of these you choose may depend on the nature of your collection and its situation. Still, it is common to be comprehensive by source of the hazard when dealing with Physical forces – type 1; to be comprehensive by path when dealing with criminals or water; and to be comprehensive by effect on collection when dealing with Incorrect relative humidity.

##### Exercise

* A collection of ten objects is introduced.
* Each group is assigned a generic risk to consider.
* Define a specific risk within that generic risk. Include source of hazard, effect on collections, and, if applicable, path. Be as specific as possible while being general enough that your specific risk describes a *good portion* of the generic risk. By *good portion* we mean at least 10% and ideally, if possible, more than 50%.

### 5) Variables for estimating magnitudes of risks

OBJECTIVE

Participants will know how to determine the variables used to estimate the magnitude of risk.

OUTCOME

* Participants recognize and know how to determine the four (4) variables used to estimate
* Magnitude of Risk (MR)
* Fraction Susceptible (FS)
* Loss in Value (LV)
* Probability (P)
* Extent (E)

BENEFITS

* Recognizing and knowing how to determine the variables used to estimate the magnitude of risks:
* Provides us with a common language for discussing components of risks
* Enables us to identify kinds of information required for estimating the variables
* Provides us with simple models for describing complex collection realities

##### Concepts – Magnitude of Risk

Magnitude of Risk (MR) is a simple ratio that represents the part of the collection value we expect to be lost due to risks occurring. It is the product of four risk

* Each variable is a simple ratio between 0 and 1.



If you want to be **RATIO**nal

express risk as a **RATIO** !

##### Concepts- variables for estimating risks, fraction susceptible

###### 5.1 Fraction Susceptible (FS)

#### Definition:

Part of a collection considered vulnerable to a *loss in value* from exposure to a *specific risk*. It is evaluated in light of its inherent susceptibility, the anticipated *severity* of the *specific risk* and, usually, its physical location.

Examples of how to determine FS

The susceptibility to corrosion of a collection of 10 spearheads, ranging from very simple to more complex, is examined.

|  |  |
| --- | --- |
| Three (3) spearheads are stone and 7 are iron. The 7 iron spearheads are considered susceptible to corrosion. FS = 0.7 |  |
| Of the 7 iron spearheads above, 4 are contaminated with salt and are much more susceptible than the 3 salt-free iron spearheads, which in turn, are more susceptible than the 3 stone spearheads. A simple model would be FS = 0.5 |  |
| The 7 iron spearheads all corrode at different rates depending on composition, structure, contamination, etc., the 3 stone spearheads are not susceptible. A simple model would be FS = 0.3 |  |
| In reality, the susceptibility of objects to risks within a collection is often continuously variable (a). A simple model can be used to distinguish between the part of the collection considered to be highly susceptible and the part considered to have low or negligible susceptibility (b). |  |

EXERCISE – estimating fraction susceptible

You are given a collection of 10 objects which are the last possessions of a famous person now deceased. The owner of the seminar room has put them on public display on a table in the room.

You are given a generic risk (PF-3, Light, etc.); define one specific risk within this generic risk.

Estimate the fraction of the collection that is susceptible (FS) to the specific risk you have defined.

Note the rationale and assumptions made to obtain your estimate.



Sometimes not all of a collection is susceptible to the effects of a particular risk.

As a simple model we can estimate what part of the collection we consider to be susceptible.

Remember this is meant to be a simple model to sort very big risks out from very small risks.

##### Concepts- estimating Loss in Value

Concepts- variables for estimating risks, Loss in Value

###### 5.2 Loss in Value (LV)

#### Definition:

Maximum possible reduction in utility, for known or anticipated uses, of the *fraction susceptible.*  It is evaluated in light of the inherent susceptibility, the physical location and the anticipated *severity* of the *specific risk*.

Examples of value

GUIDE

* LV is evaluated in light of current practices, primary storage hardware and the anticipated severity of the risk.
* It is often helpful to think of the *Loss in Value* of a single object considered as representative of the most susceptible of the *Fraction Susceptible*.

5.2-A Display value

In a few cases, market value correlates well with use-value. Gemstone exhibit-type mineral collections are an example. Market value tends to be a very good indicator of their value for exhibit. Hence, the cost difference between a completely gemmy fluorite crystal and one with a thermal shock cleavage separation in it could be used to describe the loss in value associated with the thermal shock event.

5.2-B Research, reference or cultural value

For research and reference objects we need to know the characteristics of specimens that are most important to the usefulness of the objects.

Regarding cultural value, sacred objects that have been treated with toxic pesticides might lose all of their value to the culture of origin. A medal with a severely abraded ribbon has lost little value but a medal abraded over the metal surface has lost much more value.

It is very dependent on the important characteristics of the object for its intended use. Severe light damage to a series of study skins, collected to show colour variation in a species, results in near complete loss in value while severe light damage to most plant specimens would generally be considered to have little impact on the value of the specimen.

GUIDE

* Consider what constitutes loss in value (for present-use value and future-use value if possible).
* The group assessing risks must understand what aspects of an object are important for its intended use to determine the potential loss in value.
* It is often helpful to think of the Loss in Value of a single object considered representative of the Fraction Susceptible.
* For many collections, research and cultural values greatly exceed market value.
* Consider loss in value before any restoration
* Great precision is not possible but reasonable estimates, often better than order of magnitude uncertainty, are possible.

EXERCISE – estimating Loss in Value

* Using the collection, specific risk(s) and Fraction Susceptible determined in the exercise above, estimate the Loss in Value.
* Note what you consider constitutes value (aesthetics, research, market, etc.).
* Note the rationale and assumptions made to obtain your estimate.
* Presentation of results: comments on ease or difficulty of exercise?



Some risks affect all value(s) in the objects they impact (fire and theft are examples).

Some risks only affect some or parts of the value(s) of objects (fading of colors or chemical contamination might be examples).

We can describing the potential Loss in Value as a ratio of all value(s).

##### Concepts- estimating Probability

###### 5.3 Probability (P)

#### Definition:

Chance of at least one event causing *damage* taking place over a 100-year period.

Probability information comes from statistics on the probability of events, generally stated as expected frequency. It must be interpreted in consultation with experts in the areas of concern such as security, fire, etc. (NFPA, NRC, geological survey, etc.)

Most natural hazards are expressed in terms of frequency. Thus an earthquake causing structural damage might be expected, say, every 400 years. Similarly, for engineered systems the expected number of operating years to failure is the value estimated.

For extreme occurrences of more common events the average time between extreme events is estimated. A rainfall might be described as a 100 year event meaning, on average, there will only be one such severe rainfall event every 100 years. While not exactly accurate, the expected frequency of an occurrence can be used to estimate the Probability of occurrence.

Using the value of one event every 400 years, the expected number of earthquakes of that magnitude in a century is:



##### EXAMPLE - Risk of flood on a flood plain

The diagram below shows a map of a floodplain indicating the limits for 100-, 200-, and 500-year flood events. A museum located just on the edge of the 100-year flood limit (A) would expect one flood every century. That would be considered a Type 2 risk. A museum just on the edge of the 200-year flood limit (B) can be assigned a “Probability” of flood of about 0.5 over the next century while at the 500-year flood limit (C) the “Probability” of flood will be about 0.2 over the next century.

|  |  |
| --- | --- |
| A river and its floodplain. The contours marking the reach of 100-, 200- and 500-year flood events are shown. | river%20diagram-ai |

Information about probabilities, or expected frequencies, of Type 1, rare, events cannot be deduced from the experience of even a large collective of museums. This information must be obtained from national or international agencies or organizations.

GUIDE

* For type 1 risks, the probability is the chance that the event causing damage will take place.
* For type 2 and 3 risks, the probability will be 1, as the events causing damage are certain to happen over an extended period of time.

##### Concepts- variables for estimating risks, Extent

###### 5.4 Extent (E)

#### Definition:

Measure to which a *specific risk* will result in *loss in value* to the *fraction susceptible* of a collection over a 100- year period. It reflects the amount of the *fraction susceptible* that is affected, or the degree to which a potential *loss in value* is realised, or both.

Like the other risk variables, Extent is measured as a simple ratio.

Unlike the other risk variables, there is no single simple formula for Extent.

It is helpful to think of these two parts of Extent separately.

Ask the questions:

Will all of the FS be affected? If so, then EFS = 1.

Or will the museum situation, including policies and procedures, limit the spread, or effect, of the risk to only a part of the FS?

Will all of the LV be realized? If so, then ELV = 1.

Or will the museum situation, including policies and procedures, limit the degree to which the LV will be reached?

TIPS

* Begin by assuming EFS = ELV = 1; then ask why not?
* Extent is a measure of the risk mitigation provided to the collection by your collection care and preservation system
* Accept that Extent is often hard to think through – be open to considering how best to think through how to calculate or estimate Extent
* Think the risk scenario through in a step-wise fashion thinking whether each step might help quantify Extent

##### EXAMPLES – Many ways to arrive at Extents

|  |  |  |
| --- | --- | --- |
| Type 1 | EFS | ELV |
|  | Consider, for example, details of the risk scenario: how many of the objects in the FS might be affected?  Example: for Water-1, if the FS was all works of art on paper or canvas but not sculptures and the scenario is flooding of a basement storage room then EFS = proportion of the FS held in the basement. | Consider, for example, emergency response capabilities for that risk scenario: to what degree will the LV be realized?  Example: for Water- 1 Base ELV on your confidence in emergency preparedness plans, procedures, practices and arrangements ensuring the LV realized does not exceed a small fraction of the theoretical potential loss. (e.g.: Based on damage realized in a comparable collection loss in value is expected to be no more than 10%. ELV is = 0.1) |
|  |  |  |
| Type 2 | EFS | ELV |
|  | Consider, for example, the number of incidents expected over the next 100 years and the typical (average) number of items affected in each incident: how many of the items in the FS might be affected?  Example: For Pest-2 insect infestations in cabinets in a bird study skin collection. Based on 30 years of experience and existing rates of compliance (estimated 95%) with freezing incoming specimens the collection manager anticipates not more than 1 cabinet every 20 years. Collection is held in 100 cabinets all equal in size. EFS = 1 cabinet/incident \* 5 incidents/century / 100 cabinets in FS = 5/100 = 0.05  Note that the 95% compliance rate is not used in our calculations but helps us keep in mind that no system is perfect and some failures over time are expected. | Consider, for example, a typical incident: to what degree will the LV be realized?  Example: For pest-2 insect infestations in cabinets in a bird study skin collection. Based on 30 years of experience the collection manager does not expect full LV in an incident even though LV=1 was considered the theoretical possibility. The collection manager realizes that only some parts, typically oily areas near feet and beaks, will be affected first. Given rates of usage, the collection manager expects the infestation incident will be observed and responded to before there is 20% LV to just one of an average 8 drawers per cabinet. ELV = 1/8 drawers per cabinet \* 20%LV realized before detection = 0.125\*0.2 = 0.025 |
|  |  |  |
|  |  |  |
|  |  |  |
| Type 3 | EFS | ELV |
|  |  |  |
|  | Consider, for example, the number of objects expected to be affected over the next 100 years: how many of the objects in the FS might be affected?  Example: For damage due to light fading of colourants in a collection of works of art on paper it is possible that not all susceptible objects will be exhibited. Need to consider whether rotation policy will lead to none, some or all of the reserve collection being rotated into exhibit. If 80% of the FS is designated for research and reference only and will not be exhibited then EFS = 1-80% not exhibited = 0.2 | Consider, for example, the degree to which an object will change from its current condition to the condition anticipated in setting the LV. If the LV is based on a complete fade then what light dose would be required for that amount of fade?  Example: The expected light dose to the affected fraction (FS\*EFS) over the next 100 years divided by the light dose required for a complete fade will be the degree to which the LV is realized = ELV. |

GUIDE

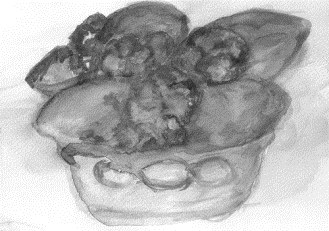
* for type 1 risks, extent is often based on including and the anticipated effectiveness of emergency response
* for type 2 risks, extent information is derived from condition documentation and/or long-term memory of staff.
* for type 3 risks, extent ideally would be determined by conservation science and knowledge of the environmental conditions affecting the collections. In practice, we usually require the experience and judgment of staff at present.



The variables FS and LV describe the potential risk to the collection.

Extent reflects the effectiveness of controls in reducing risks to collections.

**LV** = Maximum possible reduction in utility value from the given specific risk, here consider light fading of fugitive colors.



**ELV** = the degree to which a potential *loss in value* is realized over the next 100 years.

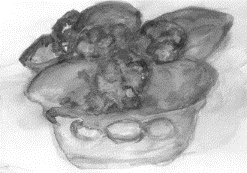


?

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?

?



Given the expected exposure over the next 100 years, how much of the LV will be realized?

### 6) Magnitudes of risk

OBJECTIVE

Participants recognize risks to be departures from the goal of preservation.

OUTCOME

Participants are able to estimate the magnitude of most risks.

BENEFITS

Estimating the magnitude of risk facilitates:

* the ranking of risks by relative importance within a collection
* the comparison of various risks among different collections
* the recognition of the influence of staff practices on the preservation of collections
* the identification of readily mitigated risks
* the creation of basic documentation on institutional practices
* the understanding of the requirements of collections users

Recognizing risks as departures from a goal:

* permits a clear conceptual understanding of the common nature of all risks
* facilitates creative thinking in identifying risks

##### Concepts – steps to assess a risk

###### 6.1 Define the specific risk

Define the specific risk(s) whose magnitude you want to estimate within each generic risk (PF1, CR2, etc.)

Decide the anticipated severity you will consider for each specific risk.

For each specific risk follow the steps outlined below.

###### 6.2 Determine the Fraction Susceptible

Are all objects in the collection equally susceptible to the risk being considered?

If they are all considered equally susceptible, set FS = 1

If necessary, define two groups of objects, sensitive and insensitive.

Explain the basis for dividing into susceptible and not susceptible parts.

Enter the ratio of sensitive objects to total number of objects in the collection in the column headed "Fraction susceptible" (*e.g.,* 0.01, 0.1, 0.5, etc*.*).

###### 6.3 Determine the Loss in value

Estimate the loss in value of sensitive objects that could possibly result from the (risk) event occurring and enter this in the column headed "Loss in value".

For example, a stolen object has lost all value and, hence, the number 1 should be entered.

The loss in value of an object that has lost most of its color would depend on the importance of color to the use of the object.

For many research objects that never retain their live colors, this loss in value is probably small, 0.01 or even 0.

###### 6.4 Determine the Probability

Estimate the probability of an occurrence within 100 years.

* for type 1 risks, we need outside expertise to determine what the chance is of an event causing damage taking place. (For subsequent exercises, use stated assumptions for probability.)
* for type 2 and 3 risks, the *probability* will be 1, as the events causing damage are certain to happen over a 100-year period.

###### 6.5 Determine the Extent

Estimate the Extent to which the FS is affected (EFS) and/or the LV realized (ELV)for the 100-year period.

* for type 1 risks the *extent* is often based on the effectiveness of emergency response in limiting damage.
* for type 2 and 3 risks, the extent is a calculated ratio, based on the part of the *fraction susceptible* that is expected to be lost and/or the degree to which the *loss in value* is expected to be realized.

###### E = EFS x ELV

###### 6.6 Calculate the Magnitude of Risk for a Specific Risk

Calculate magnitude of the risk to the collection by multiplying the variables determined above; MR = FS x LV x P x E

For most generic risks, the magnitude of the generic risk will be the simple sum of the magnitudes of two or more specific risks.

EXERCISE: Estimating magnitudes of risk

One of two exercises will be done as part of the workshop. Instructions, forms and background for each of these is given in Appendix 1. If the in-collection exercise is done in the workshop then the Frère Jacques exercise can be done later. A worked out solution is provided for you to compare with your results.

|  |  |
| --- | --- |
| GENERIC RISK (Agent and Type): | |
| SPECIFIC RISK (describe scenario – hazard source – path – effect on collection): | |
| EXISTING MEANS OF CONTROL: | |
| FS = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| FS RATIONALE: | |
| LV = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| LV RATIONALE: | |
| P = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| P RATIONALE: | |
| EFS = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| EFS RATIONALE: | |
| ELV = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| ELV RATIONALE: | |
| E = EFS x ELV = | |
| MR = FS x LV x P x E = | |

### Help for those who are Frustrated with Numbers

It is easy to get frustrated trying to find a good number to express one of the risk variables. Note that we just ask for a good number. We don’t ask for the ***right*** number – because we can never know what that is. We don’t even ask for the ***best*** number – because we also cannot know what that is. We simply ask for a ***good*** number. We just want a number that will be useful in deciding priorities for investments in improved preservation.

We only need to select a number that is between 0 and 1. If we are highly uncertain then we can restrict ourselves to choosing either 0 or 1. If we choose 0 then we are saying there is no Fraction Susceptible, no Loss in Value, etc. At the other extreme, if we choose 1 then we are saying that the whole unit considered is susceptible, that all value is lost, etc. If nothing else, we can pick which of 0 or 1 is closer to the truth and use that number.

Often we know that we can do better than just picking 0 or 1. Often we might know that 1/2 is a better estimate than either 0 or 1. Even if we think that the best estimate is just somewhere between 1/3 and 2/3 then we are better to use 1/2 (0.5) rather than use either 0 or 1. This is the sense of seeking a useful estimate.

Further, we might have some confidence that 0.4 is a better estimate than either 0.2 or 0.3. This may be because collection inventories show us that 40% of the collection is a material that is subject to the risk being considered. If we have a reasonable basis for using a more precise number for any variable then we should go ahead and use the more precise number.

Numbers near 0 (or near 1)

Some of the changes (risks) that we want to consider happen to very small fractions of a collection or affect object values to very slight extents. We want to be able to capture this in our calculations. We do this by expanding the scale between 0.1 and 0 into what is called a logarithmic scale. That is, we divide it into progressively smaller fractions: 0.1, 0.01, 0.001, 0.0001 and so on.

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|  | | | | | | | | | | | | | 0.9 | | | | | | | | | | | | | 0.99 | | | | | | | | | | | 0.999 | | | | | | | | | | | | | | 0.9999 | | | | | | | | | | | | 0.99999 | | | | | | | | | | | | | 0.999999 | | | | | | | | | | | | | |
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|  | | | 0 | | | | | | 0.1 | | | | | | | | | | | 0.2 | | | | | | | | | 0.3 | | | | | | | | | | | 0.4 | | | | | | | 0.5 | | | | | | | | | 0.6 | | | | | | | | | 0.7 | | | | | | | 0.8 | | | | | | | | | | 0.9 | | | | | | | | 1 | | | | | |
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|  | | | |  | | | | | | | | | | 0.00001 | | | | | | | | | | | | | | | | 0.0001 | | | | | | | | | | | | | 0.001 | | | | | | | | | | | | | | | | | 0.01 | | | | | | | | | | 0.1 | | | | | | | |

We can associate other expressions, images or descriptive words with these ever-smaller fractions to help us visualize what they mean.

A similar situation exists if we consider nearly all of a collection unit susceptible or nearly all of the value lost. Here we divide the scale to progressively approach 1 using values such as 0.9, 0.99, 0.999 and so on.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Decimal | Fraction | Expression | Description | Area | Volume |
| 1 | 1 | whole | all |  |  |
| 0.1 | 1/10 | one tenth | small fraction |  |  |
| 0.01 | 1/100 | one percent | slight amount |  |  |
| 0.001 | 1/1000 | one part per thousand | very slight amount |  |  |
| 0.0001 | 1/10000 | one hundred parts per million | tiny amount |  |  |
| 0.00001 | 1/100000 | ten parts per million | miniscule |  |  |
| 0.000001 | 1/1000000 | one part per million | negligible |  |  |

# How to present results

OBJECTIVE

To demonstrate how to present risk assessment results.

OUTCOME

Participants are able to present results to, and produce useful reports for, a variety of audiences.

BENEFITS

Documentation and presentation of results will:

* provide documentation of risk mitigation practices and risk exposure within the institution
* allow magnitudes of specific risks to be placed in context with other specific risks
* facilitate consideration of priorities within each administrative unit
* give an overview of risk exposure based on the nature of the hazard
* provide a means of determining collection preservation priorities
* allow comparison of risks to individual collection units, leading to institution-wide priorities for improving preservation.

##### Concepts – strategies for presenting risk assessment results

###### 7.1 Documentation

The following can be used as a checklist of what detailed documentation you will need to produce:

* List of specific risks assessed,  
  this should include:
  + anticipated probability and severity of occurrence
  + details of existing risk mitigation strategies that are considered significant in limiting risks. See example (Appendix 3, Report Appendix 2, page 2).
* Summary information on each collection unit assessed,  
  this should include:
  + details of included or excluded material where there might be any uncertainty
  + any deviations from assumption of each object has equivalent value
  + basic levels of collection maintenance activities such as pest inspections, fluid preservative inspections, etc.
  + unusual current situation or anticipated major changes in immediate future
  + how ancillary materials are included or considered. See example (Appendix 3, example unit report after Report Appendix 4)
* Details on each specific and generic risk to a collection unit,  
  These should include:
  + description of the effect of the specific risk on the collection unit
  + bases for risk variable determinations or estimates
  + specific risks within each generic risk are added
  + distributions of magnitudes of generic risks are considered for each collection unit. See example (Appendix 3, example unit report after Report Appendix 4, page RA10-8)

###### 7.2 Institution-wide quantitative results

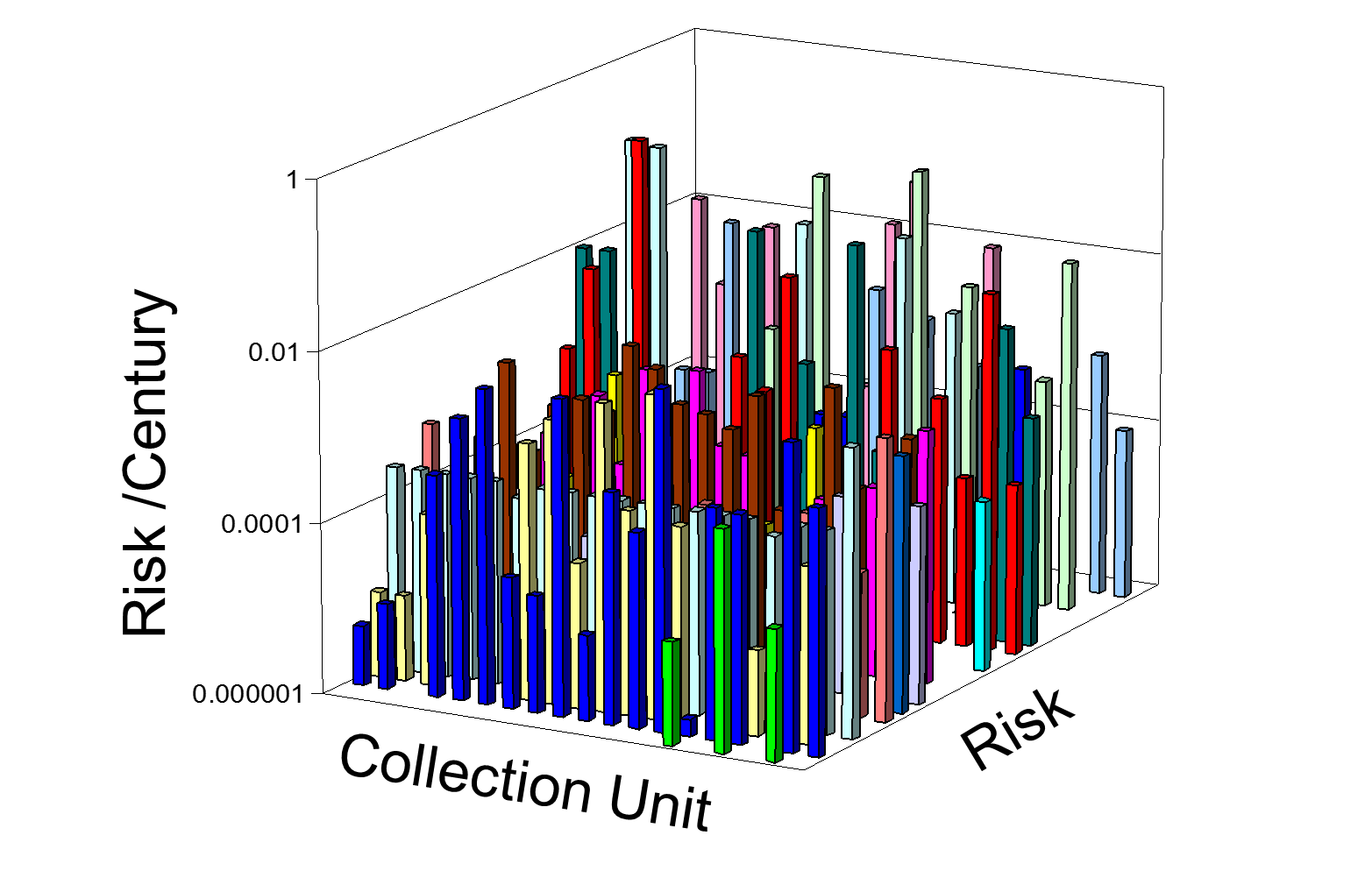
Risk assessment data on all generic risks considered for all collection units can be presented in a table like the one shown on page 8 of Appendix 3. This table was created in an Excel spreadsheet and is linked to another spreadsheet through an “if greater than some value” function [IF (risk\_value>threshold, risk\_value,)] to display only the most significant risks in terms of expected loss.

Using this type of table, the risk analyst can:

* set up the table to report risk to a collection unit, to a set of collection units within an administrative unit, or to the institution as a whole
* set the “threshold” value as a cell location, allowing it to be varied dynamically while the risk analyst discusses the results with managers, creating an interactivity with the data.



The figure shown on page 5 of Appendix 3 graphically depicts the data in the table described above.



This presentation shows:

* the complexity of the situation that preventive conservation seeks to manage
* data elements, each representing a generic risk affecting a collection unit.
* individual magnitudes of risk put into the context of magnitudes of all other specific risks to all other collection units
* easily identifiable exceptionally high or low magnitude risks

Therefore, data can be viewed either by distribution of risk, by generic risk considered, or by distribution of risk through collection units.

###### 7.3 Aggregation of data by generic risk

Aggregating data by generic risk provides an overview of risk exposure based on the nature of the hazard responsible for the risk (see Figure 4). Showing the data in a logarithmic scale (left side) allows comparison through the entire range of risk magnitudes. Showing the same information plotted against a linear scale (right side) shows the relative significance of the different generic risks.

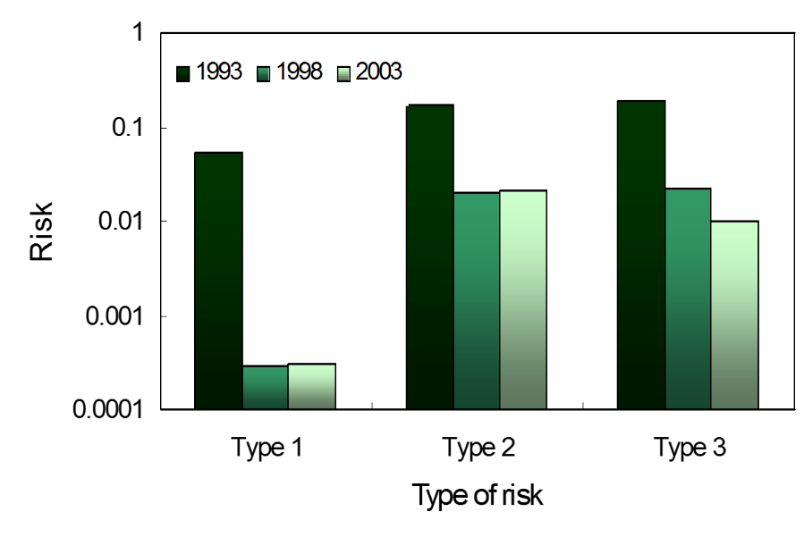


**Figure 4.** Risk to CMN collections aggregated by generic risk (CMN 1998 NHB risk assessment). Reprinted with permission from Acta Universitatis Gothenburgensis.

Data can further be aggregated to consider:

* distribution of risk by Type of risk
* distribution of risk by anthropogenic versus natural hazards
* distribution of risk by type of risk (shown in Figure 5, which compares distributions between risk assessments done in 1993 and 1998)

The hierarchical organisation of data throughout this risk assessment model facilitates this type of analysis and allows the direction of conservation priorities to particular types of risks that are of greater magnitude.



**Figure 5.** Relative contributions of Types of risks to total risk to collections in both 1998 and 1993 risk assessments. Reprinted with permission from Acta Universitatis Gothenburgensis.

Considering data by generic risk distribution also provides a means of determining collection risk related priorities for those sectors of an institution that have responsibility for systems influencing risks to collections.

Example – Determining collection risk related priorities for specific sectors

At the Canadian Museum of Nature, the Facility Management Services Division (FMSD) has responsibility for maintenance of the building envelope, heating, ventilating, and air condition (HVAC) systems, security services, and other features of importance to the preservation of collections. Results of the 1998 CMN Risk Assessment were customized, to contribute to operational priority-setting within the FMSD, by combining aggregate generic risk data with a “facility share (of responsibility) factor”. The facilities share factor represented a mutually-agreed partitioning of responsibility between the FMSD and the Collection Services Division. The results are shown in Table 4.

**Table 4** Calculation of the share of responsibility for risk to collections born by the Facilities Management Services Division of the CMN. Reprinted with permission from Acta Universitatis Gothenburgensis.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Generic risk | Total risk†  century-1 | Facilities share (ratio) | Facilities share of risk century-1 | Specimen equivalents lost year-1 |
| Physical Forces – 1 | 0.000011 | 0.5 | 0.000005 | 0.1 |
| Physical Forces – 2 | 0.002887 | 0.2 | 0.0006 | 15 |
| Physical Forces – 3 | 0.000395 | 0.1 | 0.00004 | 1 |
| Fire | 0.000239 | 0.9 | 0.0002 | 5 |
| Water – 1 | 0. | 0.9 | 0 | 0 |
| Water – 2 | 0.000077 | 0.9 | 0.00007 | 2 |
| Water – 3 | 0. | 0.9 | 0 | 0.01 |
| Criminals – 1 | 0.000006 | 0.9 | 0.000005 | 0.1 |
| Criminals – 2 | 0.000958 | 0.1 | 0.0001 | 3 |
| Criminals – 3 | 0.000215 | 0.1 | 0.00002 | 0.5 |
| Pests | 0.000303 | 0.5 | 0.0002 | 5 |
| Contaminants – 1 | 0. | 0.9 | 0 | 0.01 |
| Contaminants – 2 | 0. | 0.5 | 0 | 0 |
| Contaminants – 3 | 0.000573 | 0.1 | 0.00006 | 2 |
| Light and radiation | 0.0032 | 0.5 | 0.0016 | 40 |
| Incorrect Temperature – 2\* | 0.000047 | 0.5 | 0.00002 | 0.5 |
| Incorrect Temperature – 3\* | 0. | 0.5 | 0 | 0 |
| Incorrect Relative Humidity – 2\* | 0.000031 | 0.5 | 0.00002 | 1 |
| Incorrect Relative Humidity – 3\* | 0.00035 | 0.5 | 0.0002 | 5 |
| Custodial Neglect – 1 | 0. | 0 | 0 | 0 |
| Custodial Neglect – 2 | 0.000492 | 0 | 0 | 0 |
| Custodial Neglect – 3 | 0.00428 | 0 | 0 | 0 |
| † Values appear overly precise because rounding is done only for final results (i.e., Facilities share of risk and Specimen equivalents lost year-1).  \* Note that generic risks associated with incorrect temperature and relative humidity do not appear as issues in this analysis because their effects are distributed among other generic risks such as, insect pests, physical breakage of objects embrittled by acid hydrolysis, etc. Control of temperature and relative humidity remains a major responsibility and contribution of the Facilities Services Management Division for the protection of CMN collections. | | | | |

###### 7.4 Aggregation of data by collection unit

Data from each collection-unit Excel workbook file links to a summary workbook that updates each time it opens and the update links option is chosen. Once the data is compiled, it can be presented in tabular form, plotted, queried to determine the highest risks, or otherwise explored. Table 1 in Appendix 3 (page 3) shows summary data from all collection units. These data are shown graphically in Figure 4 in Appendix 3 (page 7). In this figure, the solid line, “risk to total”, reflects the fraction of CMN’s total collection to be lost from within each of the collection units. The dashed line, “risk to unit” reflects the fraction of each collection unit expected to be lost.

Because representing risks to collections in small ratios lacks impact, it is preferable to express data in the form of expected numbers of objects lost per year. Consideration of risk to all collection units leads to institution-wide priorities for improving preservation. Histograms showing the distribution of risk by collection unit convey the relative significance of risks to collection units (see examples below). This style of histogram can be adapted to show the relative significance of individual risks by highlighting a portion of the risk column proportionate to the magnitude of the generic or specific risk in question. Inclusion of a picture representing the risk in question further improves the clarity of communication.

|  |  |
| --- | --- |
| Histogram showing generic risks to collection units. |  |
| The specific risk of degradation of an unstable mounting media highlighted as a major contributor to total risk to collection unit four (parasites). |  |

|  |  |
| --- | --- |
| The several Incorrect Relative Humidity – 2 and – 3 risks that relate to incorrect levels and concentrations of alcohol highlighted as a major contributor to total risk to four collection units. |  |

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Aggregation of information by collection management administrative unit permits consideration of priorities within each unit. These data are discussed with individual Collection Managers on a case-by-case basis. The discussions focus on reviewing risk control systems germane to risks greater than a threshold (currently 0.001), on identifying readily mitigatable risks , and on understanding the significance of finding certain risks to be substantially lower in magnitude than they previously were believed to be.

###### 7.5 Management Implications

Recommendations at the senior management level should be action oriented at an appropriately high application level.

# PART 2 - Risk Management

In part one, ten agents of deterioration and three types of risk were identified. Variables were defined to facilitate estimation of magnitudes of risk. Magnitudes of risk were calculated. This identification and evaluation of risks is essential to managing risks to collections.

Managing risks to collections requires that all potential means of control be identified. Selecting the best means, or strategy, requires evaluation of the costs, benefits, and collateral risks associated with their implementation and maintenance.

### 1) Methods of control

OBJECTIVE

Participants will be able to identify different methods of controlling risks.

OUTCOME

Participants recognize:

Five (5) general methods of controlling risks (Michalski, 1990):

Avoid

Block

Detect

Respond

Recover

BENEFITS

Identifying methods of controlling risks:

* gives multiple approaches for mitigating risks.

##### Concepts/ Exercises

GUIDE

All possible methods of controlling risks are considered.

* Eliminating the source of the risk is generally the preferred method used to control risks, but it may create or increase other risks and is sometimes inadvisable.
* Establishing a barrier is the second preferred method for control.
* Detection is essential for signaling a need to respond.
* The direct approach of acting on the agent is often considered first but it may prove to be the worst choice when all long term costs and risks are considered.
* Recovery will limit and may reverse some damage.
* Often a combination of methods will be most cost-effective for mitigating risks.

Concepts- methods of control

Five (5) general methods of controlling risks:

* eliminating the source of the risk
* establishing a barrier between the object(s) and the risk
* identifying an occurrence of the risk
* acting on the agent responsible for the risk
* treating objects that have been damaged as a result of the risk

EXERCISE – Identifying methods of control

Facilitators will assign generic risks to each group. Write the assigned generic risk at the top of the column and fill in an example of each method of control. Use the example provided for guidance.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | FIRE-1 |  |  |  |  |
| AVOID | no smoking |  |  |  |  |
| BLOCK | fire doors closed |  |  |  |  |
| DETECT | smoke alarms |  |  |  |  |
| RESPOND | sprinkler system |  |  |  |  |
| RECOVER | conservation laboratory |  |  |  |  |

### 2) Levels for control

Objective

Participants will be able to identify different levels at which they can apply the methods of controlling risks.

Outcome

Participants identify seven (7) levels for applying methods of controlling risks.

location

site

building

room

storage unit

object

policy / procedure

Benefits

Identifying different levels to apply methods of controlling risks:

allows the framework of means of control (methods and levels for control) to be seen as comprehensive and complete;

allows the selection of the most cost-effective mitigation strategies

##### Concepts/ Exercises

Concepts- levels for control

**Table 5.** Levels for control:

|  |  |
| --- | --- |
| Levels for control: | Examples: |
| LOCATION | Do not locate building in a flood plain, high crime area, an area with unreliable electrical supplies, etc. |
| SITE | Maintain clear lines of sight along perimeter of building, make area adjacent to building unattractive to insects, drain water away, etc. |
| BUILDING | Install and maintain reliable roof, lock doors and control access, subdivide with fire walls, maintain appropriate environmental conditions, etc. |
| ROOM | Lock doors and control access, switch lights by room, maintain appropriate environmental conditions, etc. |
| STORAGE UNIT | Provide a barrier to pests, criminals, water, fire and adverse environmental conditions, render objects easily accessible for use, etc. |
| OBJECT | Provide cushioning and support to prevent physical damage, provide barriers to pests, contaminants, and adverse environmental conditions, etc. |
| POLICY / PROCEDURE | Establish safe procedures for access to and handling of collections, and work habits that will reduce the probability of fire and other disasters, etc. |

The framework of methods and levels for control gives a possibility of 35 means of control in theory. In practice, for any one specific risk, we rarely find means of control for all combinations of methods and levels for control.

paired with

could be at

room

cabinet/shelf

object

policy

procedure

location

site

building

Level for control

Method of control

applied at a

could be to

recover

detect

block

avoid

respond

is a

Risk mitigation strategy

is one or more

Means of control

**Figure 6.**  A risk mitigation strategy is a combination of means of control which comprise a method of control applied at a level for control. Reprinted from Waller (2003) with permission.

### 3) Mitigation strategies

Objective

Participants will develop preventive conservation strategies based on broad thinking and thorough analysis.

Outcome

Many means of control involving different methods of control and levels for control can be identified.

Benefits

Broad thinking and thorough analysis facilitates:

the identification of all possible means of control,

the development of the most cost-effective strategy.

##### Concepts/ Exercises

EXERCISE - Determining mitigation strategies

* Your group is assigned a generic risk from the in-collection, or other previous, exercise
* Consider all possible means of control (different levels for and methods of control) for your generic risk.
* Write each means of control in the table provided and onto a sheet of paper noting the generic risk (e.g., Water-3), and method and level for control in a corner for easy placement into the framework. At the same time, fill in neatly the table of means of control provided.
* Groups present results and discuss results of other groups.

EXERCISE - Determining means of control

GENERIC RISK: \_\_\_\_\_\_\_\_\_\_\_\_\_\_ RANK: \_\_\_\_\_\_\_\_\_\_ GROUP: \_\_\_\_\_

|  |  |  |  |
| --- | --- | --- | --- |
| Method \ Level | Location | Site | Building |
| AVOID |  |  |  |
| BLOCK |  |  |  |
| DETECT |  |  |  |
| RESPOND |  |  |  |
| RECOVER |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| Room | Storage Unit | Object | Policy/ Procedure |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

Notes

### 4) Costs, risks and benefits of mitigation strategies

Objective

Participants will understand the need to consider all the implications and learn to identify costs, risks and benefits of risk mitigation strategies.

Outcome

Participants can:

* recognise the broad range of implications that need to be considered.
* identify costs, benefits and collateral risks of mitigation strategies through both the implementation and maintenance phases.

Benefits

Identifying all costs, risks and benefits of mitigation strategies ensures that:

* the overall risk to collections will be minimised in the most cost-effective manner
* plans for risk mitigation strategies are clearly upheld by an analysis that senior management can appreciate and support.

##### Concepts/ Exercises

Concepts- mitigation strategies

A mitigation strategy is a combination of means of control implemented to reduce risks to collections. A good mitigation strategy takes into account all the costs, risks and benefits of all means of control and strikes the optimum combination of short, medium and long-term goals and activities.

Exercise - Evaluating costs and benefits of a strategy

* Having identified all possible means for control for your generic risk, pick two or three of them to constitute a:

a) Short-term, low cost mitigation strategy

b) Long-term, high cost mitigation strategy

* Identify and evaluate all costs, risks, collateral risks etc. associated with both the implementation and maintenance phases for these two strategies.
* Some mitigation strategies might result in temporary increases in other risks during implementation or permanent decreases in other risks during operation. Theoretically we might like to numerically estimate each of these risks but it would be onerous to do. It is sufficient to indicate that they will increase (+) / decrease (-) : slightly (+/-), substantially (++ / --), or greatly (+++ / ---) (see example)
* Start with one group from each agent and get a second one to comment on how their analysis differed from the first.
* Write your results in the table provided and at the same time on sheets of paper (one per table header).

**TIPS**

* It is more important to look at broad implications of mitigation actions than to get stuck on detailed administrative costing. Use orders of magnitude for costing the strategies.
* Benefits are those advantages not included or captured by the collection risk assessment (e.g., improved image of organisation, efficiency of research, etc.).
* Look through list of all 23 generic risks when evaluating implementation risks and risks for the 100-year prognosis.

EXAMPLE – Short term mitigation strategy for Contaminants- type 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| PROPOSED | IMPLEMENTATION | | | 100-YEAR PROGNOSIS | | | NON-COLLECTION |
| STRATEGY | Risks | Costs | Benefits | Risks | Costs | Benefits | EFFECTS |
| Improve building seal (windows and door detailing) | PF2 +  F +  W2 +  CR2 +  P +  T & RH ?? | $10 K | Pest monitoring | W2 -  CR2 -  P --  CO1 --  CO3 --  LUV –  T3 -  RH 3 - | - $ 1K per year | Community recognition of importance of collections | -Community trades and industry used  -Environmentally responsible, seen as green institution |
| Improve cabinet seals |  |  |  |  |  |  |  |
| Develop strategy with fire department |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |

Exercise - Evaluating costs and benefits of short-term mitigation strategy

Generic Risk : \_\_\_\_\_\_\_\_\_\_\_ Group : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| PROPOSED | IMPLEMENTATION | | | 100-YEAR PROGNOSIS | | | NON-COLLECTION |
| STRATEGY | Risks | Costs | Benefits | Risks | Costs | Benefits | EFFECTS |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |

# SUMMARY

In this workshop, we have produced a simplified and partial risk assessment and risk management plan. To produce these in a real situation, you would require several days work and access to information about a collection.

It is possible to produce estimates for at least half of the generic risks. For others, we can demonstrate what kind of information is required. By clearly demonstrating a need for information, we can encourage experts such as risk assessors and conservation scientists to produce information to fill in the gaps.

Considering all possible methods and levels for control leads to comprehensive analysis of potential strategies for risk mitigation. These strategies are a basis for risk management plans that take into account all impacts on collections and on the institution as a whole.

The system of risk assessment and management:

* ensures comprehensive thinking about preventive conservation,
* guards against "flavor of the month" priorities,
* allows comparison between risks of different frequencies and severities,
* clarifies our thinking about how variables contribute to the Magnitude of Risks,
* greatly clarifies communication,
* encourages a team spirit,
* allows comparison of different risks among different collections,
* identifies readily mitigated risks,
* creates a base of documentation on institutional practices,
* allows staff to better recognise the importance of their actions or inaction in preserving collections,
* enables cost-effective plans for mitigating risks to be developed,
* ensures all issues related to proposed strategies are considered from an institutional perspective,
* plans for risk mitigation strategies show clearly defined borders on problems and are therefore more easily appreciated and supported by senior management.

Notes

# GLOSSARY

**AGENT OF DETERIORATION** : grouping of risks from the same general cause; general cause of damage to or loss of collections, parts of collections or individual objects.

**GENERIC RISK** : *(*see *Risk)*.

**CURRENT SITUATION** : all factors influencing *risks* to collections, including the environment, building and systems, collection management policies and practices, *etc.* (see *levels)*

**EXTENT** : (E) measure to which a *specific risk* will result in *loss in value* to the *fraction susceptible* of a collection over a 100- year period. It reflects the amount of the *fraction susceptible* that is affected, or the degree to which a potential *loss in value* is realised, or both.

As a result:

1. for type 1, by default, the *extent* is often one.
2. for types 2 and 3, the extent is a calculated ratio, based on the part of the *fraction susceptible* that is expected to be lost and/or the degree to which the *loss in value* is realised.

**FRACTION SUSCEPTIBLE** : (FS) part of a collection considered vulnerable to a *loss in value* from exposure to a *specific risk*. It is evaluated in light of its inherent susceptibility, the anticipated *severity* of the *specific risk* and ,usually, its physical location .

**FREQUENCY** : the number of times an event will occur in a 100-year period.

LEVELS FOR CONTROL:

1. location : location in a geographical sense.
2. site : the land and environment surrounding the building, typically the parcel of land owned (or within about 100 meters).
3. building : the physical structure of the building and all building-wide systems for HVAC, security, fire control, *etc.*
4. room is the physical structure of the collection room and hardware and systems applicable at that level, including door locks, local humidifiers, *etc.*
5. storage unit : cabinet, shelving or racking system used to contain a sequence of objects, display case.
6. object : any support, container, barrier, *etc.* used to protect single objects or small groups of related objects.
7. policy / procedure : a written statement or set of instructions to guide management decisions or the completion of tasks according to set methods and standards.

**LOSS IN VALUE** : (LV) maximum possible reduction in utility, for known or anticipated uses, of the *fraction susceptible.* It is evaluated in light of the inherent susceptibility, the physical location and the anticipated *severity* of the *specific risk*.

**MAGNITUDE OF RISK** : (MR) estimated *loss in value* to a collection, based on the *current situation*, over a 100-year period. Calculated as a product of FS, LV, E and P.

**MEANS OF CONTROL** : a *method of control* applied at a *level for control.*

**METHOD OF CONTROL** : actions identified to reduce a *specific risk* . The three methods of control are:

1. eliminating the source of the *specific risk*.
2. establishing a barrier between the source of the *specific risk* and the object or collection.
3. acting on the *agent* responsible for the *specific risk.*

**MITIGATION** : reduction of *magnitudes of risk*

**MITIGATION STRATEGY** : a combination of *means of control* implemented to reduce risks to collections.

**TYPE OF RISK** : classification of *risks* according to the frequency at which it occurs and the *severity* of its effect

1. for types 2 and 3, the *probability* will be 1 (some exceptions such as Fire-2), as the events causing damage are certain to happen over a 100 year period.

**RISK** : potential for realisation of unwanted, adverse consequences to collections (source Society for Risk Analysis

1. *specific risk* : undesirable change occurring due to a specific cause
2. *generic risk* : classification of risks according to a type of risk and an agent of deterioration

**RISK ASSESSMENT :** evaluation of the magnitude of all specific risks affecting some entity.

**RISK MANAGEMENT** : application of available resources in such a way that overall *risk* is minimised.

**SEVERITY** : intensity of occurrence of an event.

**SPECIFIC RISK** : *(*see *Risk)*.

**STRATEGY** : see mitigation strategy.

.

# Suggested Readings

These are two books that will convince readers of our need for robust, rational planning frameworks

Plous, Scott. The Psychology of Judgment and Decision Making. McGraw-Hill Higher Education; ISBN: 0070504776, (1993), 352 pages.  
 This book provides a very engaging and enlightening review of the ways we, as humans, make judgements under uncertainty. The heuristics (rules of thumb) and their resulting biases are explained. An interesting feature of this book is that representative questions, from many of the psychological studies referred to in the book, have been grouped together into a questionnaire at the beginning of the book. By completing this before reading the book, we can see to which fallacies we are subject before we are influenced by recently reading about a particular heuristic or bias. The book helps establish a sound perspective for considering the quality of our judgements in complex situations.

Dorner, Dietrich, The Logic of Failure. Perseus Press; ISBN: 0201479486, (1996) 222 pages.  
 This book describes the ways in which humans have difficulty in managing complex systems over time. In particular, the problems of maintaining a sense of priority in managing systems that provide little or no meaningful and timely feedback about the effect of implemented strategies. This speaks directly to the difficulties in preventive conservation planning where the consequences of measures taken will usually not be known for decades, if ever.

These books provide entertaining reading at a popular level

Bernstein, Peter L. Against the Gods: The Remarkable Story of Risk. John Wiley & Sons; ISBN: 0471295639 (1998) 400 pages  
 A very well written and entertaining book about the history of risk. Its focus is on financial, and particularly investment risk but is of general interest. It discusses the development of the concepts and mathematics behind financial risk analysis beginning with the earliest games of chance and proceeding through to complex computer-based investment strategies.

Gardner, Dan. Risk: The Science and Politics of Fear. Virgin Books. ISBN-10: 0753515539 (2009) 416 pages.

This book is a great read. Very entertaining and good breadth of coverage across many areas of risk assessment.

These are two books that provide an overview of conservation management and of risk assessment for conservation activities

Ashley-Smith, Jonathan, Risk Assessment for Object Conservation. Butterworth-Heinemann, Oxford, (1999), xiv+358pp.  
 This book is a readable overview of a wide range of issues related to risk assessment and decisions related to object conservation. It does not provide a system for applying risk analysis to conservation but does explore many of interesting questions that arise when considers conservation issues from a risk assessment perspective.

Keene, Suzanne, Managing Conservation in Museums, National Museum of Science and Industry, Butterworth-Heinemann, Oxford, (1996), 265 p.  
 This book discusses many management science-based approaches to conservation, frequently with worked examples of how they apply to specific conservation issues. It includes some material and perspectives on risk analysis.

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###### Agents of deterioration

Current information can be found at the Ten Agents of Deterioration web pages hosted by the Canadian Conservation Institute at:

<http://www.cci-icc.gc.ca/caringfor-prendresoindes/articles/10agents/index-eng.aspx>

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Swiss Reinsurance Company, *Earthquake Risk Assessment*, Zurich, (1982).

###### Emergency Preparedness

Current information targeted at USA but useful to many can be found at Heritage Preservation’s Resources for Emergency Planning and Preparedness at:

###### <http://www.heritagepreservation.org/PROGRAMS/TFPlanPrepare.html>

# APPENDIX 1 In-Collection Exercise

The purpose of this appendix is to provide extra copies of work sheets for exercises so that **participants need not disrupt their course notes.**

Both instructions and worksheets are directly copied from the relevant section of the participant manual.

### Exercise – risk assessment in collection

To get a realistic view of what is involved in doing a risk assessment and establish some level of comfort in obtaining numbers.

The President / Director of the institution you are visiting has been told that a group of collection preservation specialists is in one of its buildings. (S)he has asked that you take an hour or two out of your busy workshop schedule to assess a sub-collection and give your expert advice on where the institution should go from here to improve the preservation of the sub-collection.

You will be assigned a part of a collection

Deal with specific risks that come to mind and interest the group but try to consider one example of each of the three types of risk

Identify and define clearly the specific risk, as well as the agent of deterioration and type of risk

Note existing means of control

If possible, estimate variables FS, LV, P, EFS, ELV

* + circle the appropriate magnitude,
  + OR write in intermediate values (if you can estimate better than order of magnitude)
  + OR circle two or more orders of magnitude if that better conveys your sense of uncertainty

Make notes of what further information would have to be sought to confirm or improve estimates of variables

Calculate magnitudes of risk

At end of exercise, rank risks in order of decreasing severity

TIPS

* If it takes more than about 15 minutes to do a specific risk then try working on another, easier, one - it becomes easier with experience
* Try to deal with a variety of risks
* Question any available staff to make use of their experience

|  |  |
| --- | --- |
| GENERIC RISK (Agent and Type): | |
| SPECIFIC RISK (describe scenario – hazard source – path – effect on collection): | |
| EXISTING MEANS OF CONTROL: | |
| FS = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| FS RATIONALE: | |
| LV = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| LV RATIONALE: | |
| P = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| P RATIONALE: | |
| EFS = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| EFS RATIONALE: | |
| ELV = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| ELV RATIONALE: | |
| E = EFS x ELV = | |
| MR = FS x LV x P x E = | |

|  |  |
| --- | --- |
| GENERIC RISK (Agent and Type): | |
| SPECIFIC RISK (describe scenario – hazard source – path – effect on collection): | |
| EXISTING MEANS OF CONTROL: | |
| FS = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| FS RATIONALE: | |
| LV = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| LV RATIONALE: | |
| P = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| P RATIONALE: | |
| EFS = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| EFS RATIONALE: | |
| ELV = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| ELV RATIONALE: | |
| E = EFS x ELV = | |
| MR = FS x LV x P x E = | |

|  |  |
| --- | --- |
| GENERIC RISK (Agent and Type): | |
| SPECIFIC RISK (describe scenario – hazard source – path – effect on collection): | |
| EXISTING MEANS OF CONTROL: | |
| FS = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| FS RATIONALE: | |
| LV = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| LV RATIONALE: | |
| P = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| P RATIONALE: | |
| EFS = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| EFS RATIONALE: | |
| ELV = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| ELV RATIONALE: | |
| E = EFS x ELV = | |
| MR = FS x LV x P x E = | |
| GENERIC RISK (Agent and Type): | |
| SPECIFIC RISK (describe scenario – hazard source – path – effect on collection): | |
| EXISTING MEANS OF CONTROL: | |
| FS = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| FS RATIONALE: | |
| LV = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| LV RATIONALE: | |
| P = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| P RATIONALE: | |
| EFS = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| EFS RATIONALE: | |
| ELV = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| ELV RATIONALE: | |
| E = EFS x ELV = | |
| MR = FS x LV x P x E = | |
| GENERIC RISK (Agent and Type): | |
| SPECIFIC RISK (describe scenario – hazard source – path – effect on collection): | |
| EXISTING MEANS OF CONTROL: | |
| FS = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| FS RATIONALE: | |
| LV = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| LV RATIONALE: | |
| P = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| P RATIONALE: | |
| EFS = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| EFS RATIONALE: | |
| ELV = | 0------------------------0.25------------------------0.5-----------------------0.75----------------------1  0-----------------------0.001-----------------------0.01-----------------------0.1----------------------1 |
| ELV RATIONALE: | |
| E = EFS x ELV = | |
| MR = FS x LV x P x E = | |

Exercise - Evaluating costs and benefits of a short-term mitigation strategy

Risk :

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| PROPOSED  STRATEGY | IMPLEMENTATION | | | ONGOING | | | NON-COLLECTION  EFFECTS |
| Risks | Costs | Benefits | Risks | Costs | Benefits |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |

Exercise - Evaluating costs and benefits of a long-term mitigation strategy

Risk :

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| PROPOSED  STRATEGY | IMPLEMENTATION | | | ONGOING | | | NON-COLLECTION  EFFECTS |
| Risks | Costs | Benefits | Risks | Costs | Benefits |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |

# Appendix 2 Risk Assessment Exercise

The following pages provide the Risk Assessment based on the information given in the exercise Frère Jacques’ Herbarium. You may use this information to compare with answers you work out for yourself.

Where you find differences read carefully again the definitions of Risk Variables.

COLLECTION PROFILE

This herbarium was built up by a Brother, Frère (Friar) Jacques, who used to teach Botany at the school in which it is located.

It consists of an important representation of local plants and rare, exotic medicinal plants collected by the Brother in his earlier years as a missionary in Asia and Africa. There are also many boxes of books and notes and drawings which accompany this collection.

A few years ago, after the Brother died and the school was closed down, both the school and collection were acquired by the Evergreen Botanical Society interested in continuing the brother's work. As this was his life's work, everything had been done by hand and only by the Brother who trusted no one with his precious specimens.

The collection consists of approximately 100,000 plants (see adjoining table). Roughly half of it is catalogued and accessible. About 60% of these are medicinal plants housed in cabinets on the 1st floor. The other 40% are the local plants which are stored on open shelving in file boxes. The other half of the collection is bulk, unsorted and uncatalogued plant materials, some on herbarium sheets and some not. Half of all specimens are mounted on acidic, lignin‑rich paper while the other half are mounted on 100% cotton rag paper. The ratio of medicinal to local plants is estimated to be about the same as for the catalogued part of the collection. These specimens are stored in cardboard boxes directly on the cement basement floor.

Because of their size and weight, cabinets are located on the ground floor and shelves and offices on the 2nd floor.

|  |  |
| --- | --- |
| Description | Number of Specimens |
| Total Collection | 100,000 |
| Catalogued plants | 50,000 |
| Medicinal, in Cabinets, 1st Floor | 30,000 |
| Local, on shelves, 2nd Floor | 20,000 |
| Uncatalogued plants, in boxes | 50,000 |
| Medicinal, basement | 30,000 |
| Local, basement | 20,000 |

Staff is limited to two people who share administrative and museological duties; they do most everything themselves with small budgets and volunteer support. John oversees collection management and has been working at the school and Society for 20 years. Judy oversees research of the collection and has been there 10 years.

BUILDING PROFILE

The building is a small 2‑story schoolhouse with a semi‑basement, to which only minor changes have been made.

The outside of the building is red brick with wood trim for the windows and doors. There is no vapour barrier. The roof is flat and covered with pebbled tar and eaves which run along the edge. The roof is known to leak every spring when the thaw occurs. There are large windows every 10 feet, on all sides, on each floor except the basement where they are fewer, much smaller and partially below ground level. None of the windows or doors have ever been changed and they are very draughty. There are pull‑down shades in some of the windows.

There are two tall oak trees each side of the main entrance and very close to the building, which offer shade in the summer. The main entrance is at ground level and gives onto the stairway and a central hallway which accesses collections rooms on each side of it. The 2nd floor layout is the same as the 1st. There are no elevators and the staircase is wide and winding. The ceiling, floors and walls are all wood except in the basement they are stone and cement. The paint on the interior of the outside walls is peeling.

The electrical system is ancient and easily overloaded. The lighting has been changed to suspended fluorescent lights without UV filtration. There is no air conditioning system. The heating system is a hot water heating system. There are hot water heaters in every room and pipes running through the ceilings and along the walls. These have been known to leak or burst randomly on occasion.

There is an alarm system in case of break‑in or fire but it is not linked to a security company. The smoke detectors are not linked to a central security system either. There are no sprinklers, but there is one hand‑held extinguisher on every floor. The town has only a volunteer fire department and the station is located 5 km away.

The building is located in a flood plain. There is a tide mark 6 inches off the floor on the basement walls. Temperatures can reach 30C in the summer and ‑35C in the winter. The relative humidity may reach as high as 80% in the summer and as low as 15% in the winter. There are marked variations in both temperature and relative humidity between floors. It is common practice to keep the front door open for air circulation in summer time.

USE OF COLLECTIONS

This collection is used solely for research. Although obscure, it is nonetheless internationally renowned and consulted for its medicinal plants. It is also regularly visited by the Society members wanting to compare their findings to the reference collections and identify them. It is not uncommon for visiting researchers to be allowed to snip off little bits of plants if there is enough plant material present. Most access is strictly supervised.

Unfortunately, although there may be important material in the basement it is of little use in its present state. All the collections and their associated data are located in this building. There is no back‑up information. Cataloguing is done by staff but filing and research is sometimes done by volunteers. Specimens are sometimes misfiled.

Material is often loaned to researchers in other institutions and less frequently to other museums. There are no standard packing methods or materials employed. Loans are not always returned when specified.

Information by category of risk

Physical Forces -1 Earthquake

1. Assume that there is a 50% chance of an earthquake that would result in a random displacement of unsecured objects of up to 10 cm.
2. Only unsecured objects that are five times higher than they are wide or deep would be subject to toppling over. Given that assumption, John is certain that none of his cabinets or shelving units would topple.

Physical Forces - 2 Specimen loans

1. In his experience, John found that the majority of sporadic physical damage to specimens occurs when specimens are sent on loan for research.
2. On average 400 such specimen loans are made every year.
3. These specimens are from all parts of the catalogued collection.
4. The damage can range from negligible to virtually complete destruction.
5. Judy has reviewed a number of returned loans and thinks that the average loss in value to each specimen, resulting from a loan transaction, is about 1%.

Physical Forces - 3 Abrasion (Overcrowding)

1. Although all of the collection is overcrowded, new damage from abrasion during handling is only an issue for the catalogued part of the collection.
2. All of the catalogued material is handled regularly.
3. Knowing that the collection has always been crowded, Judy looked at specimens of a variety of ages to determine the extent of damage from abrasion. Although the damage is cumulative, most of the research value of the specimens is retained in the parts that remain. She thinks that the extent to which specimens would lose value from this cause over 100 years would only be about 1%.

Fire - 1

1. John came up with a best “guestimate” of 0.5 as a probability of a fire causing major destruction occurring within a100-year period, given the current situation and his discussions with his insurance adjuster, the local fire inspector and a regional conservator.

Water -1 Major flood

1. The building site is located just outside of the 100-year flood plain. When John tried to clarify the risk with the local hydrogeologist, he was told that the flood plain had not been recalculated in twenty years.
2. His best guess was that there would be a 50% probability of a flood covering the museum property in the next 100 years.
3. John and Judy agree that damage to specimens would be extensive if such a flood occurred.

Water - 2 Sporadic leaks

1. John recalls that every year some collection material stored in boxes is damaged by small sporadic floods caused by leaks through the roof, from the hot-water heating system, or similar local sources.
2. He has noted that the cabinets have provided complete protection from these small local floods.
3. Of the material in boxes he estimates that 5% has been affected by flooding in the 20 years he has been working.
4. Due to the unpredictable sources for this local flooding, it could affect any of the boxed material at any time. In most instances, the affected boxes have been found and dried within a day of the flooding.
5. Significant loss has only occurred in the 10% of specimens that have data written in water-soluble ink.

Water - 3 Infiltrating damp

1. John had not thought of the problem of infiltrating damp until he began this risk assessment. The idea of a possible water-type-1 risk prompted him to look in some boxes sitting on the basement floor which had not been opened as long as he had been there.
2. He found that all the boxes sitting directly on the floor contained mouldy specimens. Boxes that had been undisturbed for almost 100 years had extensive mould growth on all specimens in their bottom half.
3. When Judy saw this she dropped her drawers. She thought that the worst specimens had lost all their value while those toward the middle of the box were only slightly affected. She estimated that the average loss in value for all affected specimens was about 50%.

Criminals - 1 Professional thieves

1. Judy had heard of instances of professional thieves stealing rare medicinal plants, but of the hundred herbaria she knew, only one had been subject to a professional heist in the last ten years. In that instance, only 100 especially rare plants had been stolen. She hoped that they would not be worse than that.

Criminals - 2 Unreturned specimen loans

1. On average 400 such specimen loans are made every year.
2. Some loans made over the period of 1970-1980 have yet to be returned in spite of letters requesting that they be returned.
3. (Unauthorised sampling was not considered)

Criminals - 3 Not identified as a risk

Pests - 2

1. There are no pest control procedures for incoming plant material
2. John knows that the insect pests found locally are only attracted to 20 % of the families of plants found in the herbarium

In his experience, by the time most infestations are caught, only 10% of the value of the specimens has been lost.

Contaminants - 1 Nearby bush fire

1. There is concern over bush fire leading to soot and smoke contamination of specimens
2. Past experience has indicated that particulate pollutants do not infiltrate boxes used to store specimens. The cabinets, however, are vented top and bottom and the gaskets no longer provide a good seal.
3. The outside edges and perimeter areas of sheets (less than 1% of area) show deposits of dust in addition to the top surfaces of bundles.
4. A forestry expert, who occasionally uses the herbarium has told John that, over one hundred years, it is almost a certainty that there will be a nearby forest fire that will blanket the building in smoke.
5. Judy has used some extremely sooty specimens from the Museum in Dresden. She found them unpleasant to work with but retaining most of the characteristics she needed for her research. She thought that they retained at least half of their research value.

Contaminants - 2 Specimens soiled during use

1. One ageing collection-user continues to drink coffee while working with specimens. Spills affect about 5 specimens a year.
2. He only works with catalogued plants from a particular climatic zone, representing about 10% of the collection.
3. Spills have only caused slight damage and the ensuing loss in value on average is 1%

Contaminants - 3

1. Since all specimens are being kept in folders within boxes and cabinets, dust is not a problem.
2. However, in the past some specimen labels (1% of the collection) were treated using corrosive sublimate (mercuric chloride) for pest control.
3. In some cases it darkened the labels and over time can make them illegible. This occurred with 10% of the treated labels.

Light and UV Radiation - 2

1. Only the part of the collection in use is affected
2. Approximately 100 sheets per year are exposed for one week.
3. John has shown by test that this exposure can cause a very noticeable change in colour. Judy argues that this is not an important feature and therefore the loss in value to the specimen is no more than 1%.

Incorrect Temperature - 1

1. There are no frozen collections.

Incorrect Temperature - 2

1. There is no part of the collection which is subjected to thermal shock or suffers from intermittent exposures to incorrect temperatures.

Incorrect Temperature - 3

1. Neither John nor Judy could seem to get an answer on whether or not storage temperature was a significant factor in deterioration due to acid hydrolysis of paper supports or of the plant specimens themselves.

Incorrect Relative Humidity - 2

1. The only occurrences of mould in the collection relate to infiltrating damp and have been accounted for under Water Type 3.
2. Relative humidity in cabinets and boxes of specimens is quite stable throughout the year and no instances of damage have ever been noted when specimens were removed for consultation and exposed to the ambient relative humidity.

Incorrect Relative Humidity - 3

1. John and Judy know that relative humidity is a significant factor in the deterioration of paper support through acid hydrolysis. However, they agree that it does not affect the value of the specimens themselves and that it only makes them more vulnerable to damage through handling.

Dissociation - 1 Collection Abandonment

1. The collection is sufficiently important to local residents and internationally renowned that it is considered very unlikely that it would be abandoned or orphaned.

Dissociation - 2 Misfiling

1. Volunteers help with the filing work of some 1000 catalogued specimens per year. John and Judy believe that the rate of error in filing is approximately one in one thousand.

Dissociation - 3

1. Current curatorial practices are to use stable materials but in the past improper materials were used for recording specimen data. Approximately 1% of the uncatalogued local material has data which are written on very poor quality newsprint.
2. All of these documents are more than 30 years old and are severely degraded. After 80 years the document is so damaged that data is totally illegible and irrecoverable. Therefore over the next 100 years all data for these specimens will be irrecoverable.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Collection number: | Generic collection name: Frère Jacques’ Herbarium | | | | | Date:12OC/01 |
| Contact person: Judy or John | | | Collection manager: John | | | |
| Environmental specs: high fluctuations in RH and temperature present | | | | | | |
| Component collection units: | | Collection size: | | Location: | Storage units: | |
| Catalogued Medicinal | | 30 000 | | 1st Floor | Cabinets | |
| Catalogued Local | | 20 000 | | 2nd Floor | boxes on shelves | |
| Uncatalogued Medicinal | | 30 000 | | basement | cardboard boxes | |
| Uncatalogued Local | | 20 000 | | basement | cardboard boxes | |
|  | |  | |  |  | |
| Total (Catalogued) | | 50 000 | |  |  | |
| Total (Uncatalogued) | | 50 000 | |  |  | |
| TOTAL | | 100 000 | |  |  | |
| Generic collection unit **description** : nature of material, sizes, numbers, condition of material, environmental details (special storage)  The collection includes 100 000 specimens of local plants and rare, exotic medicinal plants. 30% of the collection is stored in cabinets. 20% of the collection is stored in boxes on open shelving. The uncatalogued material, which makes up the remaining 50 % of the collection is stored in cardboard boxes, kept on the cement floor of the basement. The uncatalogued material is unsorted; half is mounted on acidic lignin-rich paper; the other half is mounted on 100% cotton rag paper.  For the purpose of this risk assessment, the uncatalogued material is counted as being part of the collection just as the catalogued material. This decision has yet to be approved by management and a change in this decision will change the risk profile to the collection. | | | | | | |
| **Use** / access: statistics, future use  Visiting researchers, students, loans   * use is solely for research purposes  1. members of the Evergreen Botanical Society regularly use specimens for comparison and identification of findings 2. visiting researchers often remove small pieces of plants for use 3. access is supervised 4. material is frequently loaned to researchers in other institutions 5. occasionally material is loaned to other museums | | | | | | |
| **Other:** particularities (facilities, foreseen changes in near future, etc.)   1. building has no vapour barrier 2. roof leaks have been a recurring problem in the past 3. building has ageing windows and doors 4. building is heated with hot water (no A/C) 5. lighting is fluorescent with no UV filters 6. water pipes run in walls near collection, bursts and leaks have been problematic in the past 7. alarm system is not linked to security company 8. extinguishers are present on each floor but sprinklers are not 9. building is on flood plain, basement has flooded to 6 inches in past 10. high fluctuations of temperature and RH are experienced with seasonal changes and within areas of the building 11. all new specimens are put on acid-free paper | | | | | | |

###### PF-1 Earthquake

FS = 0 All cabinets and shelving units will remain upright during an earthquake. Boxes will remain stacked or on shelves.

LV = 0.01 Expected LV if cabinets were to topple.

P = 0.5 Probability of a moderate (10 cm displacement of non-secured objects quake within the 100-year time frame.

E = 1 For type 1 risk

MR = 0

###### PF-2 Physical damage to loaned specimens

FS = 0.5 Only the catalogued specimens are sent on loan.

LV = 0.01 Estimated typical loss in value during a specimen loan.

P = 1 For type 2 risk

EFS = 0.8 Approximately 400 specimens are sent on loan per year. Hence, 400 specimens/year x 100 years/century ÷ 50000 specimens/FS = 0.8 It is estimated that 0.8 of the Fraction Susceptible will suffer this damage over the next century.

MR = 0.004

Note: Other PF-2 risks such as dropping a box of specimens are considered at least 10x less significant than the loan damage issue.

###### PF-3 Physical damage from collection staff handling of overcrowded specimens

FS = 0.5 Only the catalogued specimens are regularly used.

LV = 0.01 Estimated total Loss in Value to the Fraction Susceptible over a century.

P = 1 For type 2 risk

E = 1 Damage as described is expected to occur – there are no mitigating factors.

MR = 0.005

Note: We will want to make sure that Judy is not confusing this damage with damage that occurred while specimens were out on loan, that is we want to make sure we are not double-counting PF-2 damage in this PF-3 accounting.

###### Fire-1 Total consumption of building and contents by fire

FS = 1 All herbarium specimens are susceptible.

LV = 1 If consumed by fire loss in value is total.

P = 0.106 Calculated according to Harmathy et al. 1989.

E = 1 By definition for the scenario considered.

MR = 0.106

###### Fire-2 Consumption of one fire compartment within the building

FS = 1 All herbarium specimens are susceptible.

LV = 1 If consumed by fire loss in value is total.

P = 0.5 Calculated according to Harmathy et al. 1989.

E = 0.33 Assuming that 1 fire compartment out of 3 is consumed.

MR = 0.165

###### Fire-3 Fire with no flashover

FS = 1 All herbarium specimens are susceptible.

LV = 1 If consumed by fire loss in value is total.

P = 1 Certain to happen in a century.

E = 0.0024 Assuming that 1m² is consumed out of 600 m² total building area and

expecting a rate of fire incidences as reported by Harmathy et al. 1989.

MR = 0.0024

###### Water - 1

FS = 0.5 The material in boxes in the basement would be much more susceptible than material on the first or second floor.

LV = 1 High, but only if not responded to in time to prevent mould

P = 0.2 Major flood considered unlikely at this site

E = 1 There is no emergency plan.

MR = 0.1

###### Water – 2 Roof leak or plumbing leak

FS = 0.7 Material in boxes is at risk while material in cabinets is considered safe.

LV = 1 High, but only if water-soluble inks are used on labels and/or not responded to in time to prevent mould.

P = 1 Certain to happen in a century

E = 0.025 product of 0.1 (fraction of specimens with soluble ink on labels) and 0.25 (area affected = 5%/20 years or 25%/century)

MR = 0.0175

###### Water – 3 Rising/infiltrating damp

FS = 0.5 All specimens in boxes in the basement

LV = 1 Mould damage can be total

P = 1 Some mould growth due to infiltrating damp is certain in this situation.

E = 0.1 Very hard to estimate but 0.5 Loss in Value has already been realised in the lowest layer of boxes hence the estimate of an additional spread through the remaining half of the boxes on the floor.

MR = 0.05

###### Criminals – 1 Major theft

FS = 0.6 Medicinal plants are considered susceptible

LV = 1 Damage would be total – no insurance and no expectation of return

P = 0.1 Estimated P per century based on 1/100 herbaria experiencing this kind of theft over 10 years. Hence, estimate 10/100 herbaria would be affected per century.

E = 0.00167 Scenario considered has 100/60000 medicinal plants would be affected.

MR = 0.0001

###### Criminals – 2 Theft – non-returned loans

FS = 0.5 Only catalogued specimens will be sent on loan.

LV = 1 Loss is total if material unreturned

P = 1 For Type 2 risk – this will happen

E = 0.04 Rate of non-return of loans is 200/4000 = 0.05. Rate of loans is 400/year x 100 years/century = 40000. As a fraction of the FS this is 40000/50000 = 0.8. Hence E = 0.8x0.05 = 0.04

MR = 0.02

###### Criminals – 3 Pilfering – unauthorized sampling

FS = 0.5 Only specimens in use are susceptible, depends on interest of pilferer/ thief

LV = 0.1 Estimate of damage based on experience. Damage considered here is sampling of part of a specimen.

P = 1 for Type 3 risk

E = 0.006 John’s estimate of frequency (equivalent to about 1 incident every few years, maximum 10 specimens affected per incident or about 300 specimens per century) Hence 300/50000

MR = 0.0003

###### Pests - 2 - Insects

FS = 0.2 Families (Salix, Rosacea, composites) appealing to insects. No infestation has ever been seen in algae collection.

LV = 0.1 Damage due to pests is seldom complete but will be serious when flowers are eaten.

P = 1 Some infestation is certain to occur.

E = 0.25 Estimate about 1 box (100 specimens) of the susceptible material is affected every two years. Hence 5000 per century out of the FS of 0.2. 5000/20000 = 0.25. Maintenance and monitoring have improved, as have humidity and temperature controls, reducing reproduction rates; also present de-infestation procedures and equipment are better and more accessible

MR = 0.005

###### Contaminants – Type 1 – Smoke from nearby forest fire

FS = 0.3 Specimens in cabinets are at risk

LV = 0.001 Contaminated specimens retain most of their value

P = 1 Assumed very low probability – many faults must occur simultaneously

E = 0.02 Only top 1 of 100 sheets in a stack and outer 1% of other 99 sheets will be affected.

MR = 0.000006

###### Contaminants – Type 2 – None

FS = 0.5 Catalogued (and hence accessible) specimens are most susceptible to soiling

LV = 0.01 Estimate of LV due to soiling

P = 1 Collection users continue to soil specimens

E = 0.01 Estimated as 5 specimens/year x 100 years / 50000 susceptible specimens.

MR = 0.00005

###### Contaminants – Type 3 - Blackening from mercuric chloride use

FS = 0.01 Fraction of the total collection on which mercuric chloride was used as pest control method.

LV = 1 Loss in value is complete where labels darken to the point of obscuring label data.

P = 1

E = 0.1 Progressive darkening is occurring in 10% of the FS.

MR = 0.001

###### LUV – Damage from light and UV radiation

FS = 0.5 Catalogued part of collection that is being used.

LV = 0.01 Where flower colour is an important identification characteristic

P = 1

E = 0.2 Specimens exposed are 100 specimens/year x 100 years/century ÷ 50000 specimens/FS

MR = 0.001

###### T – 2 No specific risk identified

###### T – 3 No specific risk identified

Although thermal degradation is occurring, damage will be identified in physical forces as the herbarium sheets embrittle and fail.

###### RH – 2 No specific risk identified

Mould was addressed within Water Type 3; the risk due to RH in storage and exposure to ambient RH has not been observed.

###### RH – 3 No specific risk identified

Although humidity regulated degradation is occurring, damage will be identified in physical forces as the herbarium sheets embrittle and fail.

###### DISSOCIATION – 1 No specific risk identified

###### DISSOCIATION – 2 Misfiling of specimens during use

FS = 0.5 Only catalogued specimens are susceptible

LV = 1

P = 1

E = 0.002 Estimate that 1000 specimens per year are re-filed by volunteers and that about 1 specimen per thousand is misfiled. Hence 100 specimens per century or FS = 100/50000.

MR = 0.001

###### DISSOCIATION – 3 Other use of improper materials e.g. ballpoint pen inks

FS = 0.002 Of the uncatalogued local (20000/100000) about 1% has poor quality labels subject to deterioration. (0.01 x0.2)

LV = 1 Maximum loss in value if labels are illegible.

P = 1 Deterioration is occurring

E = 1 All of the FS is expected to be affected over the next century

MR = 0.002

Notes