ENVIRONMENT & BUILDING SYSTEMS
Workshop Part A

Utah Field Services

Utah Division of Arts and Museums

July 6, 2023: USU Eastern Prehistoric Museum

10 am - 5 pm

PROGRAM OVERVIEW: Year at a Glance

~~1. ACCESS AND ARTIFACT HANDLING~~

JANUARY
FEBRUARY
MARCH

- ~~Workshop (pt A & B)~~
- ~~1. Webinar~~
- ~~2. Webinar~~
- ~~3. Webinar~~

~~2. PRESERVATION IN STORAGE AND DISPLAY~~

APRIL
MAY
JUNE

- ~~Workshop (pt A & B)~~
- ~~1. Webinar~~
- ~~2. Webinar~~
- ~~3. Webinar~~

3. ENVIRONMENT AND BUILDING SYSTEMS

JULY
AUGUST
SEPTEMBER

- Workshop (pt A & B)
- 1. Webinar
- 2. Webinar
- 3. Webinar

4. RISK MANAGEMENT, EMERGENCY PREPAREDNESS & DISASTER RESPONSE

OCTOBER
NOVEMBER
DECEMBER

- Workshop (pt A & B)
- 1. Webinar
- 2. Webinar
- 3. Webinar

COLLECTIONS PRESERVATION

GOALS

Gain a better understanding of Key Themes...

Key Themes

- Increase understanding of environmental monitoring and temperature and relative humidity
- Understand building HVAC systems that manage your environment
- Increase understanding of how to analyze environmental monitoring data
- Increase understanding of decision-making in response to environmental data

AGENDA

Handout

Environment and Building Systems

Workshop Part A Agenda

USU Eastern Prehistoric Museum

July 6, 2023

Learning Goals for Workshop pt A

1. Increase understanding of environmental monitoring of temperature and relative humidity
2. Understand building HVAC systems that manage your environment
3. Increase understanding of how to analyze environmental monitoring data
4. Increase understanding of decision-making in response to environmental data

Agenda

10:00-10:40	Introductions- What does Environmental Monitoring for Collections mean to you?
10:40-11:10	Introduction to the Collections Environment 1. General Environmental Parameters and Impacts on Collections o Agents : Temperature, Relative Humidity, Pollutants, Light, Pests
11:10-11:30	Introduction to Environmental Monitoring
11:00-11:20	Activity: Environmental Monitoring Tools How-to: Light meters, data loggers, Elsec
11:30-11:45	**BREAK (15 min)**
11:45-12:30	Introduction to Environmental Data analysis 1. Brief review of using light data 2. Basics of using environmental monitoring free software 3. Introduction to HVAC Systems
12:30-1:30	**LUNCH**
1:30-2:30	Group walk through HVAC systems at Museum, tour of Museum spaces
2:30-3:15	Discussion: Observations form HVAC systems we viewed; Q&A with facilities staff
3:15-3:30	**BREAK (15 min)**
3:30-4:00	Activity: Environmental Monitoring Systems at Home Institutions
4:00-4:30	Circle back to software: Drive-through demo with free software tool
4:30-5:00	Reflection on Activity, wrap-up, evaluation

INTRODUCTIONS

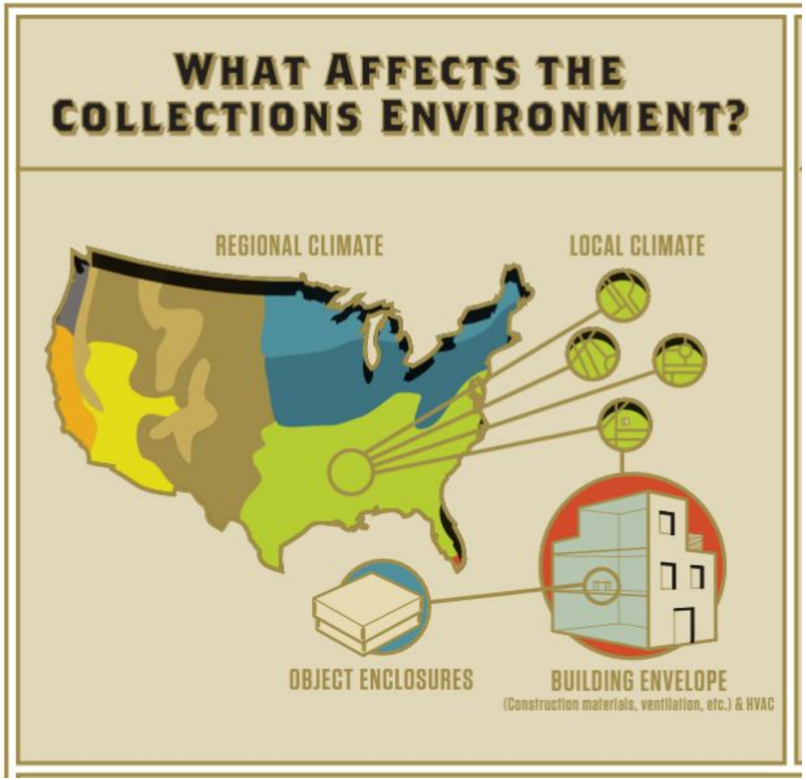
THANK YOU TO OUR HOST: Utah State University Eastern Prehistoric Museum, Katy Corneli and Timothy Riley

Please share the following:

1. Name
2. Where you work, your role and how long you have worked there
3. What does environmental monitoring for collections mean to you?

INTRODUCTION TO
THE COLLECTIONS ENVIRONMENT

COLLECTIONS ENVIRONMENT



Infographic courtesy of Conservation Center for Art and Historic Artifacts

1. Regional Climate
2. Local Climate
3. Building Envelope
4. Object Enclosures

COLLECTIONS ENVIRONMENT

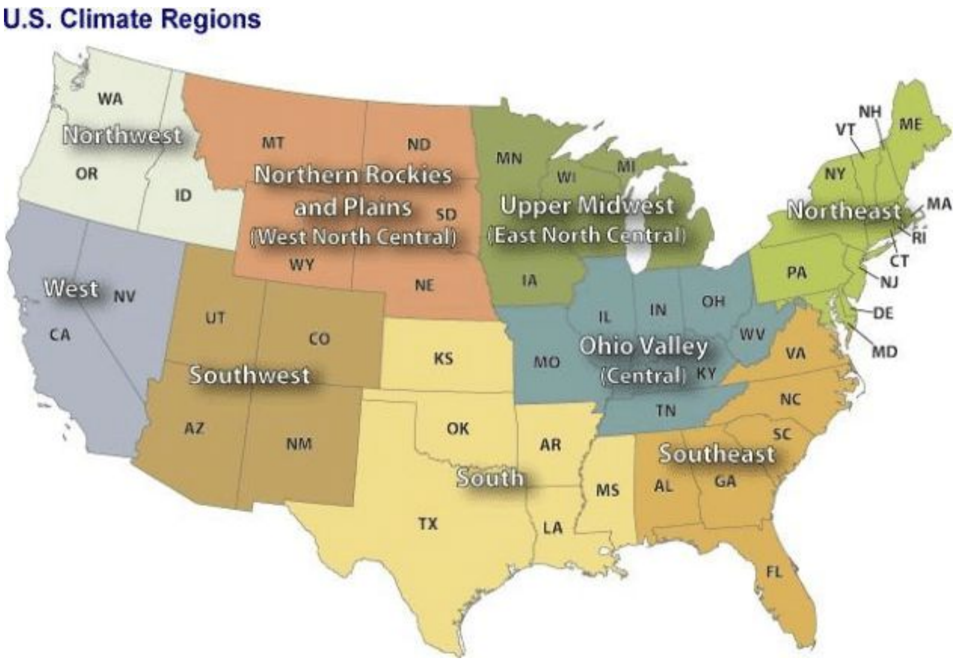


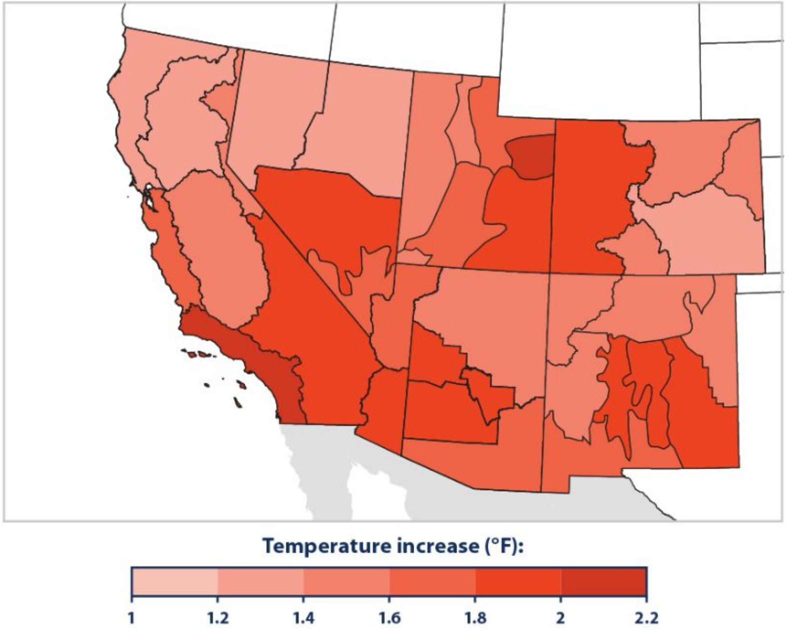
Image Courtesy of NOAA (National Oceanic and Atmospheric Administration)

1. Regional Climate
2. Local Climate
3. Building Envelope
4. Object Enclosures

- The Climate where you live
- Based on average weather patterns over thirty years: wind, temperature, rain and snowfall
- American Southwest

COLLECTIONS ENVIRONMENT

Figure 1. Average Temperatures in the Southwestern United States, 2000–2020 Versus Long-Term Average

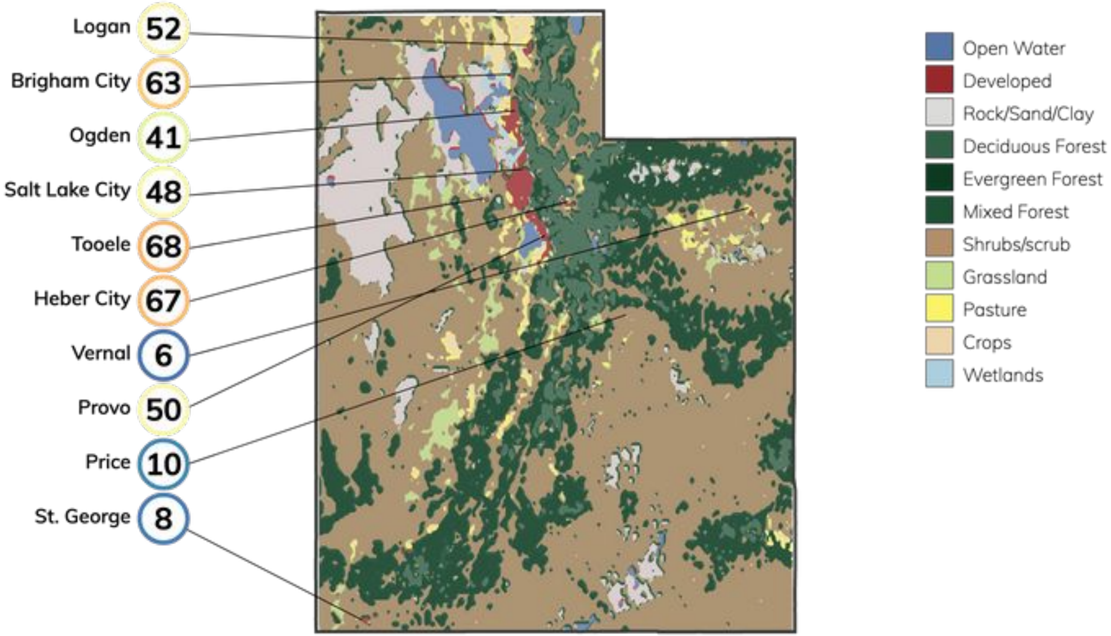


1. **Regional Climate**
2. Local Climate
3. Building Envelope
4. Object Enclosures

- The Climate where you live
- Based on average weather patterns over thirty years: wind, temperature, rain and snowfall
- American Southwest

This map shows how the average air temperature from 2000 to 2020 has differed from the long-term average (1895–2020). To provide more detailed information, each state has been divided into climate divisions, which are zones that share similar climate features.
Image Courtesy of NOAA (National Oceanic and Atmospheric Administration)

COLLECTIONS ENVIRONMENT

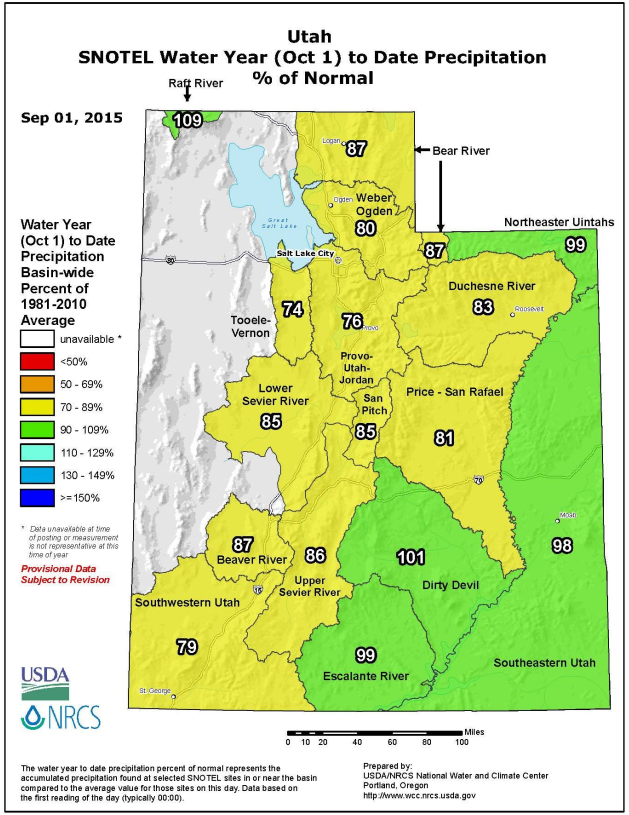


Map Courtesy of Climate Check

1. Regional Climate
2. **Local Climate**
3. Building Envelope
4. Object Enclosures

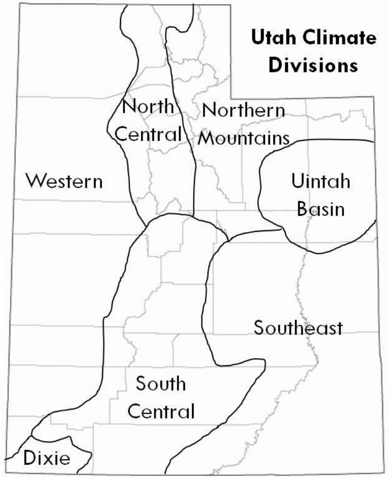
- More specifically where you live
- Based on average weather patterns over thirty years: wind, temperature, rain and snowfall
- Soil types and plants indicate average weather patterns

COLLECTIONS ENVIRONMENT

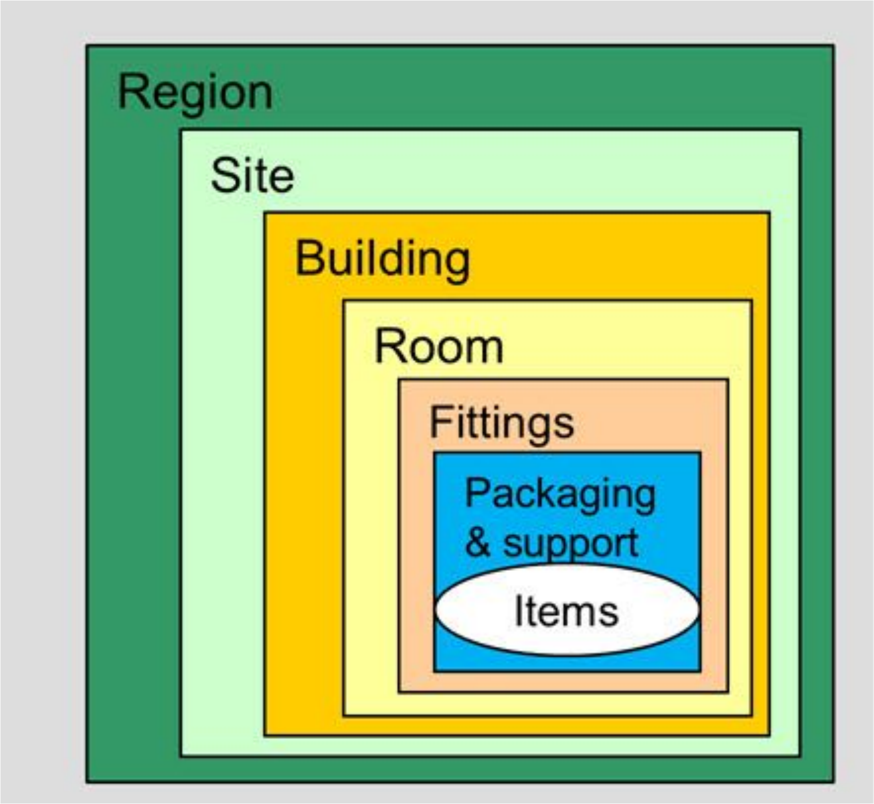


www.nrcs.usda.gov

1. Regional Climate
2. **Local Climate**
3. Building Envelope
4. Object Enclosures



COLLECTIONS ENVIRONMENT

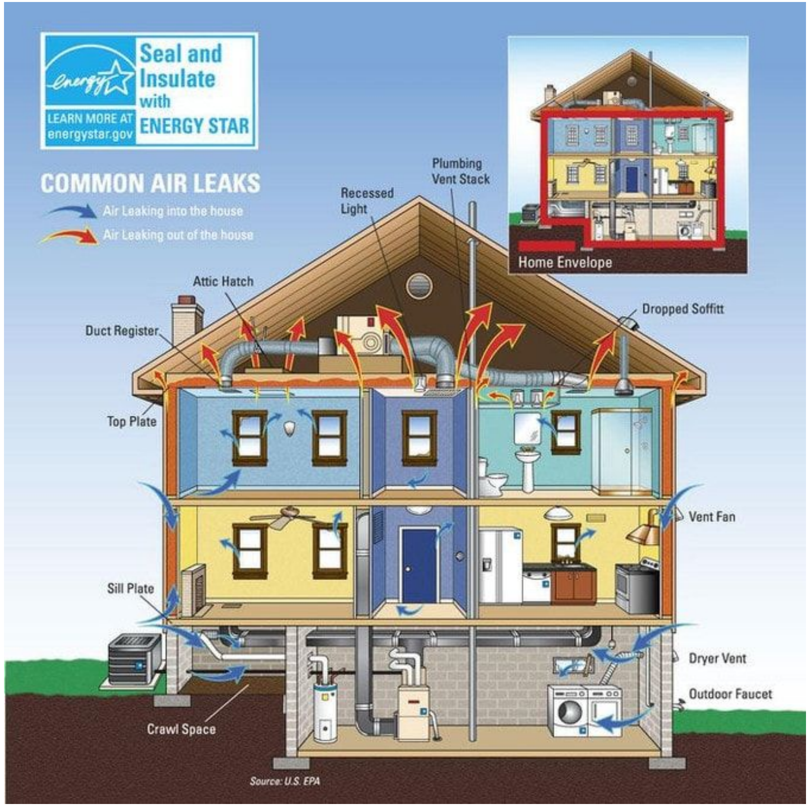


Canadian Conservation Institute

1. Regional Climate
2. Local Climate
3. **Building Envelope**
4. Object Enclosures

"...includes the walls, windows, roof, and foundation, forms the primary thermal barrier between the interior and exterior environments. With envelope technologies accounting for approximately **30% of the primary energy consumed in residential and commercial buildings**, it plays a key role in determining levels of comfort, natural lighting, ventilation, and how much energy is required to heat and cool a building."
-United States Department of Energy

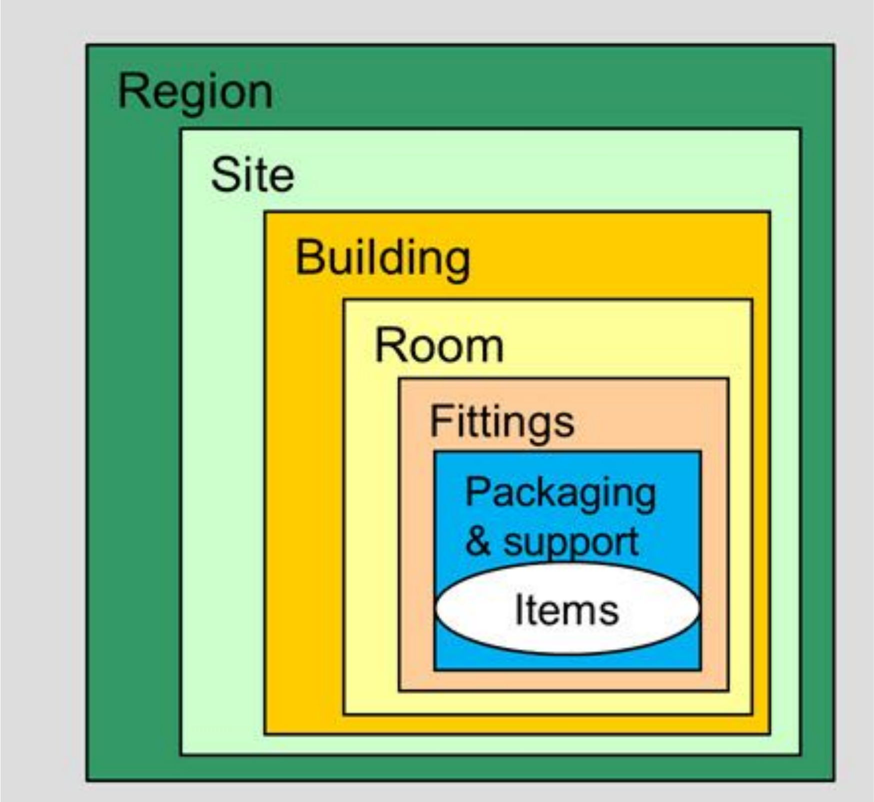
COLLECTIONS ENVIRONMENT



PV Heating and Air

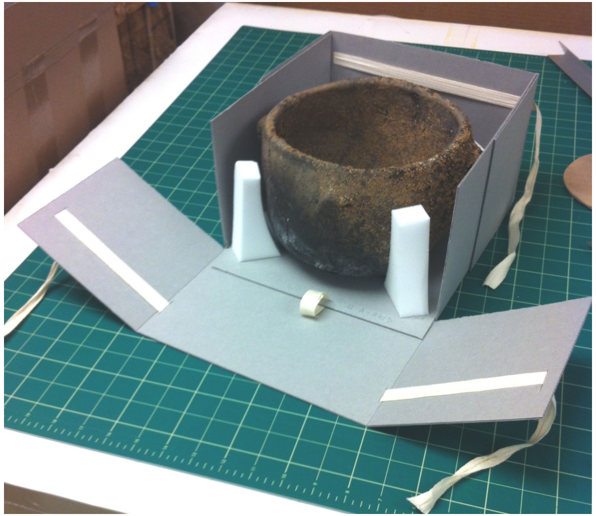
1. Regional Climate
2. Local Climate
3. **Building Envelope**
4. Object Enclosures

COLLECTIONS ENVIRONMENT



Canadian Conservation Institute

1. Regional Climate
2. Local Climate
3. Building Envelope
4. **Object Enclosures**



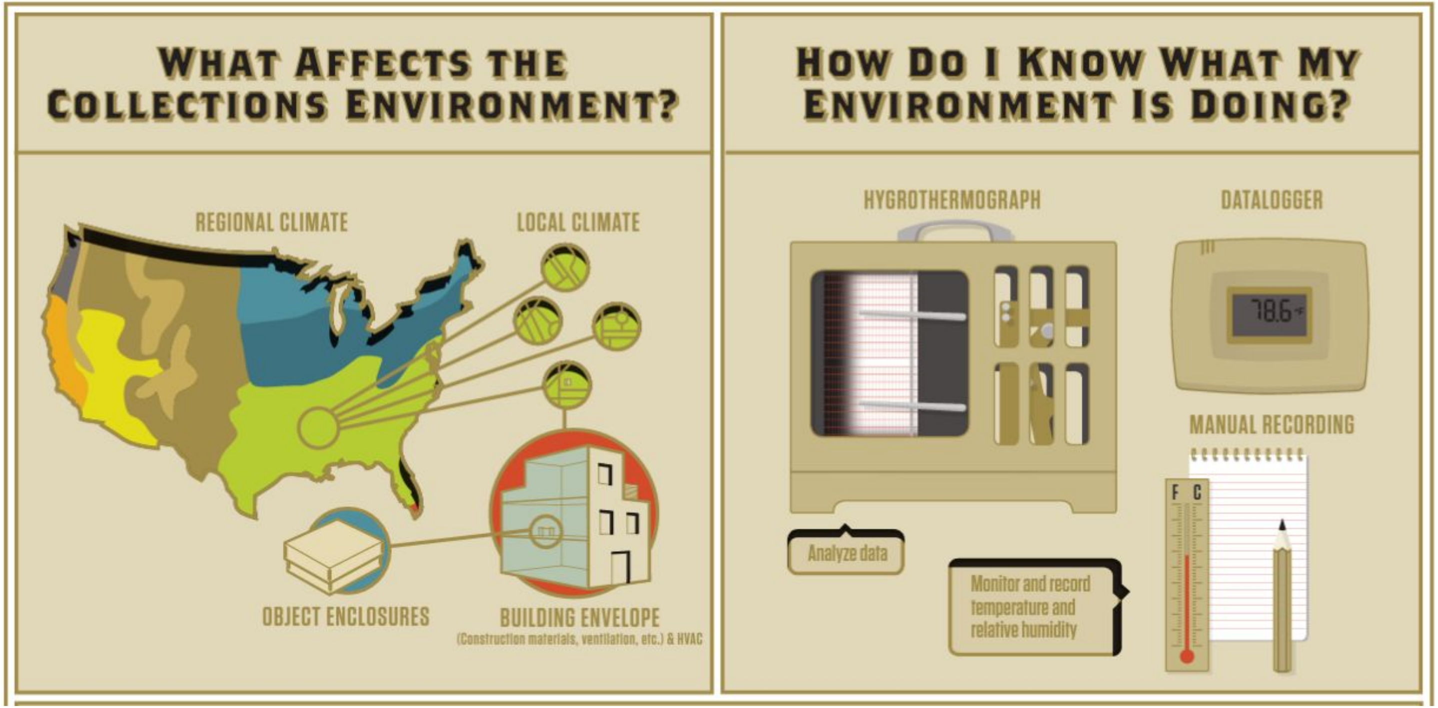
COLLECTIONS ENVIRONMENT

Workshop 2 at Uintah County Heritage Museum (2022)

1. Regional Climate
2. Local Climate
3. Building Envelope
4. **Object Enclosures**

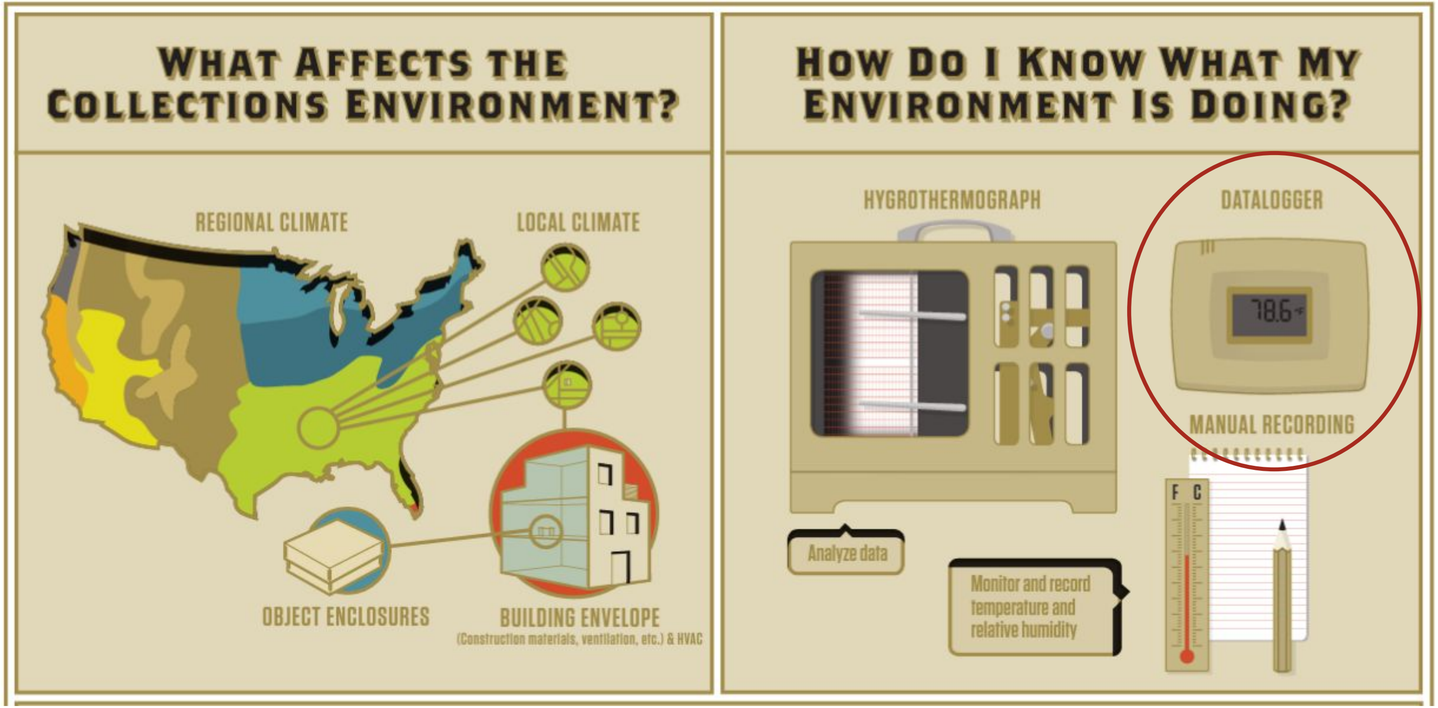
Buffering Capacity- ability of an enclosure to maintain a stable internal environment

COLLECTIONS ENVIRONMENT



Infographic courtesy of Conservation Center for Art and Historic Artifacts

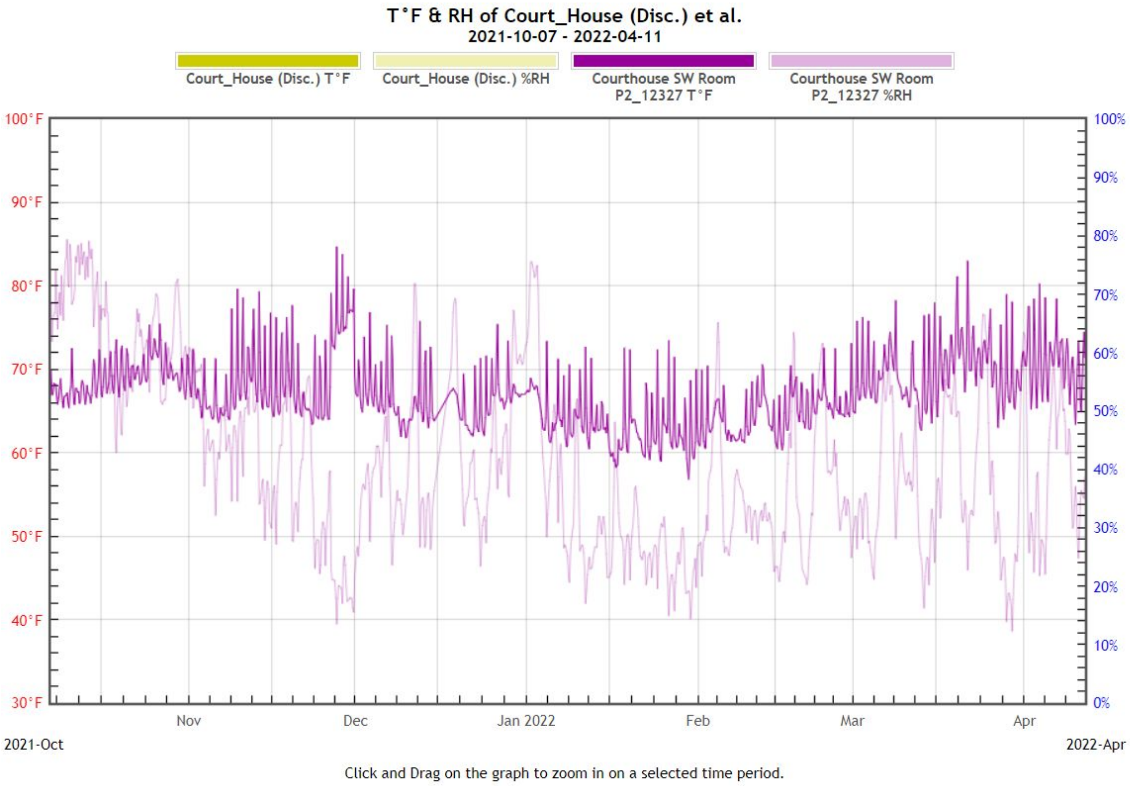
COLLECTIONS ENVIRONMENT



The best tool we currently have

Infographic courtesy of Conservation Center for Art and Historic Artifacts

MONITORING COLLECTIONS ENVIRONMENT



Onset "hobo" data logger is one example of what's out there, and it is commonly used by Museum collections staff

On the left is an example of what several months of environmental data could look like, plotted with eClimate Notebook Software

BASIC PARAMETERS

For several decades, museums have used the environmental parameters of 70°F and 50% relative humidity to guide preservation. **We now acknowledge, though, that no single temperature and relative humidity point works for all collections.**

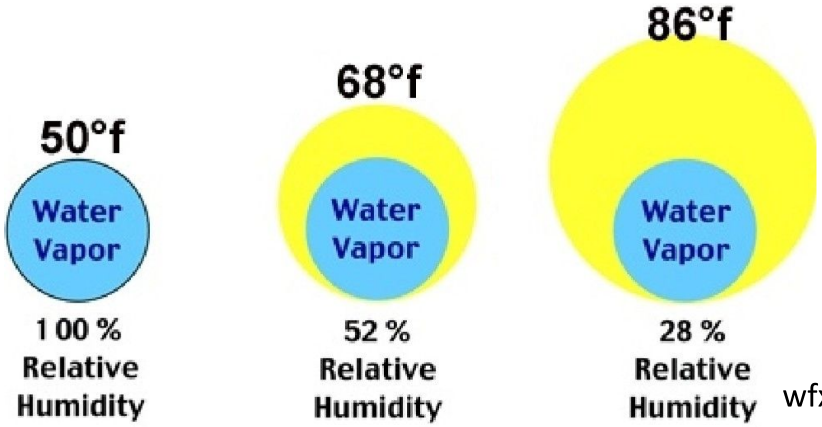
2 GUIDELINES FOR TEMPERATURE AND RH

Over the past decade, climate change, soaring energy costs, and a conscious movement towards more sustainable, green approaches to energy consumption have dramatically changed the way that libraries, museums, and archives manage their environment. During the latter half of the twentieth century, air conditioning technology improved dramatically and targets for an "ideal" temperature and relative humidity evolved as a way of assuring an appropriate environment for collections in storage, exhibition, or on loan. The "50/70" rule --shorthand for conditions of 50% ±5% relative humidity and 70°F ±2° -- served for many years as the "ideal" setting for many materials in cultural heritage collections and was written into many building specifications, HVAC programs, and loan agreements.

From the Northeast Document Conservation Center, the **“50/70” rule**

BASIC PARAMETERS:
Incorrect Relative Humidity

Relative Humidity- the amount of water vapor present in air expressed as a percentage of the amount needed for saturation at the same temperature.



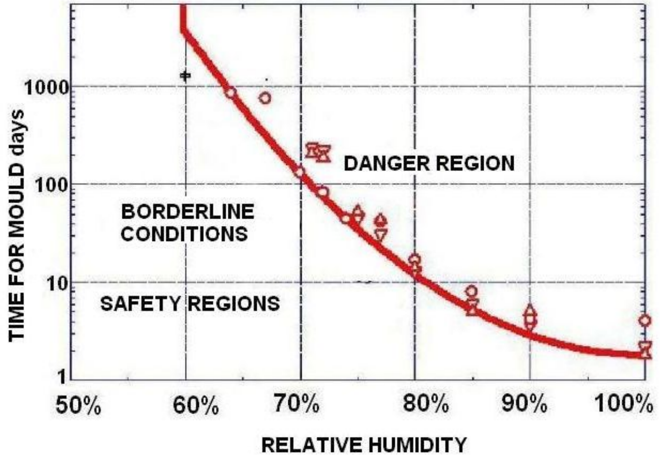
wfxl.com

Deterioration by Incorrect Relative Humidity, and the Collections Most Vulnerable

Damp (over 75% RH)

Damp has been understood since ancient times. It remains a constant battle, especially in the historic buildings that so often house museums. Damp causes several types of deterioration – mould, rapid corrosion, and extreme forms of mechanical damage. Although the practical boundary for damp is given as 75% RH, the deterioration rates all climb rapidly with increasing RH, so any reduction below 100% RH is beneficial.

Damp causes mould, which disintegrates or discolours skin, leather (Figure 1), textiles, paper, basketry, and occasionally wood, paint, and glass. Table 1 summarizes the different sensitivities to mould.



Canadian Conservation Institute

BASIC PARAMETERS:
Incorrect Relative Humidity

From the Canadian Conservation Institute:

From a practical risk assessment perspective, the many forms of incorrect RH can be subdivided into **four types**:

- **Damp**, over 75% RH.
- RH above or below a **critical value** for that object.*
- RH above 0%.
- RH **fluctuations**.

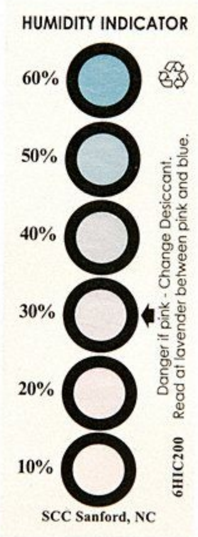
***Critical Value**- RH point when a material undergoes dramatic physical changes through moisture, examples: “sweating” glass and “weeping” iron

INCORRECT RELATIVE HUMIDITY

Carriage experiencing mold growth and corrosion due to damp storage conditions (left). Glass beads crizzling due to RH above critical RH (right) -Canadian Conservation Institute

WAYS TO MEASURE RELATIVE HUMIDITY

Hygrothermograph (old school)



Humidity Indicator Card

Analog hygrometer

Digital hygrometer/data logger

What we recommend

BASIC PARAMETERS: Incorrect Temperature

Table 1a: Chemical sensitivity of materials to room temperature

Low sensitivity	Medium sensitivity	High sensitivity	Very high sensitivity
Wood, glue, linen, cotton, leather, rag paper, parchment, oil paint, egg tempera, watercolour media, and gesso. Serviceable examples of all these exist that are 1–3 millennia old from dry burial or dry enclosures at ~20°C. These examples were protected from any acid exposure, such as air pollution in the Industrial Revolution, and have never been damp. Skin, bone, and ivory of the wooly mammoth have survived intact for over 40 millennia while frozen.	Current best estimate for stable photographic materials to remain usable as images with little or no change, e.g. 19th century black-and-white negatives on glass, 20th century black-and-white negatives on polyester film.	Acidic paper and some film become brittle and brown, difficult to access, e.g. newsprint and low-quality books, papers, post- 1850 . Acetate film shrinks, image layer cracks. Celluloid and many early plastics, become yellow, crack, distort. Natural materials acidified by pollution (textiles, leather) weaken, may disintegrate.	So-called "unstable" materials. Typical magnetic media begins to be unplayable, e.g. tapes of video, audio, data; floppy discs. Least stable of the photographic materials decay, e.g. colour prints fade (in the dark), poorly processed items yellow, disintegrate; cellulose nitrate yellows, disintegrates, faster when packaged in large amounts. Many elastic polymers, from rubber to polyurethane foams, become brittle, or sticky, or disintegrate. Some acrylic paints on some canvas supports yellow rapidly.

Canadian Conservation Institute

BASIC PARAMETERS:
Incorrect Temperature

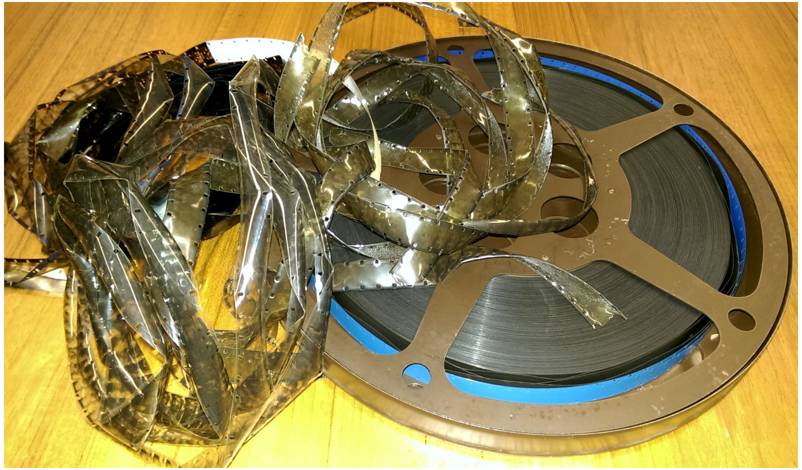
From the Canadian Conservation Institute, 3 main categories:

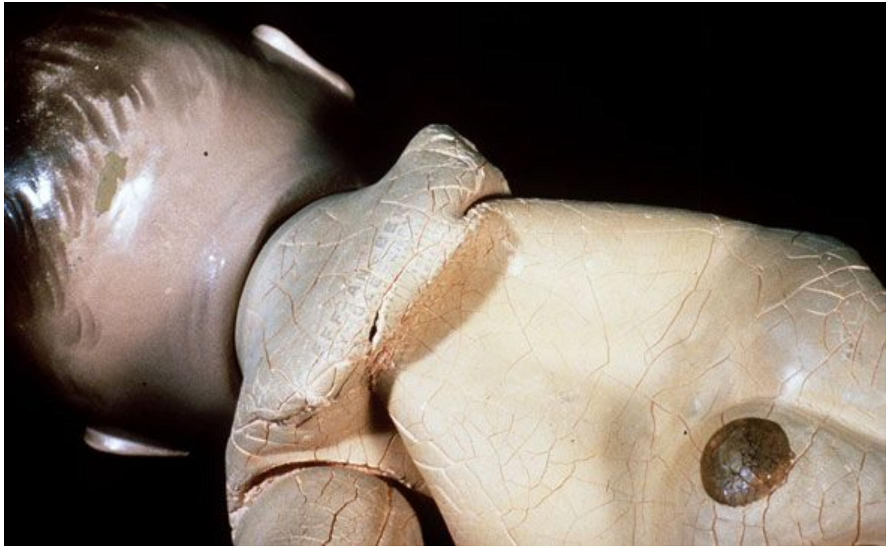
- **Temperature too high.** Subdivided into chemical, physical, and biological phenomena. Most important is chemical deterioration: room temperatures are too high for long-term preservation of unstable human-made materials.

- **Temperature too low.** Overall, low temperature is beneficial to collections, but some materials, become more brittle and fragile. Careful handling mitigates most of this risk.

- **Temperature fluctuation.** Temperature issue that has challenged most museums and driven requests for climate control. This emphasis on temperature fluctuation has been out of all proportion to its significance for collection preservation.

INCORRECT TEMPERATURE

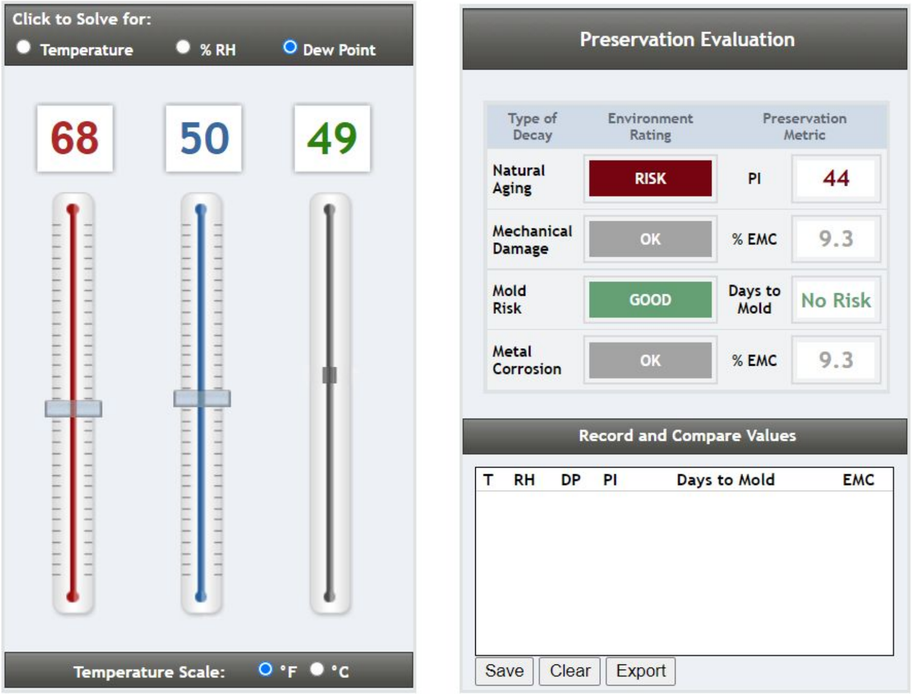




Both of these objects require colder temperatures than "human comfort" for optimal preservation. Their deterioration is the result of storage in incorrect temperature.

Images from the Canadian Conservation Institute

TEMPERATURE AND RH ARE LINKED



The dew point temperature determines what combinations of temperature and RH will be possible in the storage environment. At a constant dew point, when the temperature goes up, the RH goes down and when the temperature goes down, the RH goes up. Controlling the dew point is key to managing the risk of material decay. What's your dew point? If you know the T & RH in your space you can use the DP Calculator to get the DP. If your building does not have humidification or dehumidification, the indoor dew point is the same as the outdoor dew point.

Dew Point is an absolute measure of how much water vapor is in the air, the point at which the air is fully saturated with water.

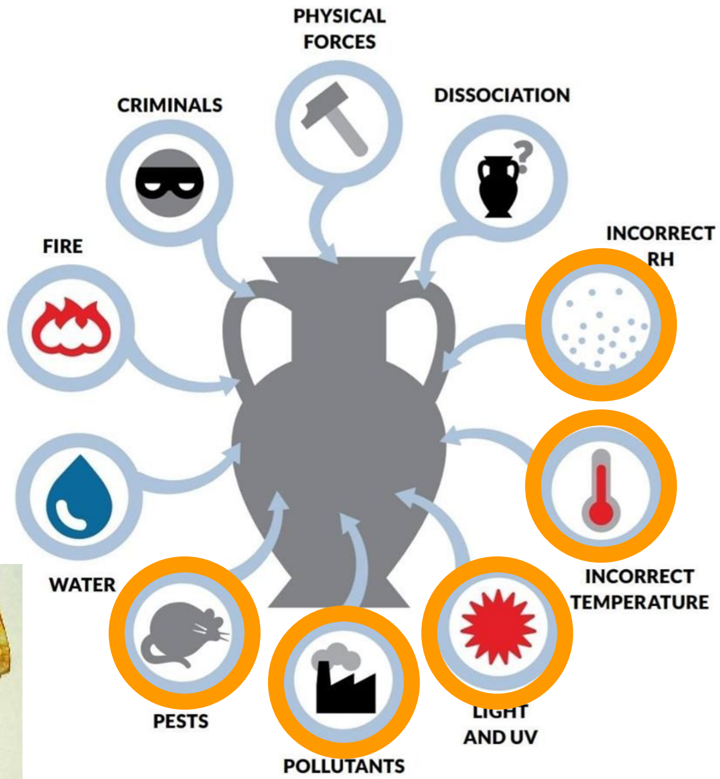
It is the result of specific combinations of RH and temperature working together in an environment

[Dew Point Calculator by Image Permanence Institute]()

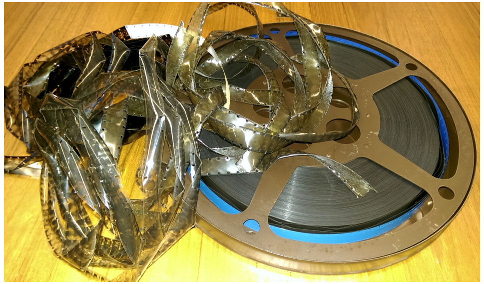
AGENTS OF DETERIORATION

Centroid PM

IMPACTS ON COLLECTIONS: Deterioration

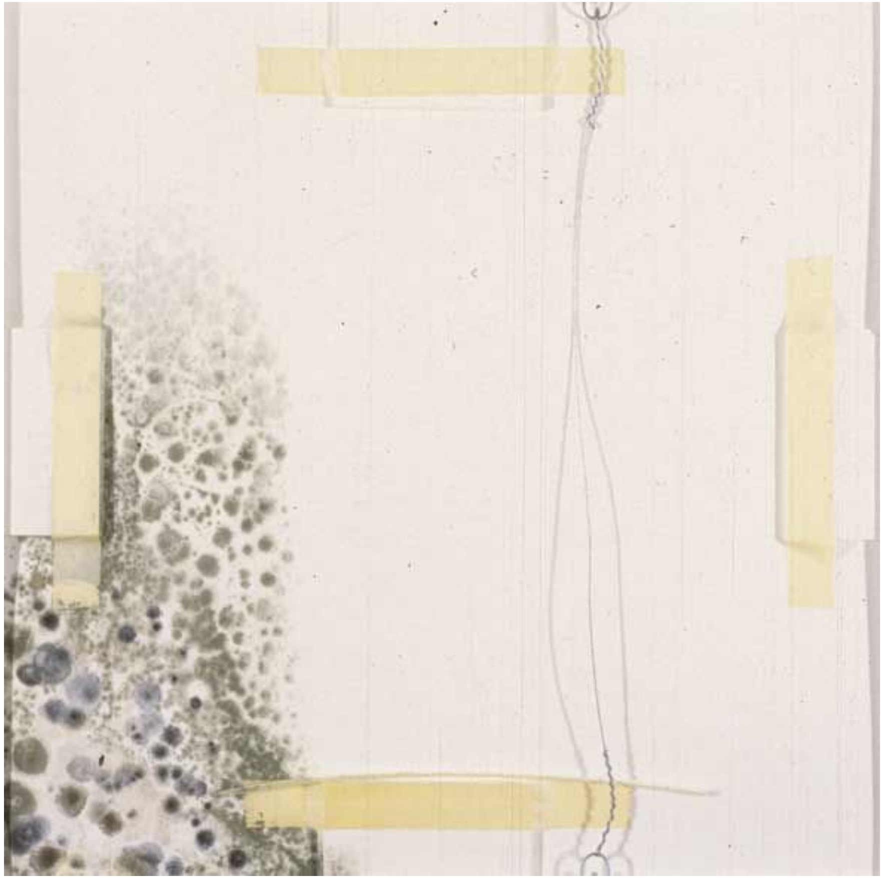


Centroid PM



PESTS

Wooden object internally damaged by insects

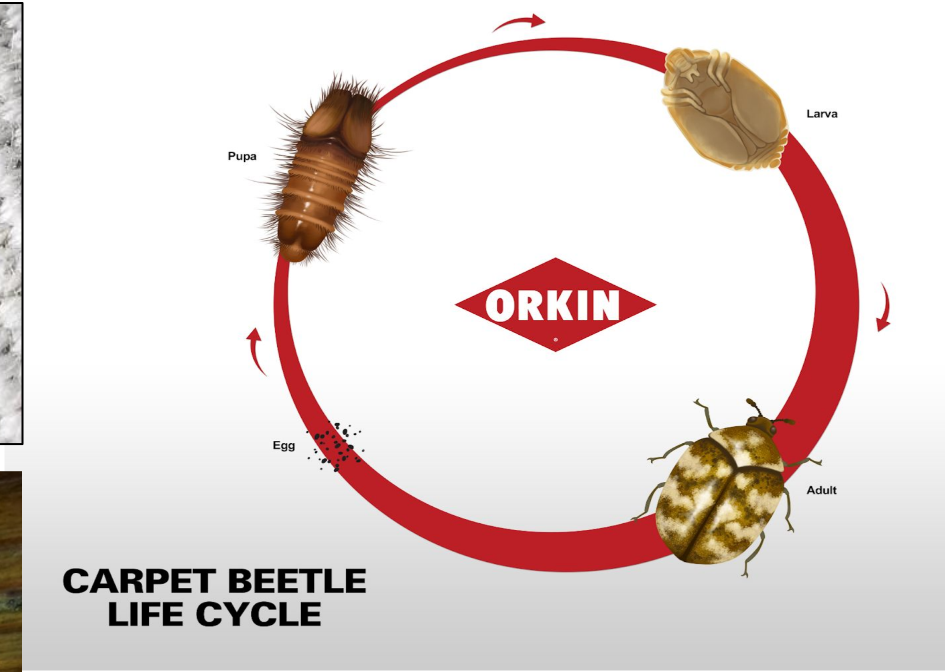


Mold growth on the back of a paper object

(Images courtesy of Canadian Conservation Institute)

PESTS

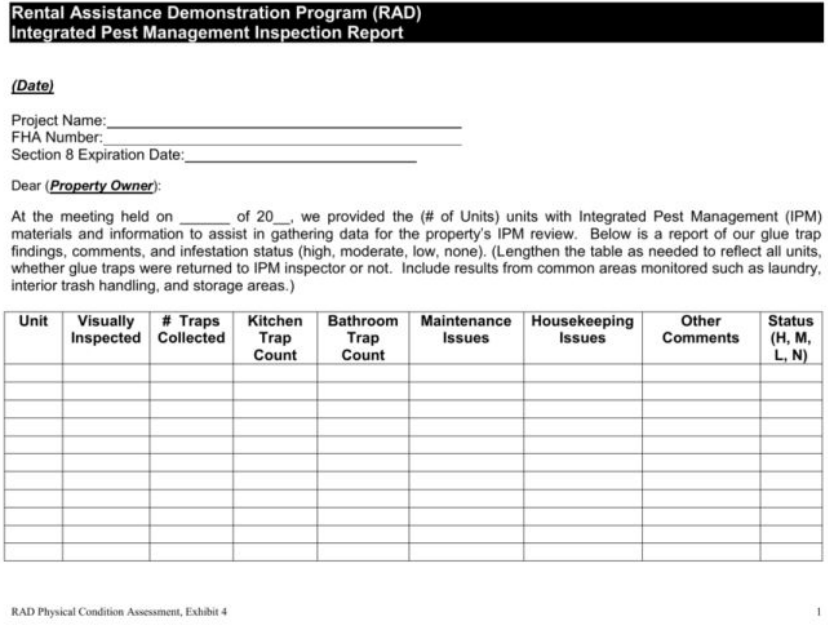
Carpet beetle larvae found feeding on the underside of a wool rug



Carpet Beetles are **dermestids**, or insects that eat proteinaceous materials. They are one of the most common and destructive museum pests. Other common pests include: moths, termites, and silverfish

HOW DO WE MEASURE PEST ACTIVITY?

“Blunder” or sticky trap will provide a sample of pests existing within a targeted area.



Rental Assistance Demonstration Program (RAD)
Integrated Pest Management Inspection Report

(Date)

Project Name:____________________________________
FHA Number:____________________________________
Section 8 Expiration Date:________________________

Dear (***Property Owner***):

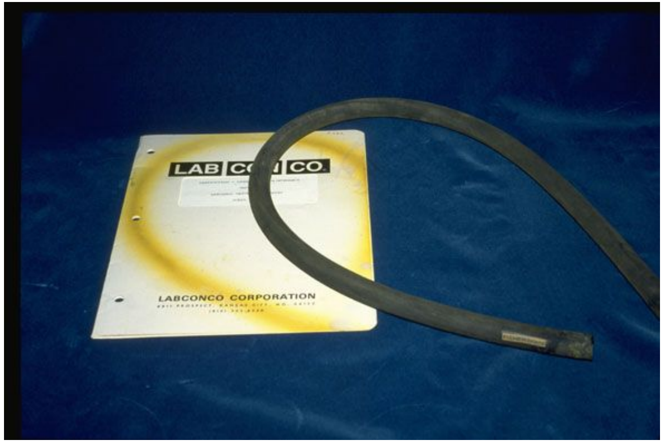
At the meeting held on ______ of 20__, we provided the (# of Units) units with Integrated Pest Management (IPM) materials and information to assist in gathering data for the property's IPM review. Below is a report of our glue trap findings, comments, and infestation status (high, moderate, low, none). (Lengthen the table as needed to reflect all units, whether glue traps were returned to IPM inspector or not. Include results from common areas monitored such as laundry, interior trash handling, and storage areas.)

Unit	Visually Inspected	# Traps Collected	Kitchen Trap Count	Bathroom Trap Count	Maintenance Issues	Housekeeping Issues	Other Comments	Status (H, M, L, N)

RAD Physical Condition Assessment, Exhibit 4 1

Keep a log of what you find and take good images

POLLUTANTS



Cellulose nitrate comb deterioration (above) and staining of paper from deteriorating rubber

DUST is a pollutant

Images from the Canadian Conservation Institute

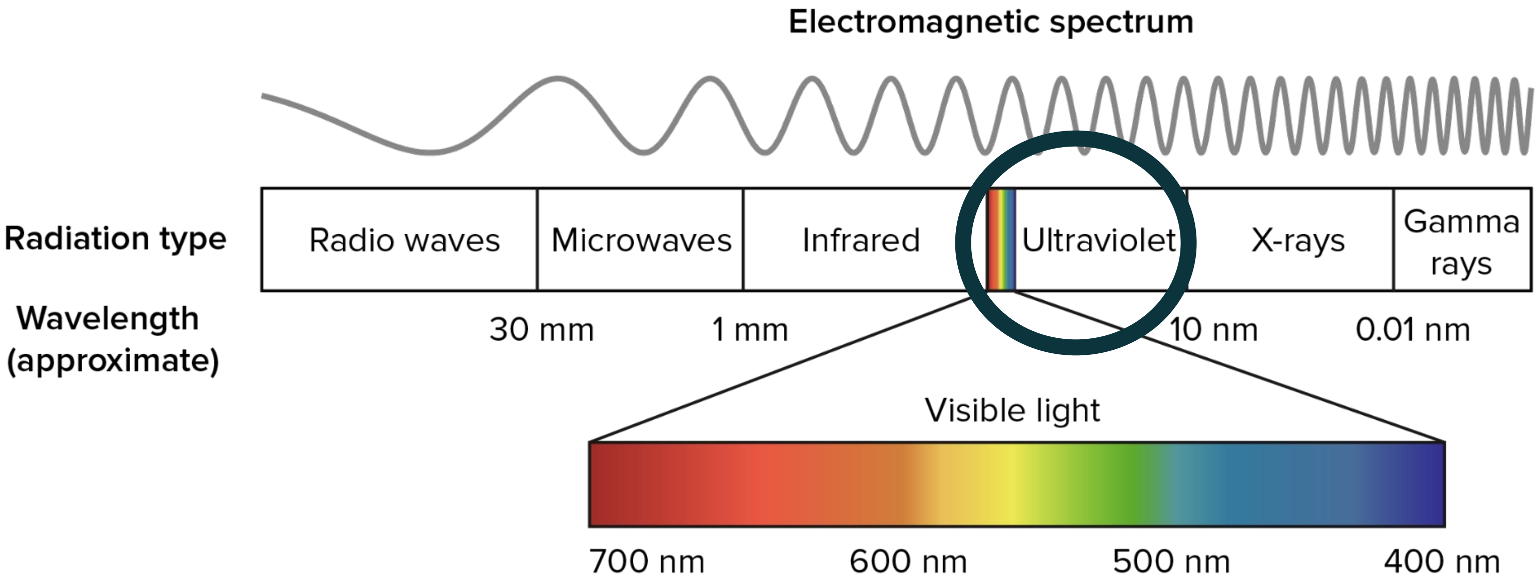
HOW DO WE MEASURE Pollutants?

...not that easily

Pollutants	Nature	Effects
Airborne pollutants	Atmospheric sources: ozone, hydrogen sulfide, carbonyl sulfide, sulfur dioxide, nitrogen dioxide, and particles (e.g. soot, salts). From emissive products, objects and people: sulfur-based gases, organic acids (e.g. carboxylic acids), particles (e.g. lints, danders).	Acidification of papers, corrosion of metals, discoloration of colorants, efflorescence of calcium-based objects with RH (e.g. seashells), loss of strength for textiles. Dust: disfiguration of objects; attractant for pests, scratching of soft surfaces by friction.
Pollutants transferred by contact	Plasticizer from flexible PVC (polyvinyl chloride), sulfur compounds from natural rubber, staining materials from wood (especially knots), viscous compounds from old polyurethane foams, paper clips on papers, adhesives on objects from previous presentation, oily materials from leather, acids from some mineral specimens, fatty acids from people or from greasy objects such as skin/leather. Impregnation of salts during burial or immersion in seawater. Impregnation of residue of cleaning agents. Impregnation of salt from brick or stone floors or foundation.	Discoloration or corrosion of surface of the object in contact with harmful material from products or objects.
Intrinsic pollutants	Composite objects having compounds harmful for the other parts of the object, such as alum or iron gall ink in papers, 'original' adhesive tape on papers, corrosion of copper in contact with leather (e.g. tanned leather object having copper parts), composite objects made of sulfur- based compounds and metals. Secondary pollutants such as acetic acid and nitrogen oxide compounds from the hydrolysis of cellulose acetate and cellulose nitrate respectively.	Deterioration of the objects: acidification, discoloration or stain on objects. Secondary pollutant may speed up the degradation processes caused by oxygen, water vapour or other pollutants.

Effects of pollutants on objects, Canadian Conservation Institute

LIGHT



Light energy on the greater electromagnetic spectrum

No sensitivity	Low sensitivity	Medium sensitivity	High sensitivity
Materials that do not change colour due to light. (These materials may change colour due to ageing or pollutants.) Most but not all mineral pigments. The "true fresco" palette, a coincidence with the need for stability in alkali. The colours of true glass enamels, ceramics (not to be confused with enamel paints). Many monochrome images on paper, such as carbon inks, but the tint of the paper and added tint to the carbon ink are often high sensitivity. Paper itself must be cautiously considered low sensitivity. Many high-quality modern pigments developed for exterior use, automobiles.	Materials rated ISO Blue Wool #7, #8 (and higher). Artists palettes classified as "permanent" (a mix of truly permanent AND low-light sensitivity paints, e.g. ASTM D4303 Category I; Winsor and Newton AA). Structural colours in insects (if UV blocked). A few historic plant extracts, especially indigo on wool. Silver/gelatine black-and-white prints (not resin coated paper) assuming all UV blocked. Many high-quality modern pigments developed for exterior use, automobiles. Vermilion (blackens due to light).	Materials rated ISO Blue Wool #4, #5, or #6. Alizarin dyes and lakes. A few historic plant extracts, particularly madder-type reds containing primarily alizarin, as a dye on wool or as a lake pigment in all media. It varies throughout the range of medium and can reach into the low category, depending on concentration, substrate, and mordant. The colour of most furs and feathers. Most colour photographs with "chrome" in the name, e.g. Cibachrome, Kodachrome.	Materials rated ISO Blue Wool #1, #2, or #3. Most plant extracts, hence most historic bright dyes and lake pigments in all media: yellows, oranges, greens, purples, many reds, blues. Insect extracts, such as lac dye and cochineal (e.g. carmine) in all media. Most early synthetic colours such as the anilines, all media. Many cheap synthetic colourants in all media. Most felt tip pens including blacks. Most red and blue ballpoint inks. Most dyes used for tinting paper in the 20thcentury. Most colour photographs with "colour" (or "color") in the name. e.g. Kodacolour, Fujicolour.

Light Sensitivity Table from Canadian Conservation Institute. (Full resource linked in Drive)

No sensitivity	Low sensitivity	Medium sensitivity	High sensitivity
Materials that do not change colour due to light. (These materials may change colour due to ageing or pollutants.) Most but not all mineral pigments. The "true fresco" palette, a coincidence with the need for stability in alkali. The colours of true glass enamels, ceramics (not to be confused with enamel paints). Many monochrome images on paper, such as carbon inks, but the tint of the paper and added tint to the carbon ink are often high sensitivity. Paper itself must be cautiously considered low sensitivity. Many high-quality modern pigments developed for exterior use, automobiles.	Materials rated ISO Blue Wool #7, #8 (and higher). Artists palettes classified as "permanent" (a mix of truly permanent AND low-light sensitivity paints, e.g. ASTM D4303 Category I; Winsor and Newton AA). Structural colours in insects (if UV blocked). A few historic plant extracts, especially indigo on wool. Silver/gelatine black-and-white prints (not resin coated paper) assuming all UV blocked. Many high-quality modern pigments developed for exterior use, automobiles. Vermilion (blackens due to light).	Materials rated ISO Blue Wool #4, #5, or #6. Alizarin dyes and lakes. A few historic plant extracts, particularly madder-type reds containing primarily alizarin, as a dye on wool or as a lake pigment in all media. It varies throughout the range of medium and can reach into the low category, depending on concentration, substrate, and mordant. The colour of most furs and feathers. Most colour photographs with "chrome" in the name, e.g. Cibachrome, Kodachrome.	Materials rated ISO Blue Wool #1, #2, or #3. Most plant extracts, hence most historic bright dyes and lake pigments in all media: yellows, oranges, greens, purples, many reds, blues. Insect extracts, such as lac dye and cochineal (e.g. carmine) in all media. Most early synthetic colours such as the anilines, all media. Many cheap synthetic colourants in all media. Most felt tip pens including blacks. Most red and blue ballpoint inks. Most dyes used for tinting paper in the 20th century. Most colour photographs with "colour" (or "color") in the name. e.g. Kodacolour, Fujicolour.

Light Sensitivity Table from Canadian Conservation Institute. (Full resource linked in Drive)

HOW DO WE MEASURE Light?

The exposure of an artifact to light is a product of illumination level and time:

Light level (lux) x Time (hours) = Exposure (lux hours)

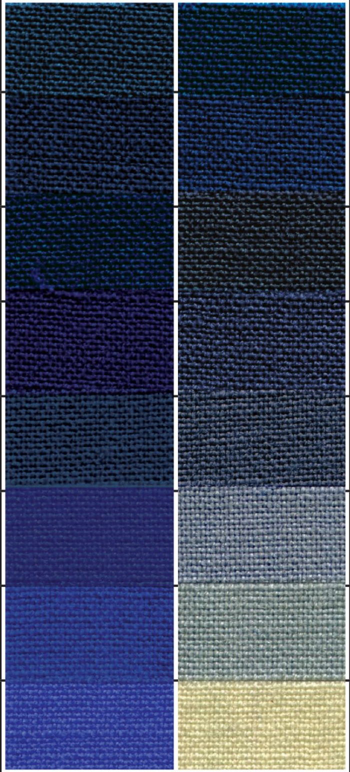
Visible light is measured in **lux** or footcandles. One footcandle (fc) is equivalent to approximately 11 lux.

Ultraviolet is measured in **microwatts per lumen** (µW/lm), which describes the fraction of ultraviolet radiation in visible light. Because it is a ratio, the total UV will increase as the light levels increase, even as the ratio remains constant.

HOW DO WE MEASURE Light?

Another way to measure light over time

The Blue Wool Standard is used in a variety of disciplines to measure light exposure over time. This simple card can be placed next to a collection object, and it will indicate how much light exposure an object has received in a certain environment.

Blue wool zone	Photo unexposed left, exposed right	DE* [4]	ASTM Lightfastness equivalent
8		.93	I (DE* 0-4) Excellent (low to middle of range change)
7		3.40	I (DE* 0-4) Excellent (far end of range approaching a LF 2 rating) (DE* 4-8)
6		8.72	3 (DE* 8-16) Fair
5		18.82	4 (DE* 16-24) Poor
4		18.64	4 (DE* 16-24) Poor
3		50.32	5 (DE* 24 and up) Very Poor
2		51.12	5 (DE* 24 and up) Very Poor
I		70.63	5 (DE* 24 and up) Very Poor

https://justpaint.org/hansa-update/

REMINDER ABOUT LIGHT

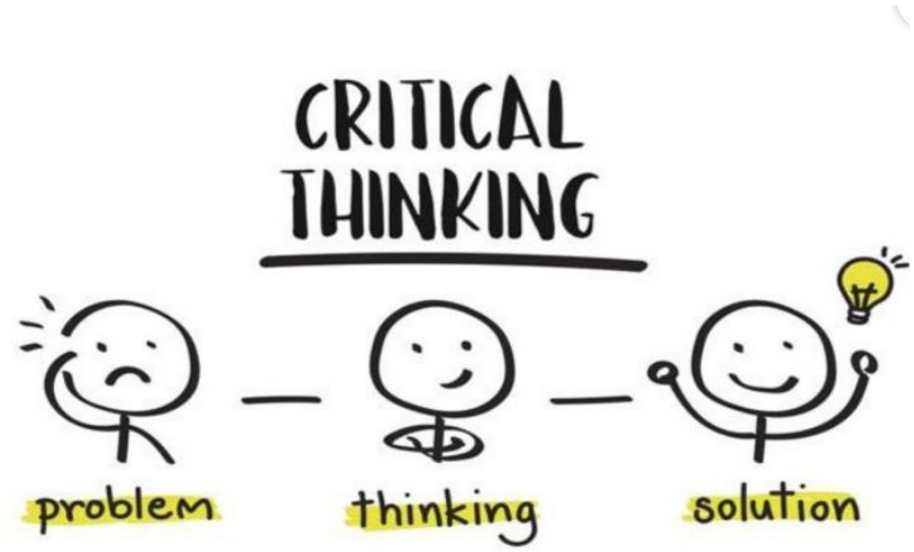
Best practice likely includes using multiple methods and implementing policies

Objects on display are “working” and we want to be informed, through the measurement of light, of how we are spending our collections’ time before they experience significant deterioration

TOOLS FOR QUICK

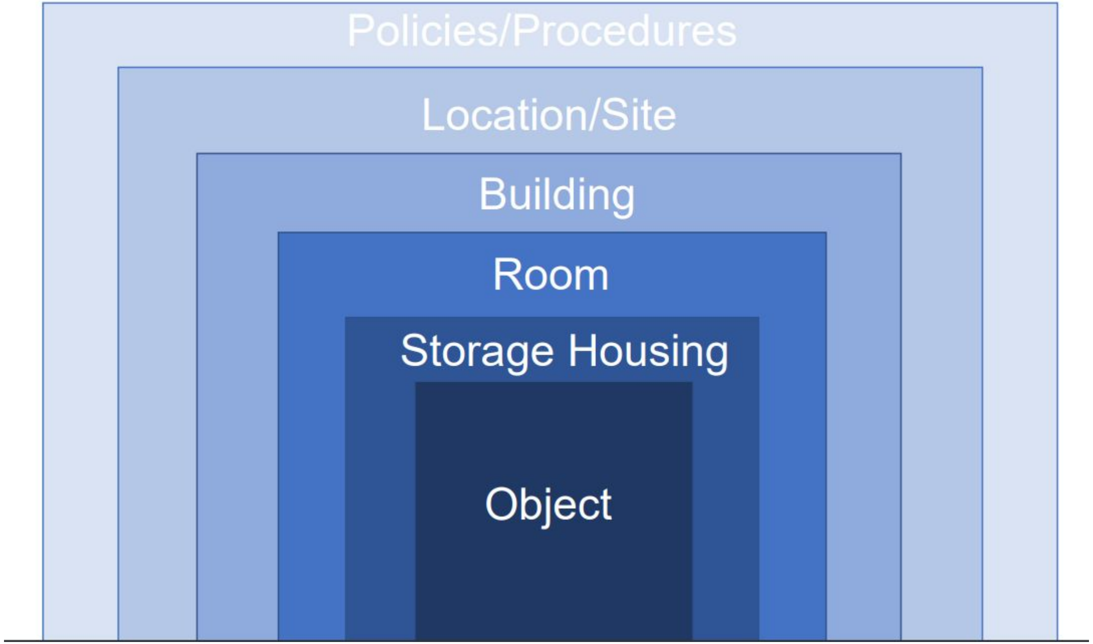
DATA COLLECTION

ENVIRONMENTAL MONITORING IS THE FIRST STEP



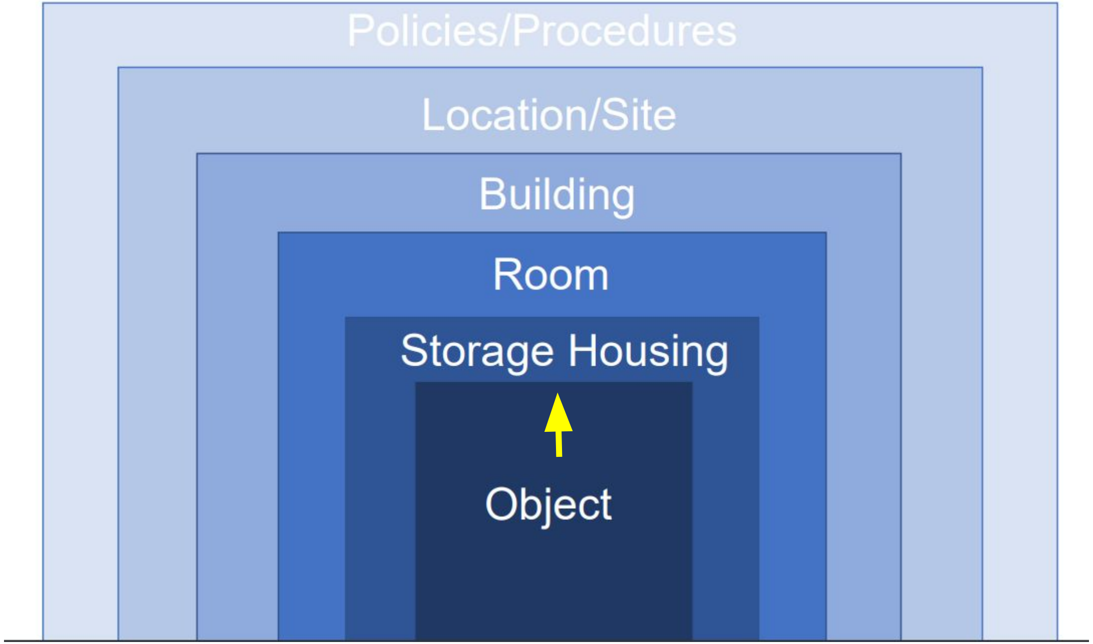
Identifying the problem, or determining there is no problem at all!
(Medium)

ENVIRONMENTAL MONITORING IS THE FIRST STEP



Levels of Control (from Image Permanence Institute)

ENVIRONMENTAL MONITORING IS THE FIRST STEP



Levels of Control (from Image Permanence Institute)

TOOLS FOR COLLECTING ENVIRONMENTAL DATA

We use loggers to collect and store data over time so we can analyze trends and understand our space

TOOLS FOR COLLECTING ENVIRONMENTAL DATA

Analog Hygrometer

Elsec 765

Environmental Monitor

Testo 540 Light Meter, 0-100,000 LUX

We use loggers to collect and store data over time so we can analyze trends and understand our space

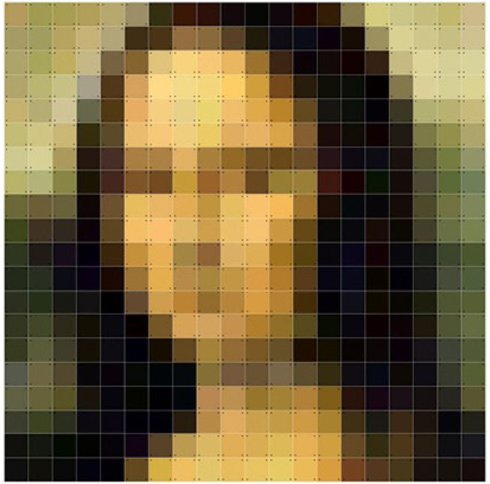
BREAK (10 Minutes)

INTRODUCTION

ENVIRONMENTAL DATA ANALYSIS

YOU'VE COLLECTED THE DATA: NOW WHAT

- We're going to cover the basics of how to organize and get a handle on the environmental data you've collected
- Over the course of a year of datalogging, you can easily collect thousands of data points
- Alone, each data point may not tell you much, but together they show a picture of the environment your collection is experiencing



Think about data points as pixels, and overall picture as the resolution

LET'S START WITH LIGHT DATA

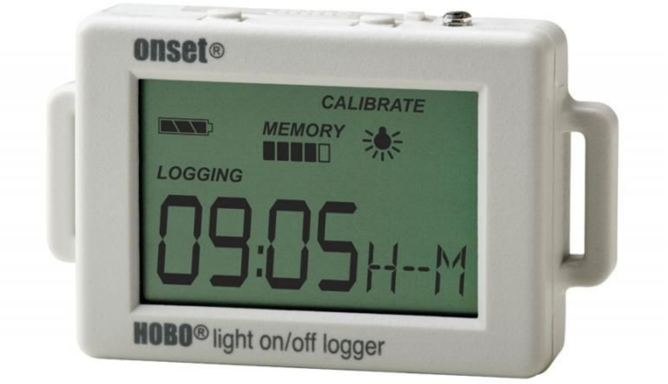
Unlike environmental data, we usually collect light data in single measurements, not logging many points over many days and weeks.

The exposure of an artifact to light is a product of illumination level and time:

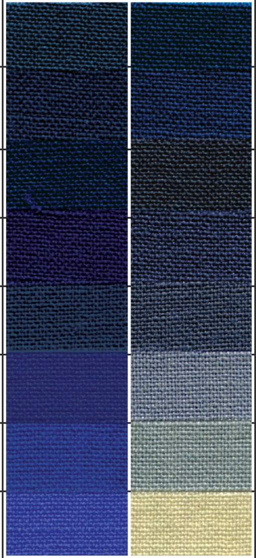
Light level (lux) x Time (hours) = Exposure (lux hours)

LET'S START WITH LIGHT DATA

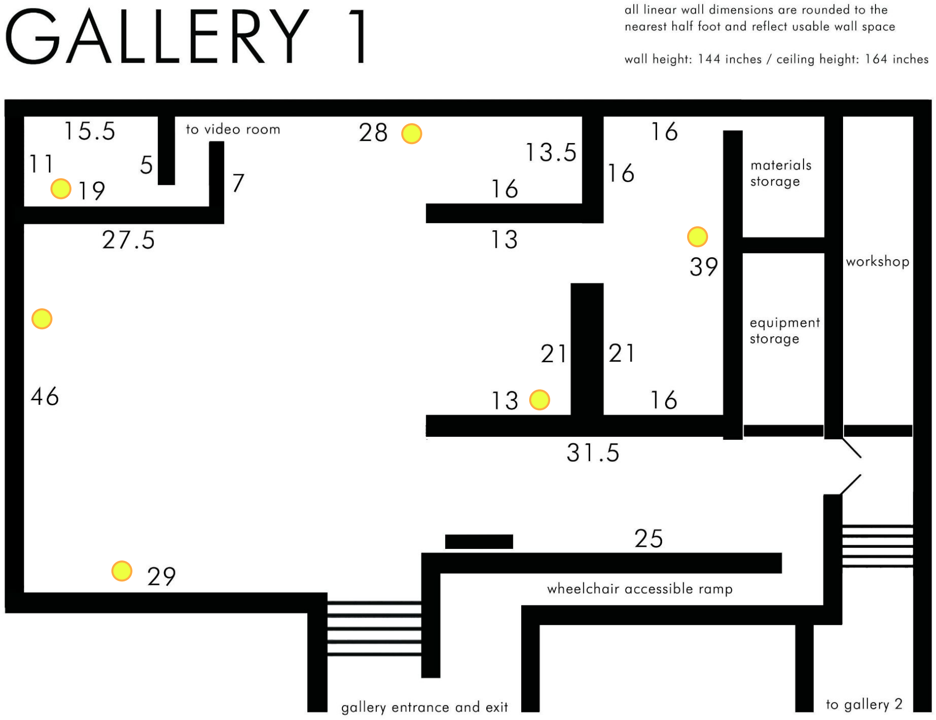
There are options for continuous light data collection, but usually one round of routine testing, and later on testing can provide sufficient information for decision making.



Onset UX90-001 HOBO State Data Logger

Blue wool zone	Photo unexposed left, exposed right	DE* [4]	ASTM Lightfastness equivalent
8		.93	1 (DE* 0-4) Excellent (low to middle of range change)
7		3.40	1 (DE* 0-4) Excellent (far end of range approaching a LF 2 rating) (DE* 4-8)
6		8.72	3 (DE* 8-16) Fair
5		18.82	4 (DE* 16-24) Poor
4		18.64	4 (DE* 16-24) Poor
3		50.32	5 (DE* 24 and up) Very Poor
2		51.12	5 (DE* 24 and up) Very Poor
1		70.63	5 (DE* 24 and up) Very Poor

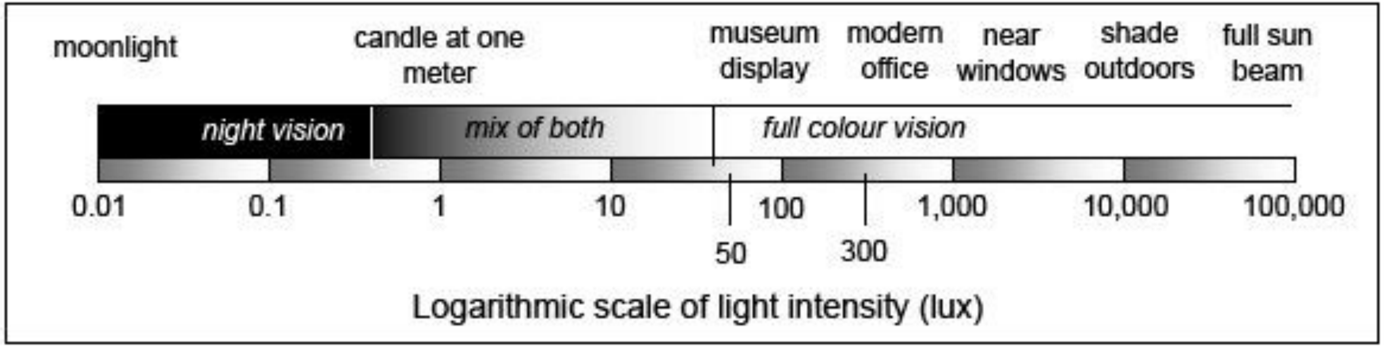
GENERIC FLOOR PLAN: EXAMPLE FOR LIGHT MONITORING



Conducting a Light Study

- Mark a floor plan of a a space, marking locations where readings will be repeated
- Measure light levels at different times of day, during different seasons
- Document each reading and conditions of readings in an excel spreadsheet

GENERIC FLOOR PLAN: EXAMPLE FOR LIGHT MONITORING



Canadian Conservation Institute- a great reference for decision-making in terms of light levels

Conservation Plan “Lighting” section should include:

- A range of light levels to be maintained, with specifications for particularly light sensitive objects
- Equipment in place to ensure light levels: window shades, UV films and filters, LED lights at the correct levels, light schedule (on/off times) and calculated impact
- Schedule for regular checking of light levels, measurements

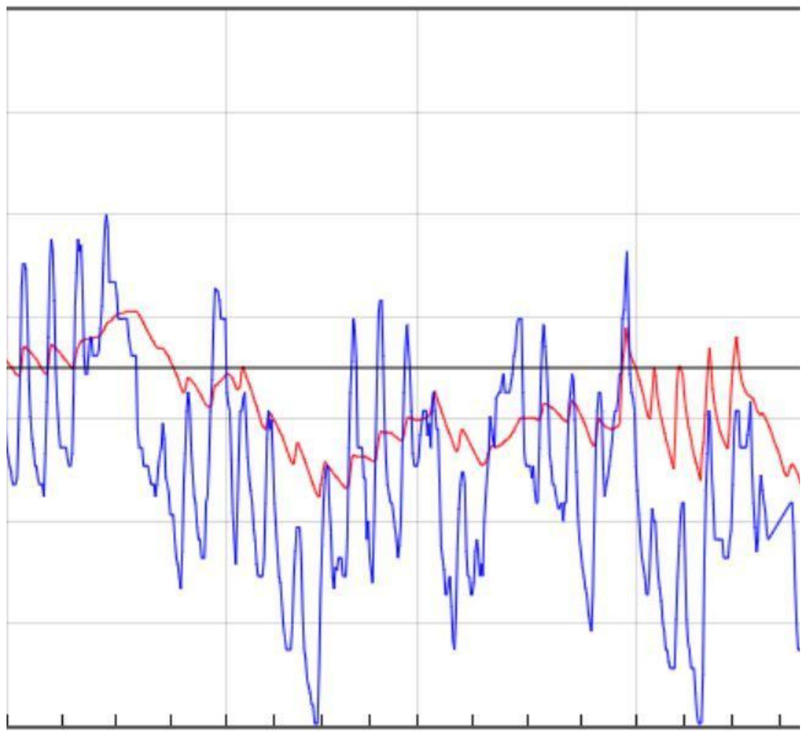
WHAT ABOUT ALL THAT RH AND TEMP DATA?

Things to consider:

- What is your question?
- What did you measure?
- What is your data telling you?

Why is this the result?

Solutions



Environmental Monitoring

USU EASTERN PREHISTORIC MUSEUM

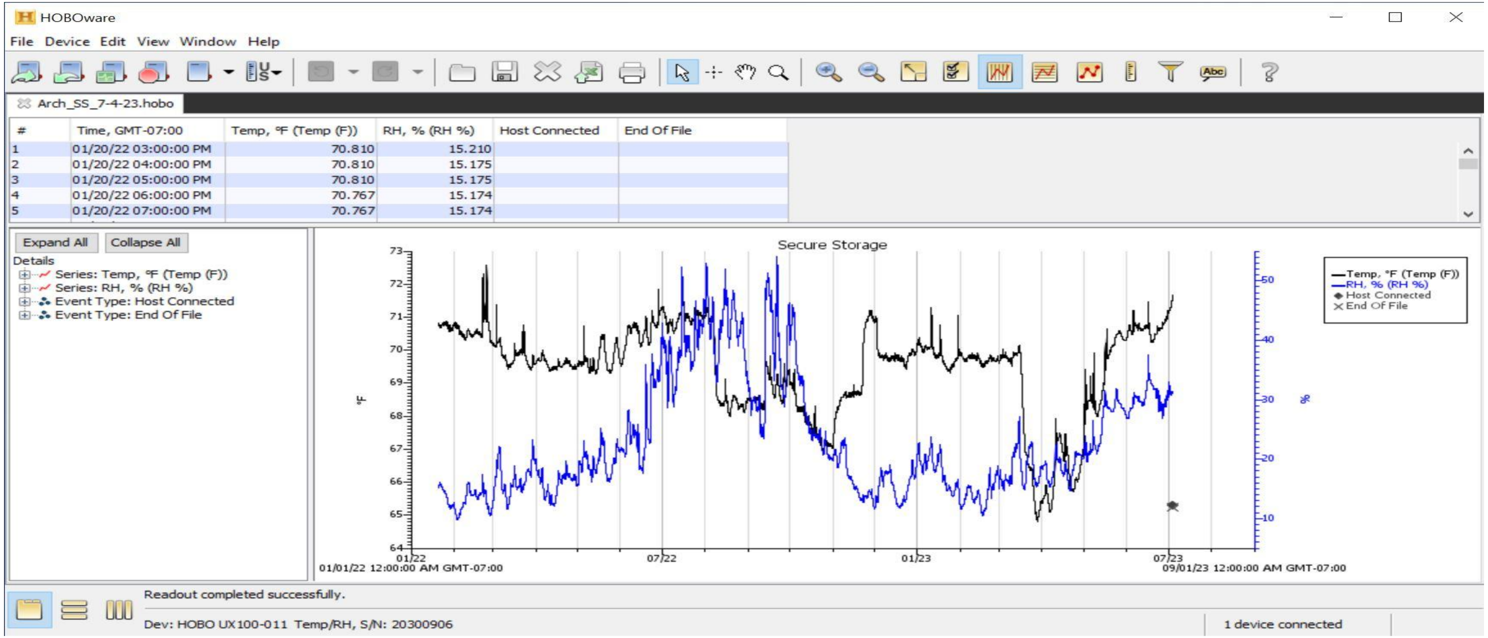
Museum Building

- Locations:
  - Hall of Paleontology
  - Hall of Archaeology
  - Special Exhibits Gallery
  - Secure Storage
  - Within cases*
- HOBO® loggers from Onset® (UX100 Series)
  - Cable download
  - Free software
  - Export to CSV file in Excel
- Manipulate & Compare Data

Off-Site Storage

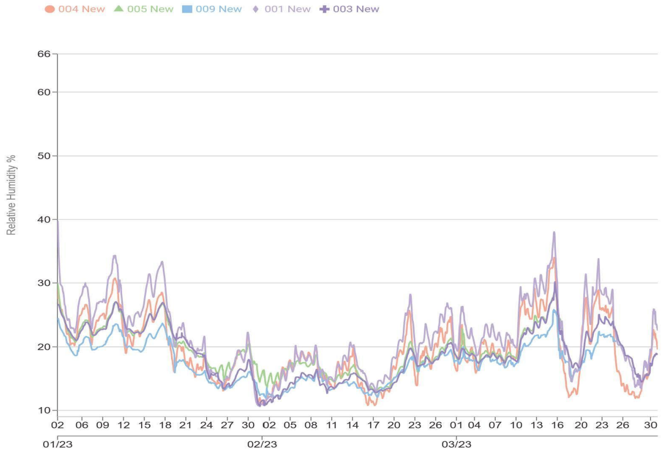
- Locations:
  - Archives
  - Archaeology
  - Ethnographic
  - Cenozoic/Mammoth
  - Paleozoic
- Smart Sensor from Conserv
  - Wireless/remote access
  - Manage data online
  - Export to CSV file in Excel
- Pricier with some kinks

Using the Data - Hoboware®



Using the Data – Conserv

START DATE	END DATE	READINGS	SENSORS
01/02/2023	03/30/2023	Relative Humidity %	004 New 005 New 009 New 001 New 003 New



004 NEW

READING	MIN	AVG	MAX	STD. DEV.
Temp	65.7°F	69.0°F	72.4°F	0.83
RH	10.7%	19.5%	34.1%	4.94
Illum	0.0lx	2.1lx	58.3lx	9.32

005 NEW

READING	MIN	AVG	MAX	STD. DEV.
Temp	66.8°F	69.4°F	71.9°F	0.56
RH	12.6%	19.2%	30.0%	3.56
Illum	0.0lx	1.6lx	79.2lx	9.72

009 NEW

READING	MIN	AVG	MAX	STD. DEV.
Temp	69.1°F	74.1°F	78.7°F	0.71
RH	11.8%	17.3%	26.0%	3.22
Illum	0.0lx	24.5lx	539.1lx	68.36

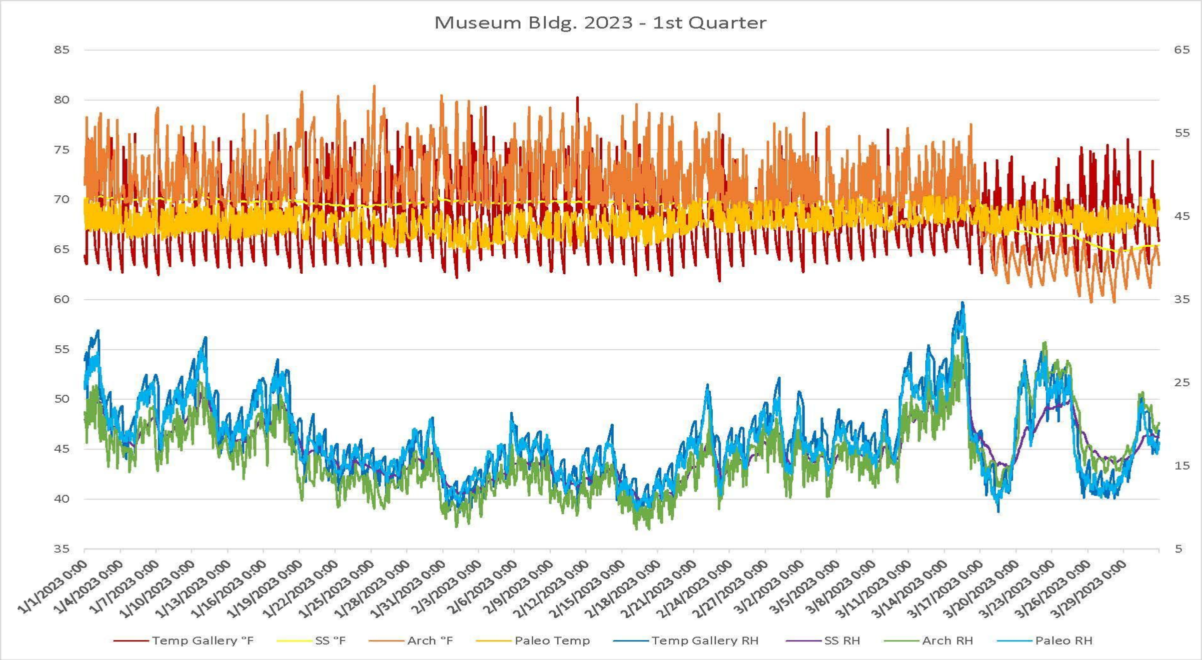
001 NEW

READING	MIN	AVG	MAX	STD. DEV.
Temp	60.8°F	64.6°F	69.6°F	0.84
RH	10.5%	21.0%	40.2%	5.59
Illum	0.0lx	3.1lx	106.1lx	17.14

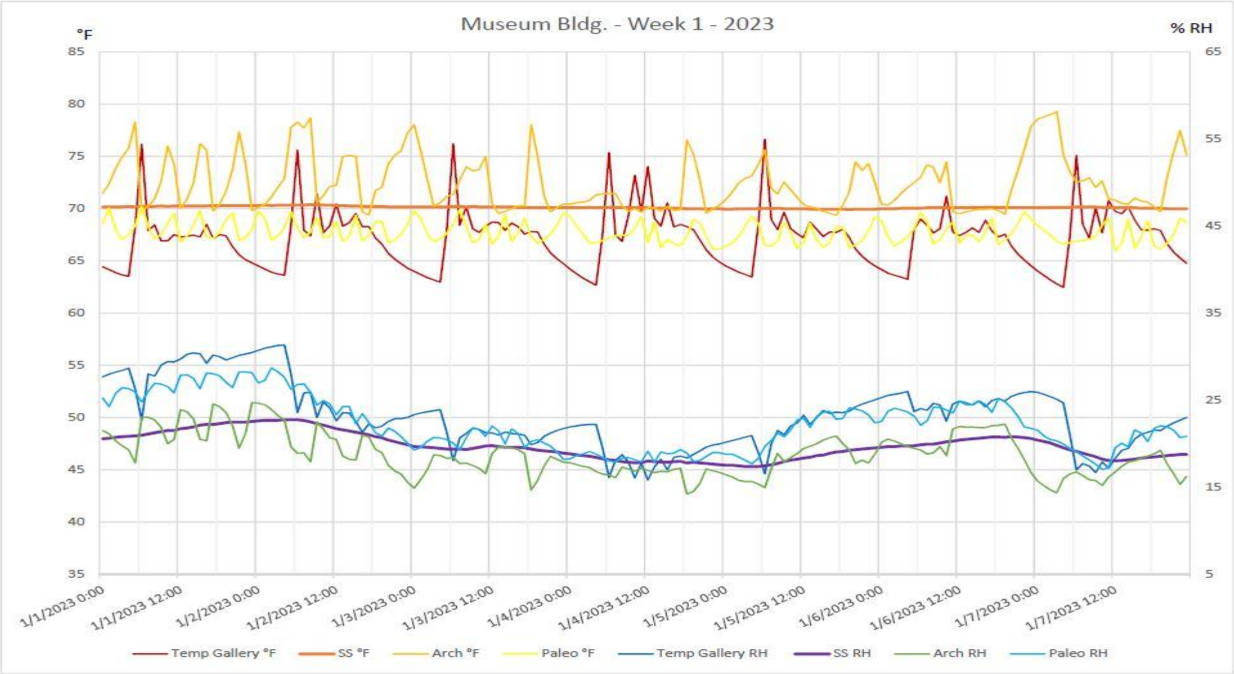
003 NEW

READING	MIN	AVG	MAX	STD. DEV.
Temp	66.4°F	69.3°F	72.6°F	0.68
RH	10.7%	18.8%	30.7%	4.10
Illum	0.0lx	1.1lx	299.4lx	18.37

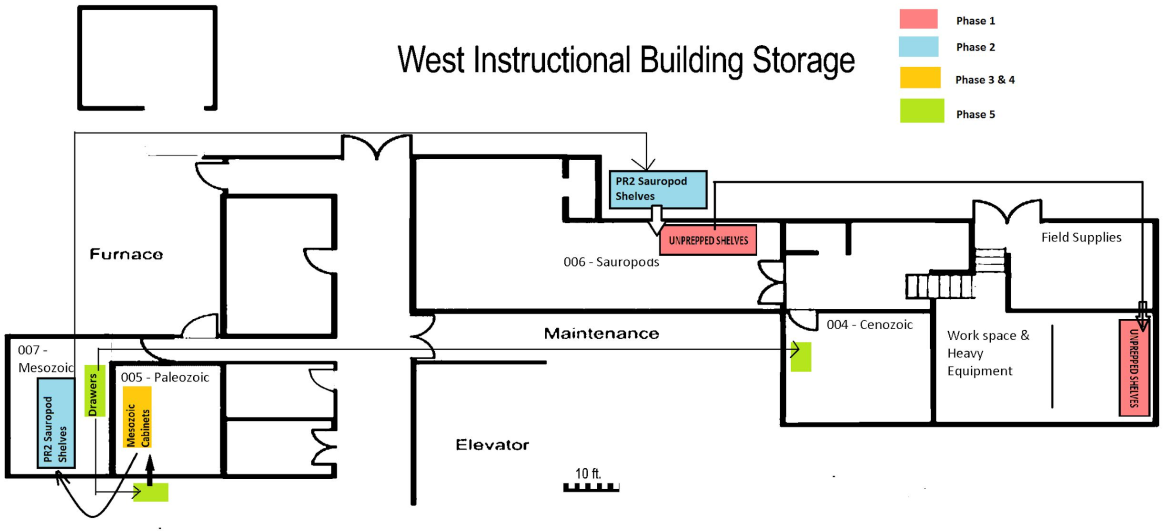
Using the Data - Excel



Excel continued



Data Informed Policy



Questions?

Katy Corneli

Collections Manager & Conservator

USU Eastern Prehistoric Museum

155 E. Main Street, Price, Utah 84501

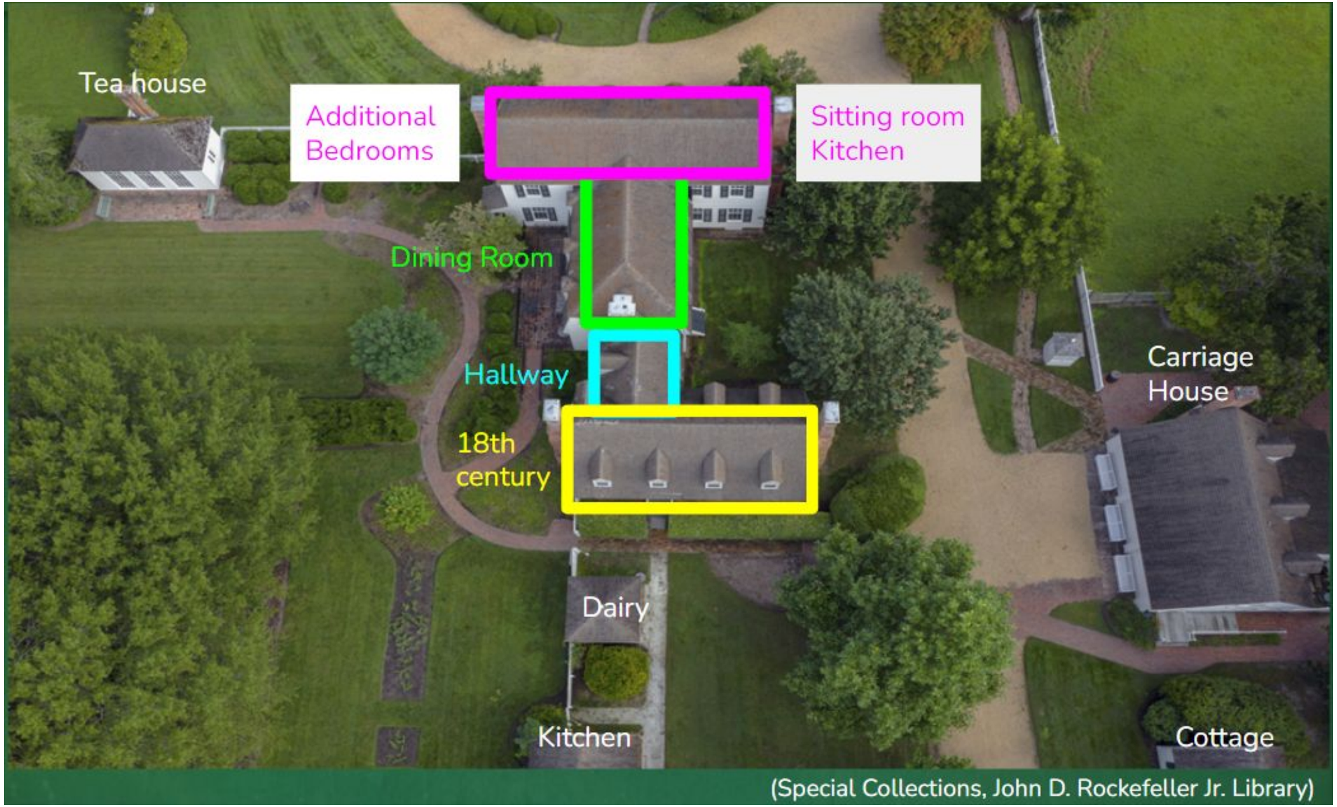
Katharine.corneli@usu.edu

435-613-5765

Thank you!

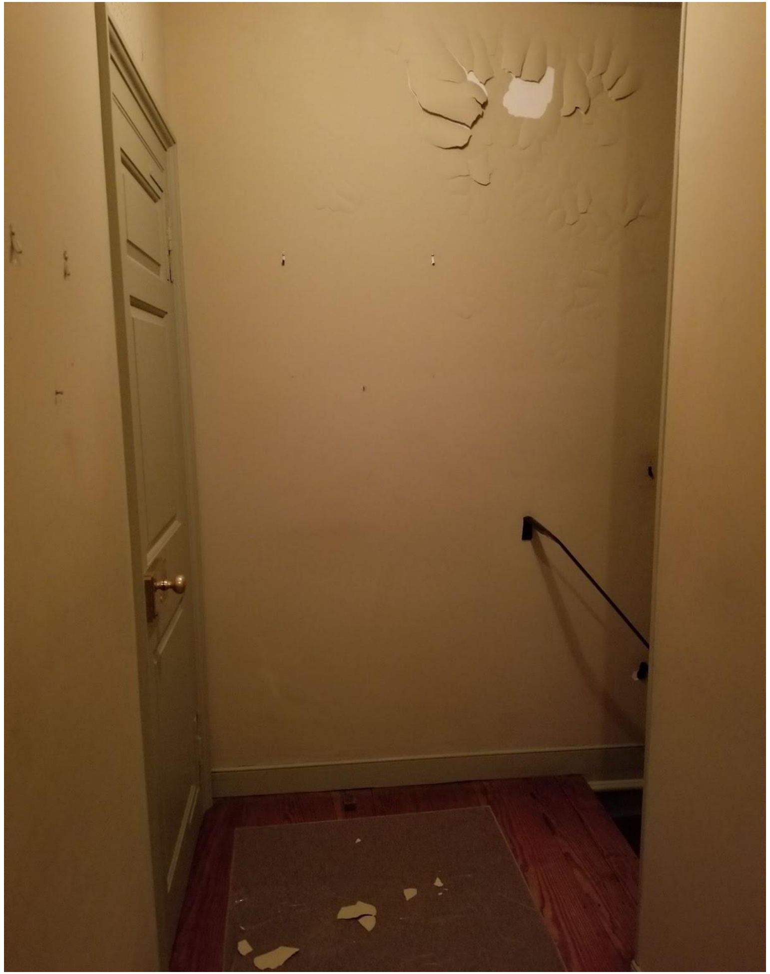
EXAMPLE OF AN ENVIRONMENTAL STUDY

EXAMPLE OF AN ENVIRONMENTAL STUDY



SYMPTOMS OF A PROBLEM

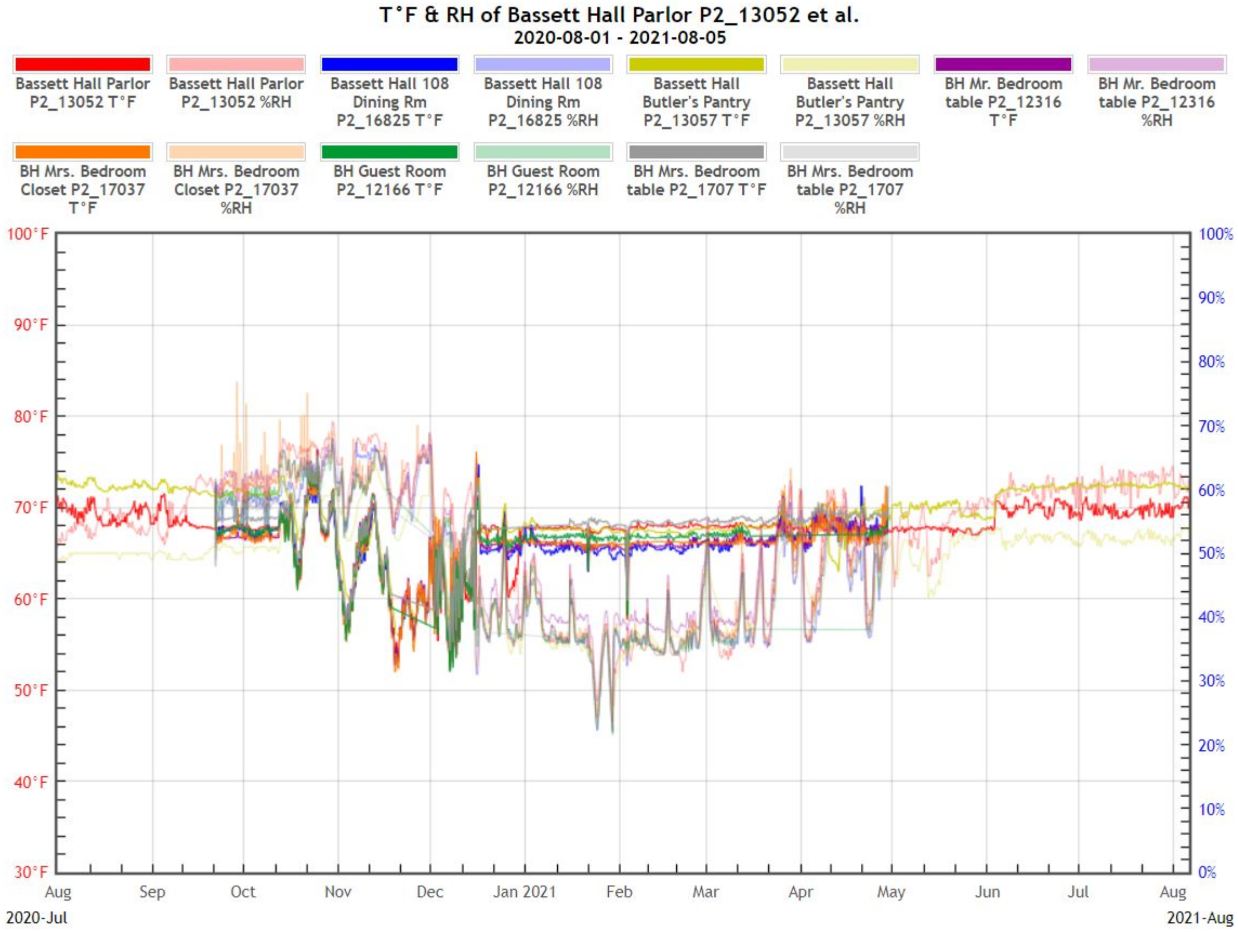
Bubbling (above) and delaminating (right) paint point toward moisture issues and microclimates within the house’s environment



SYMPTOMS OF A PROBLEM

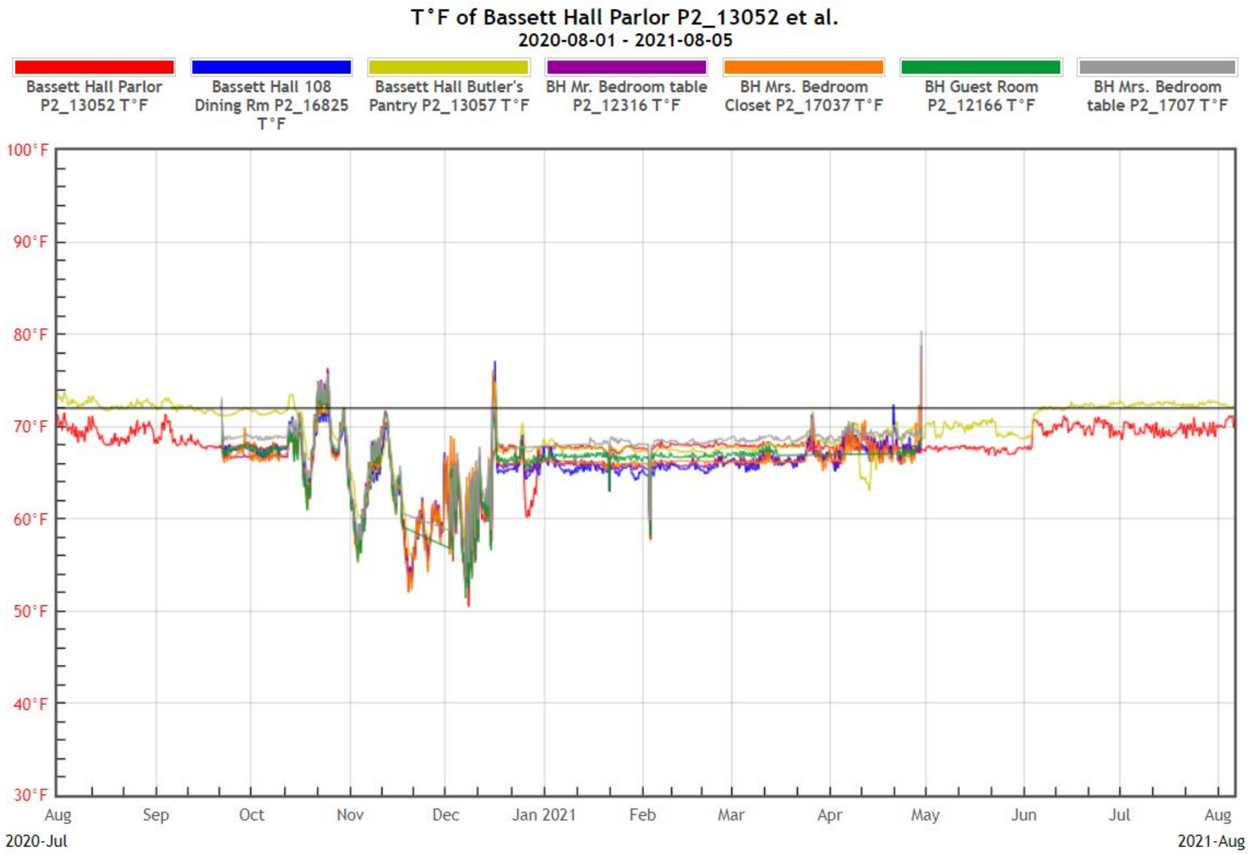
Repeated single readings of some areas expanded the data collection beyond the set loggers; fans circulated air during system shut downs; rehousing and desiccants helped prevent mold in close microclimates

PLOTTED DATA IN THE E-CLIMATE NOTEBOOK SOFTWARE



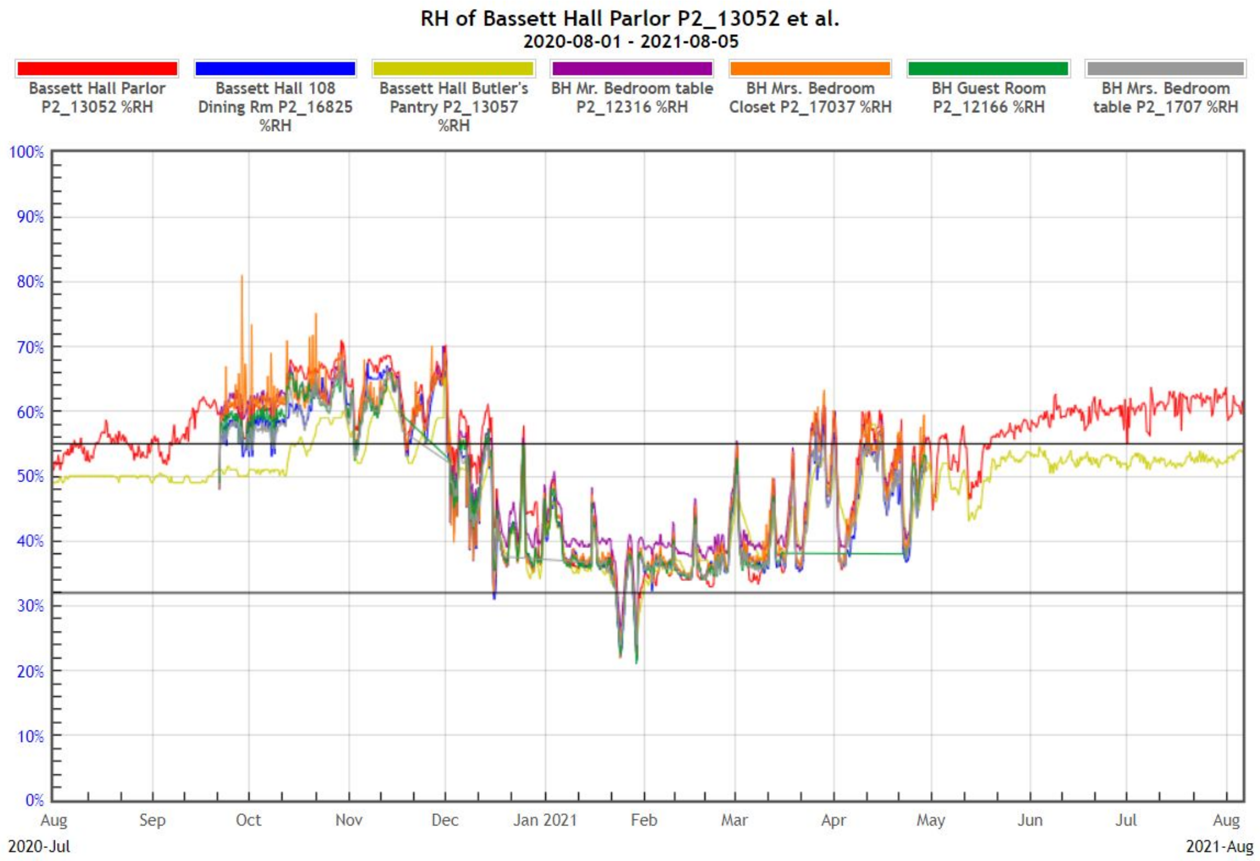
Data for different rooms of one house over a 1 year period

PLOTTED DATA IN THE E-CLIMATE NOTEBOOK SOFTWARE



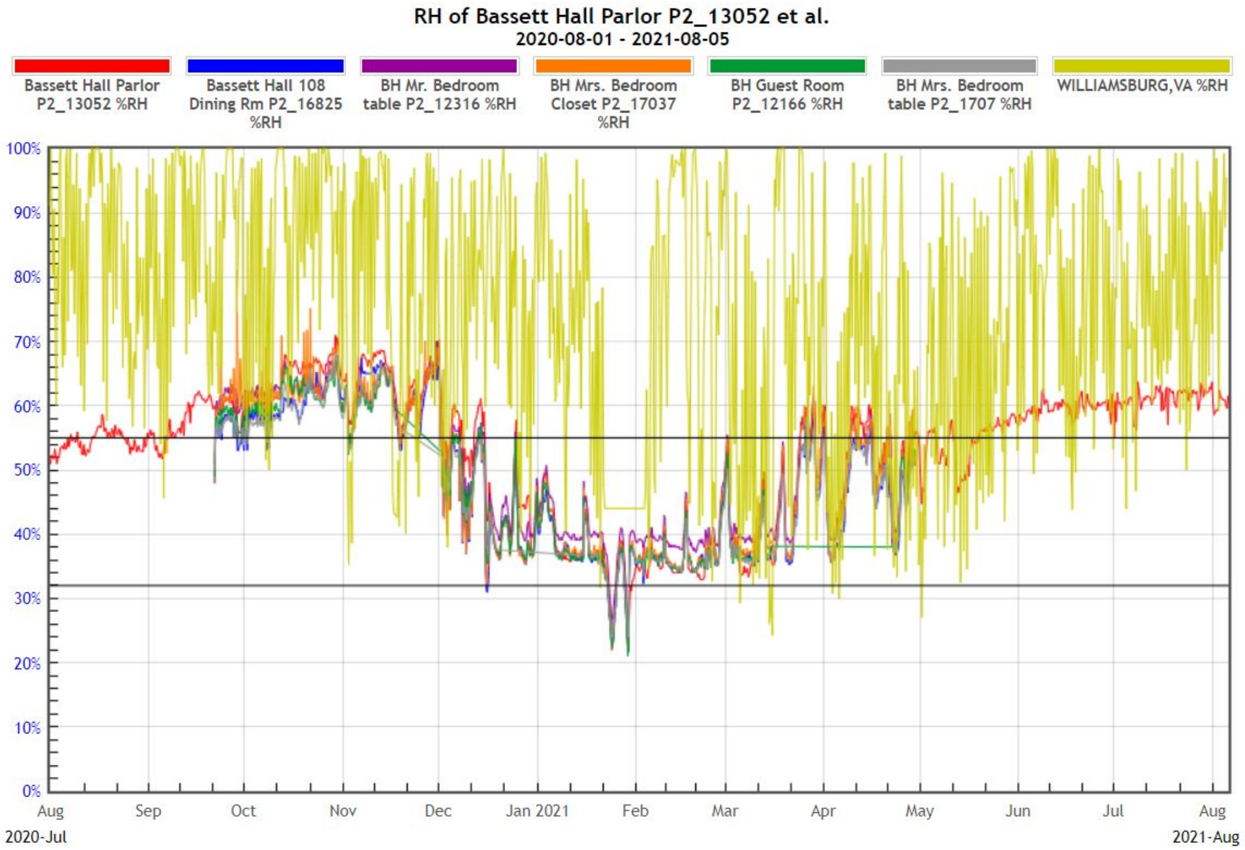
Temperature data for different rooms of one house over a 1 year period

PLOTTED DATA IN THE E-CLIMATE NOTEBOOK SOFTWARE



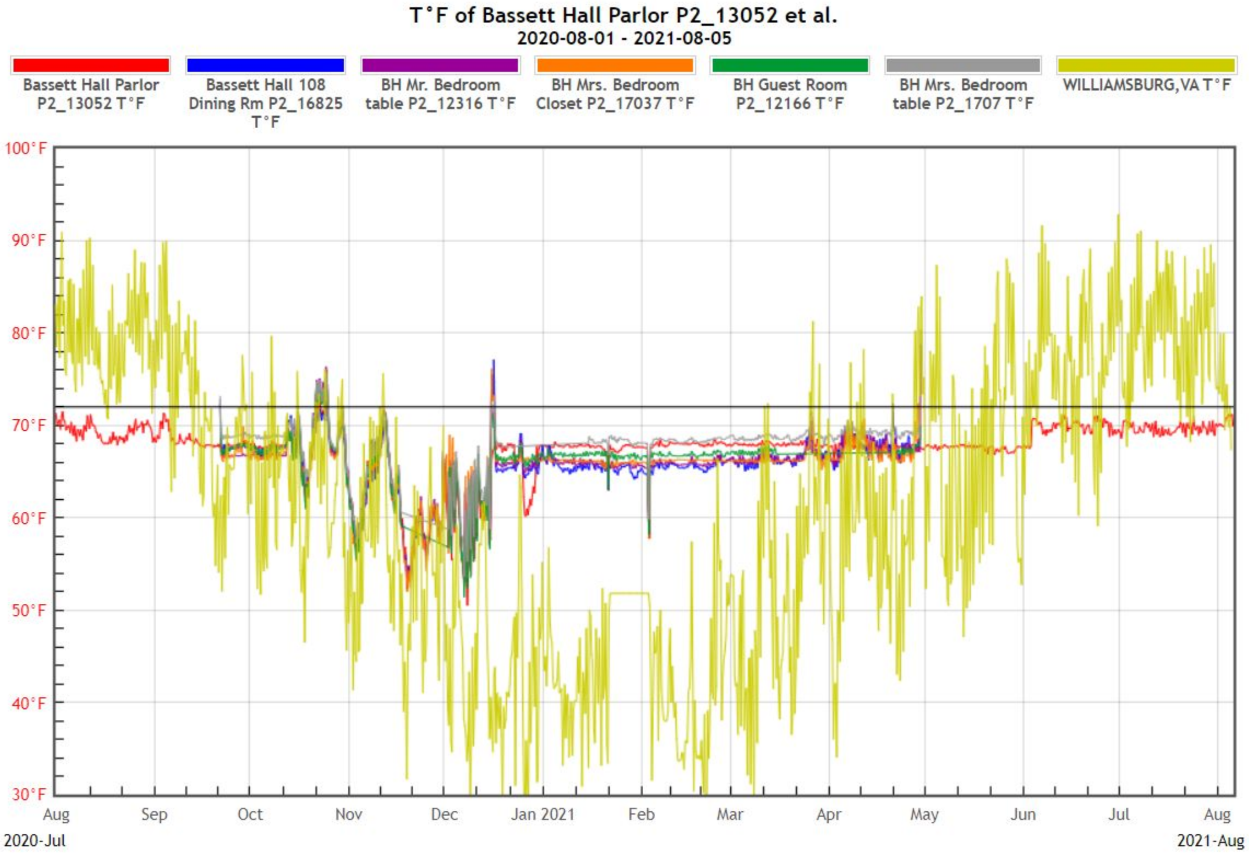
RH data for different rooms of one house over a 1 year period

PLOTTED DATA IN THE E-CLIMATE NOTEBOOK SOFTWARE



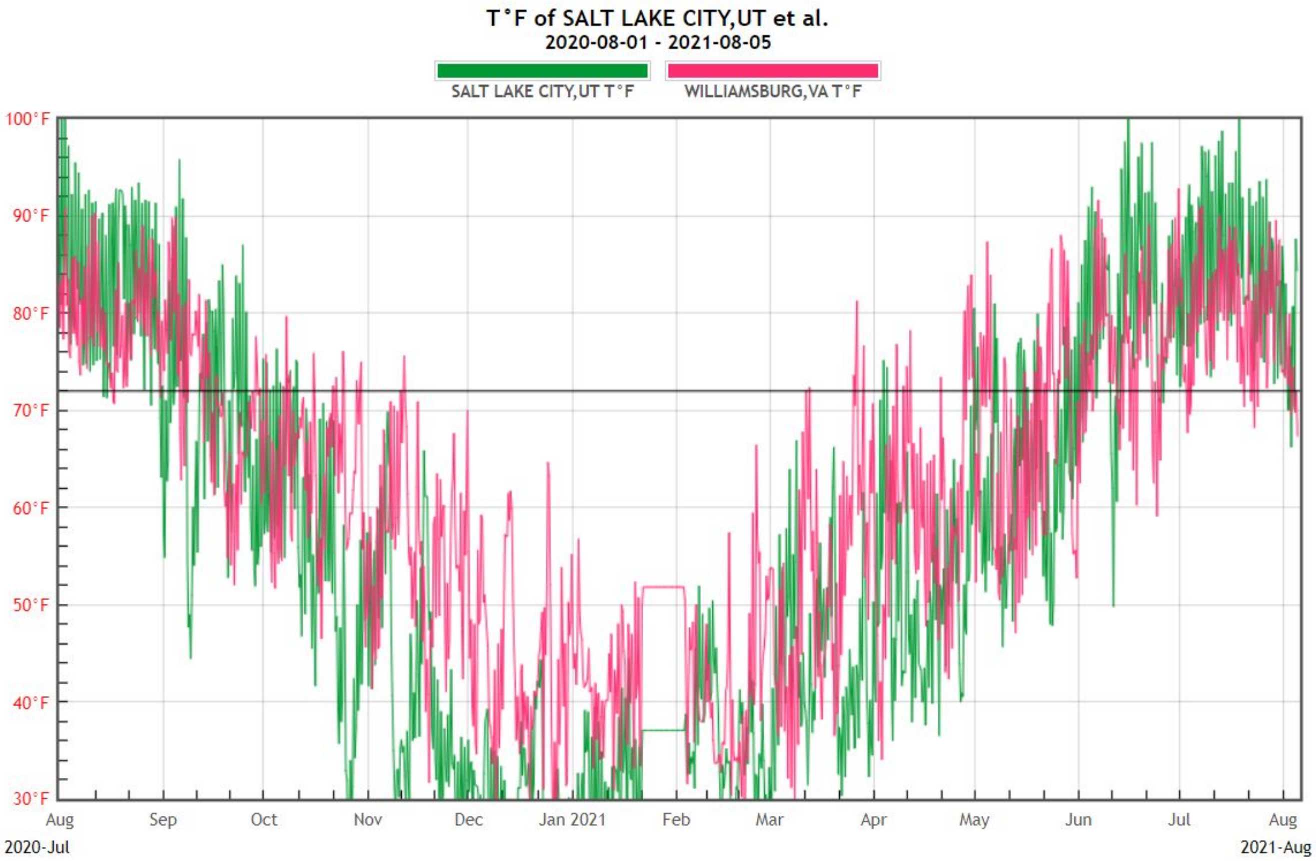
RH data for different rooms of one house over a 1 year period vs. outdoor RH

PLOTTED DATA IN THE E-CLIMATE NOTEBOOK SOFTWARE



T data for different rooms of one house over a 1 year period vs. outdoor T

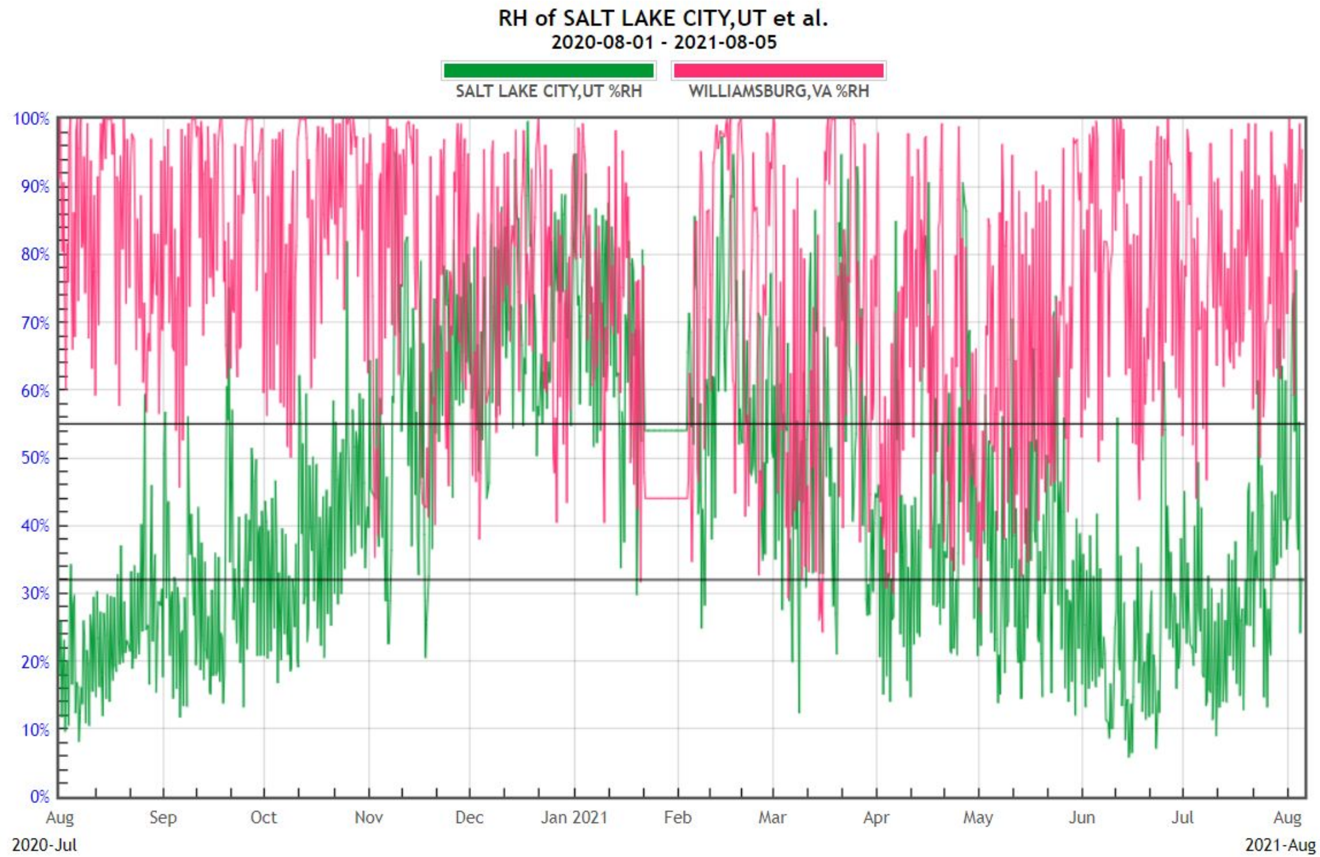
PLOTTED DATA IN THE E-CLIMATE NOTEBOOK SOFTWARE



Outdoor T data of Williamsburg, VA vs. Salt Lake City

Note- shoulder seasons

PLOTTED DATA IN THE E-CLIMATE NOTEBOOK SOFTWARE



Outdoor RH data of Williamsburg, VA vs. Salt Lake City

PLOTTED DATA IN THE E-CLIMATE NOTEBOOK SOFTWARE

Our limits for the Museum storage site are 66-70 degrees and 25-35% RH (but again, no way to control humidity). Our limits for the ECC are currently 54-58 degrees and 30-34% RH.

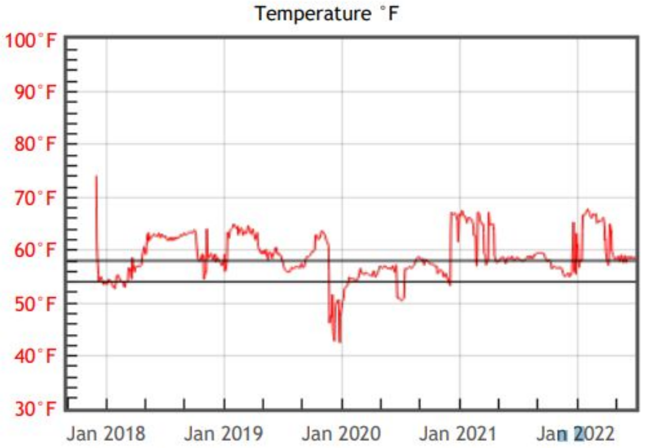
P2_16858
Park City Museum

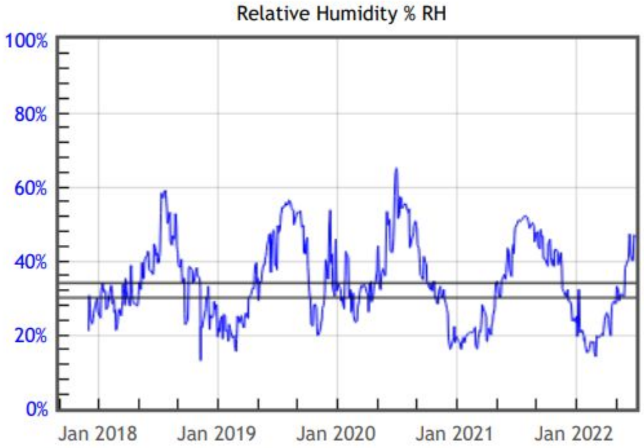
2017-11-30 to 2022-07-01
4 years, 7 months, 2 days

Preservation Environment Evaluation

Type of Decay	Risks & Metrics	Evaluation & General Comments
Natural Aging Chemical decay of organic materials	GOOD TWPI = 121	Slow rate of chemical decay in organic materials such as paper, leather, textiles, plastics and dyes
Mechanical Damage Physical damage to hygroscopic materials	RISK % DC = 1.92 % EMC min = 3.8 % EMC max = 10.6	Heightened risk of physical damage to any hygroscopic material, such as paintings, rare books, furniture, paper, leather, film, or color photos, due to extremely low or high levels of humidity, and / or excessive humidity fluctuation.
Mold Risk Mold growth in area or on collection objects	GOOD MRF = 0	Minimal risk of mold growth.
Metal Corrosion Corrosion of metal components or objects	RISK % EMC max = 10.6	Heightened risk of metal corrosion due to extended periods of high levels of humidity.

PLOTTED DATA IN THE E-CLIMATE NOTEBOOK SOFTWARE





Statistics

Temperature		Relative Humidity		Dew Point		T Limits		%RH Limits	
T°F Mean	58.9	%RH Mean	34	DP°F Mean	29.5	T°F < 54	7.7%	%RH < 30	38.2%
T°F Median	58.2	%RH Median	33	DP°F Median	28.2	T°F [54,58]	37.7%	%RH [30,34]	17%
T°F Stdev	4.3	%RH Stdev	11	DP°F Stdev	7.4	T°F > 58	54.7%	%RH > 34	44.8%
T°F Min	40.8	%RH Min	13	DP°F Min	10.4				
T°F Max	74.1	%RH Max	67	DP°F Max	50				

Overview Report - Created: 2022-08-01

PLOTTED DATA IN THE E-CLIMATE NOTEBOOK SOFTWARE

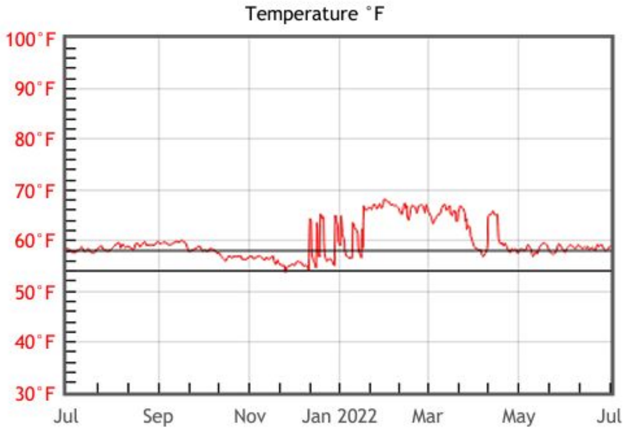
P2_16858
Park City Museum

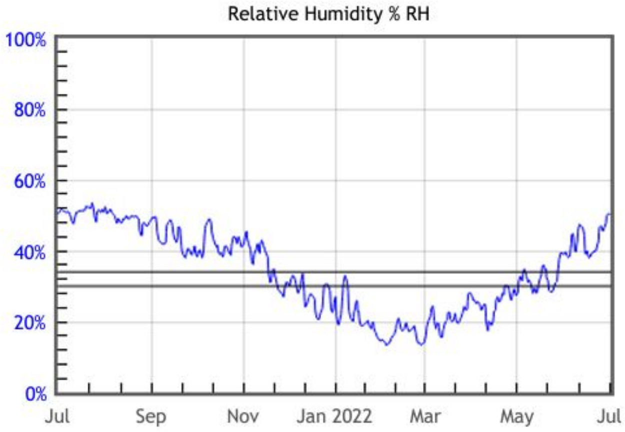
2021-07-01 to 2022-07-01
1 year, 1 day

Preservation Environment Evaluation

Type of Decay	Risks & Metrics	Evaluation & General Comments
Natural Aging Chemical decay of organic materials	GOOD TWPI = 115	Slow rate of chemical decay in organic materials such as paper, leather, textiles, plastics and dyes
Mechanical Damage Physical damage to hygroscopic materials	RISK % DC = 1.62 % EMC min = 3.8 % EMC max = 9.5	Heightened risk of physical damage to any hygroscopic material, such as paintings, rare books, furniture, paper, leather, film, or color photos, due to extremely low or high levels of humidity, and / or excessive humidity fluctuation.
Mold Risk Mold growth in area or on collection objects	GOOD MRF = 0	Minimal risk of mold growth.
Metal Corrosion Corrosion of metal components or objects	OK % EMC max = 9.5	Generally OK, but archeological or salt-encrusted metals may corrode due to extended periods of moderately high levels of humidity.

PLOTTED DATA IN THE E-CLIMATE NOTEBOOK SOFTWARE





Statistics

Temperature		Relative Humidity		Dew Point		T Limits		%RH Limits	
T°F Mean	59.8	%RH Mean	34	DP°F Mean	30	T°F < 54	0%	%RH < 30	39.8%
T°F Median	58.6	%RH Median	33	DP°F Median	29.4	T°F [54,58]	33.2%	%RH [30,34]	11.2%
T°F Stdev	3.6	%RH Stdev	12	DP°F Stdev	7.4	T°F > 58	66.8%	%RH > 34	48.9%
T°F Min	53.7	%RH Min	13	DP°F Min	12.7				
T°F Max	69.8	%RH Max	54	DP°F Max	42.4				

PLOTTED DATA IN THE E-CLIMATE NOTEBOOK SOFTWARE

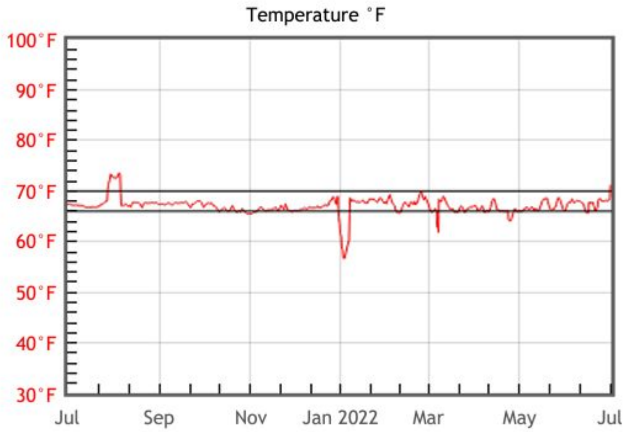
P2_16851
Park City Museum

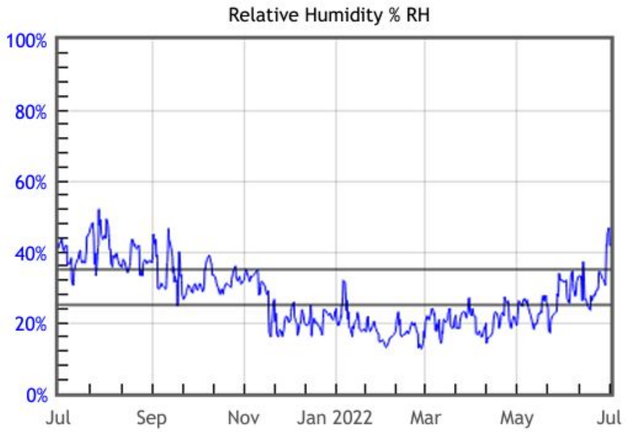
2021-07-01 to 2022-07-01
1 year, 1 day

Preservation Environment Evaluation

Type of Decay	Risks & Metrics	Evaluation & General Comments
Natural Aging Chemical decay of organic materials	GOOD TWPI = 84	Slow rate of chemical decay in organic materials such as paper, leather, textiles, plastics and dyes
Mechanical Damage Physical damage to hygroscopic materials	RISK % DC = 1.1 % EMC min = 3.9 % EMC max = 7.9	Heightened risk of physical damage to any hygroscopic material, such as paintings, rare books, furniture, paper, leather, film, or color photos, due to extremely low or high levels of humidity, and / or excessive humidity fluctuation.
Mold Risk Mold growth in area or on collection objects	GOOD MRF = 0	Minimal risk of mold growth.
Metal Corrosion Corrosion of metal components or objects	OK % EMC max = 7.9	Generally OK, but archeological or salt-encrusted metals may corrode due to extended periods of moderately high levels of humidity.

PLOTTED DATA IN THE E-CLIMATE NOTEBOOK SOFTWARE





Statistics

Temperature		Relative Humidity		Dew Point		T Limits		%RH Limits	
T°F Mean	66.9	%RH Mean	27	DP°F Mean	30.9	T°F < 66	23.4%	%RH < 25	46.9%
T°F Median	66.9	%RH Median	26	DP°F Median	30.1	T°F [66,70]	73.8%	%RH [25,35]	33.3%
T°F Stdev	1.8	%RH Stdev	9	DP°F Stdev	8.3	T°F > 70	2.8%	%RH > 35	19.9%
T°F Min	53.6	%RH Min	11	DP°F Min	10.9				
T°F Max	74.1	%RH Max	52	DP°F Max	54.2				

eClimateNotebook® - Image Permanence Institute - Rochester Institute of Technology - © 2022
Overview Report - Created: 2022-08-01

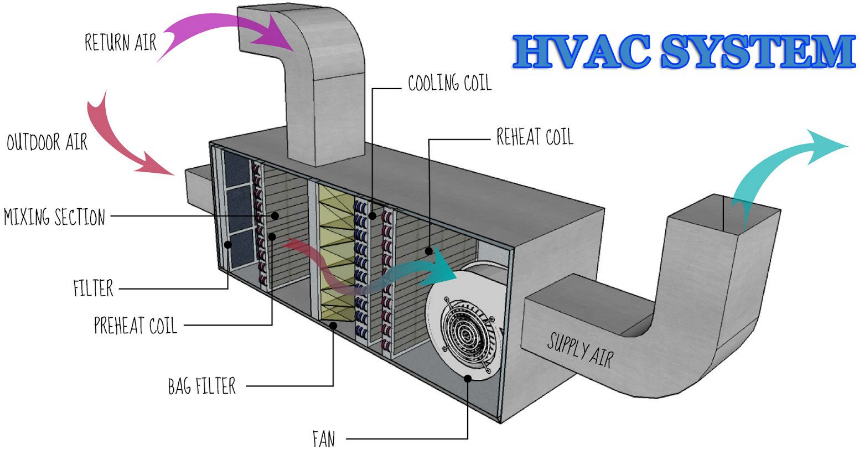
INTRODUCTION

HVAC SYSTEMS

ENVIRONMENT & BUILDING SYSTEMS

We are going to shift our focus to some nuts and bolts, one of the most important building systems that controls our collection environments.

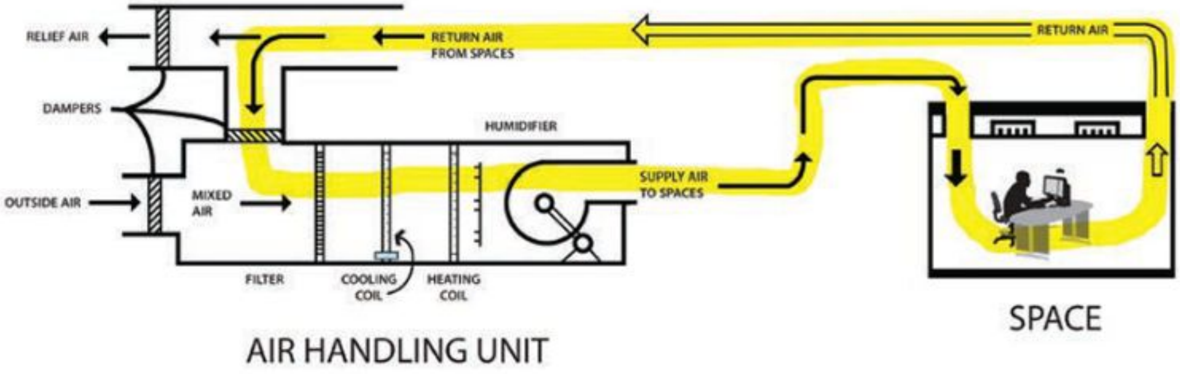
Heating, Ventilation, Air Conditioning (HVAC) is a system of air flow in multiple directions, and the many system parts that alter the condition of that air for a space.



ENVIRONMENT & BUILDING SYSTEMS

The Loop—Components of a Typical Air Handling Unit (AHU)

Climate control systems can best be understood if they are conceived of as a moving loop of air that enters the space, passes through it, leaves the space, returns to the place where the conditions of that air are appropriately altered (air handling unit) and returned again to the space (see diagram below). It is along this loop of moving air that temperature can be raised or lowered, humidity can be raised or lowered, filtration can occur, and outside air can be added or removed.

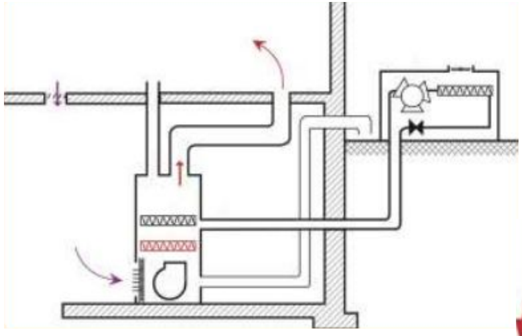


Excerpt from Image Permanence Institute, Sustainable Preservation Practices

ENVIRONMENT & BUILDING SYSTEMS

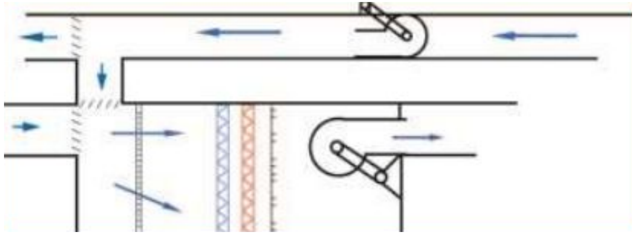
HVAC may also be referred to as a “Mechanical System”

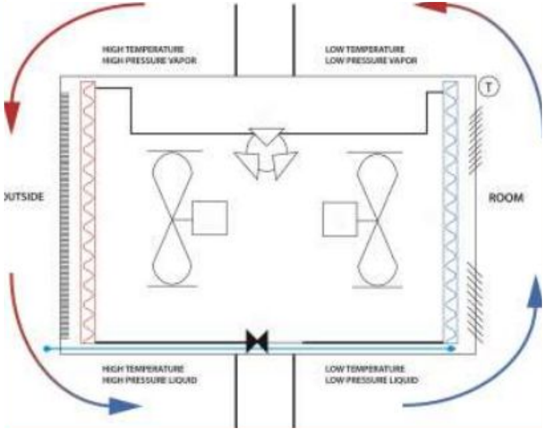
These are some of the key parts you will likely encounter



Forced Air System

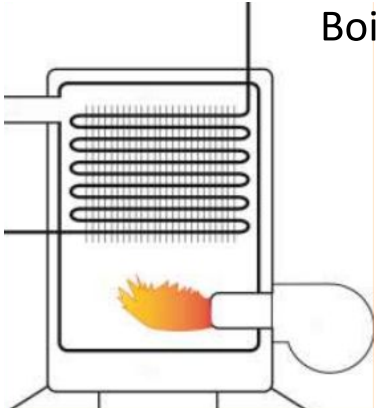
Air Handling Unit





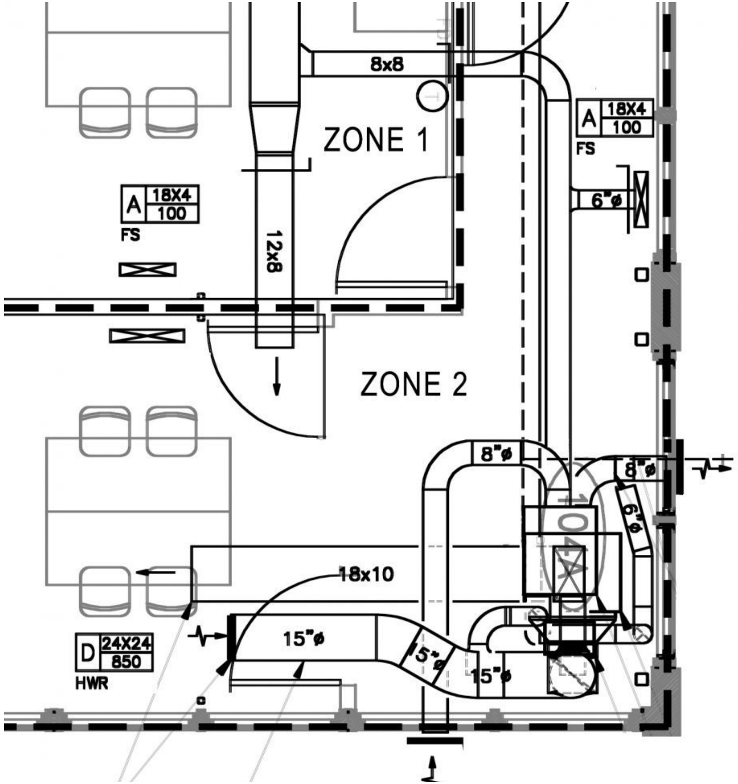
Air Conditioner

Boiler



Images from Image Permanence Institute

ENVIRONMENT & BUILDING SYSTEMS



Excerpt from architectural drawing plan

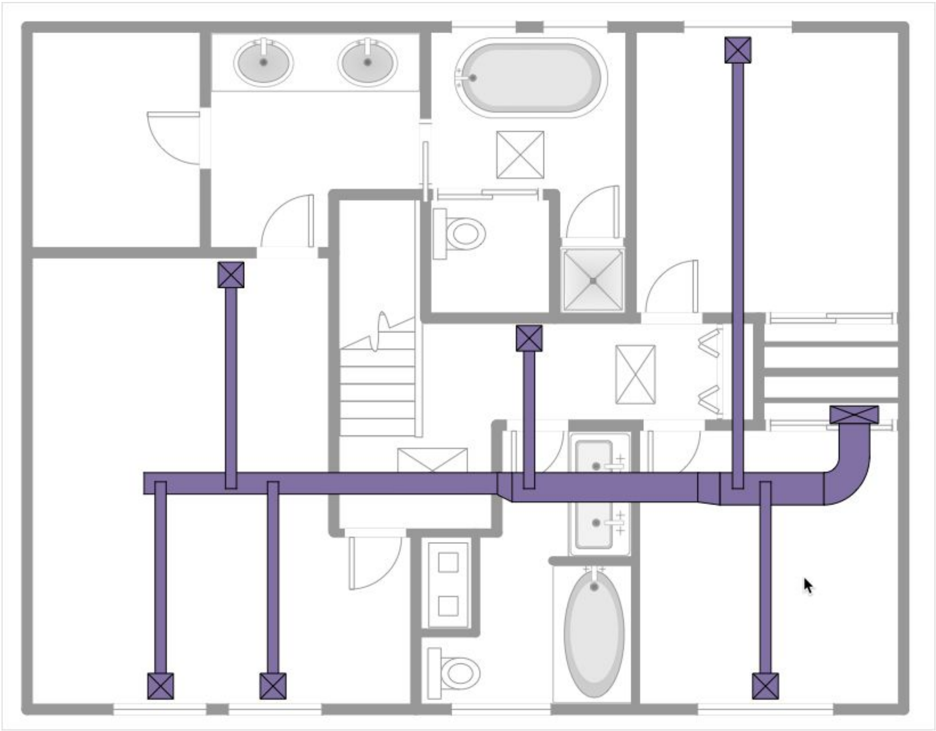
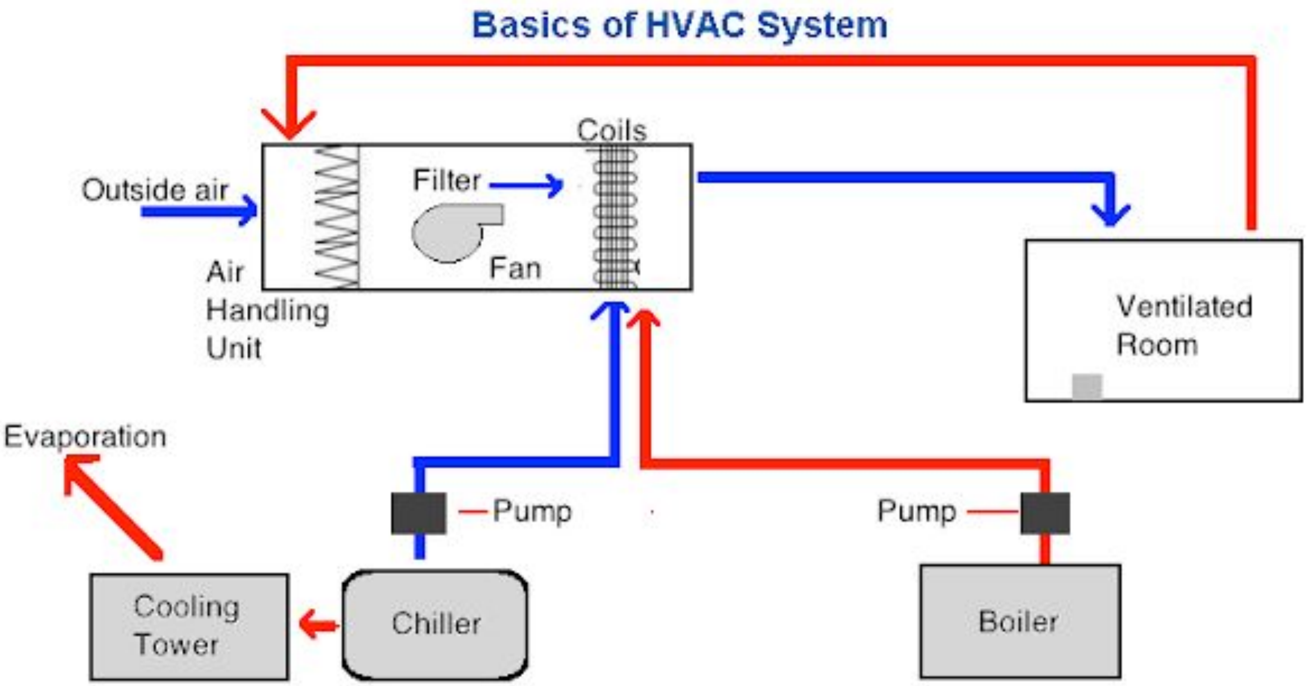


Diagram of hvac ductwork in a space

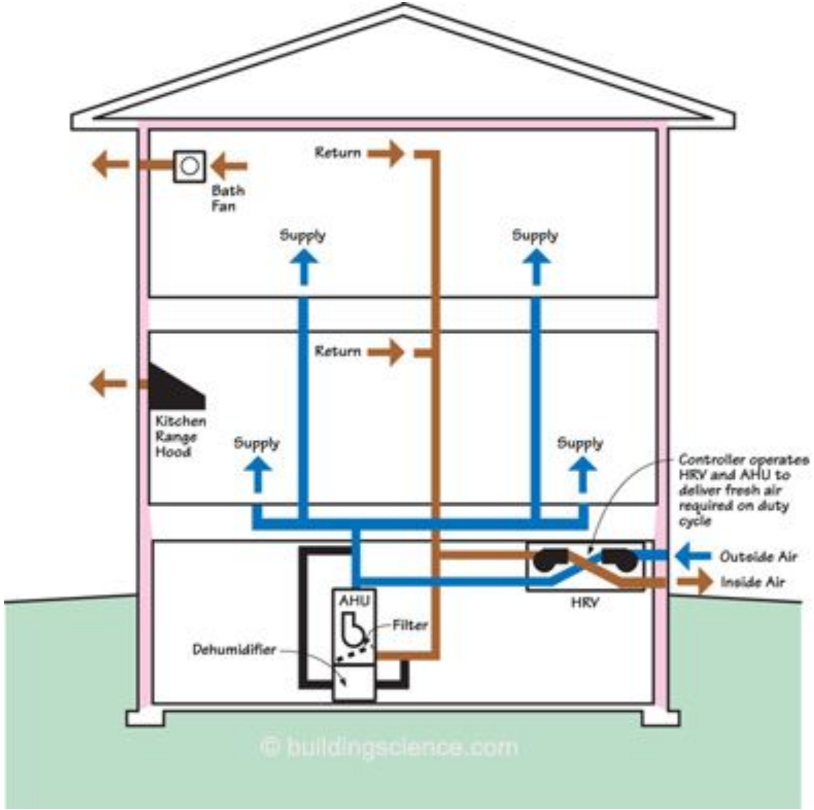
HVAC SYSTEM BASICS



These components illustrate a basic configuration of a basic AHU system with heating and cooling.

COLLECTIONS CARE AND CONSERVATION PLAN

Here is how a similar system might exist in a multi-story residential home. Note the "flows" inward and outward of air across the building envelope



Lunch (1 Hour)

ACTIVITY: BUILDING WALK THROUGH

This tour will highlight building systems and design decisions for the collections storage environment.

DISCUSSION:

- What did we see in terms of types of building systems (HVAC and beyond)?
- Which system components stood out to you? What did you recognize?
- Did you see your components of your own building's systems in this structure?
- What did you notice about building envelope?

COLLECTIONS PRESERVATION

BREAK (10 Minutes)

ACTIVITY: Environmental Monitoring Planning and Mapping at your home institution (20 min)
DISCUSSION (30)

Environment and Building Systems
Workshop Part B Activity
Park City Museum, Education & Collections Center
August 4, 2022

Environmental Monitoring Planning at your home institution
Using what you know about your building's internal systems, and what you don't know, this is an opportunity to brainstorm and roadmap what you need to find out or investigate further to manage your collections' environments. Use your building's floor plan to work through this, or create a floor plan if you don't already have one.

1. What components of your HVAC system can you identify?

2. What questions do you have about your HVAC system? What do you want to learn more about?

3. Who is your in-house HVAC resource (if anyone)? Can you think of someone in your community who could answer any questions?

Handout

Wrap-Up

- Reflections from the day
- Evaluation
- Homework

HOMEWORK

1. Begin to draft and outline Collections Care and Conservation Plan (focusing on both storage and display). Please send draft to Marie before next workshop.

2. Dust Monitoring and Environmental Monitoring at your home institution: Place a dust monitoring slide in an area of interest. Bring it with you to the next workshop (and/or images of your findings)

Thank you!

Marie Desrochers | mdesrochers@utah.gov

https://artsandmuseums.utah.gov/utah-collections-preservation/

This project was made possible in part by the National Endowment for the Humanities.

NATIONAL ENDOWMENT FOR THE HUMANITIES

UTAHHUMANITIES
Ideas in Action

Utah Division of Arts & Museums